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IDEAL VOUCHERS

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I. Introduction

When vouchers or other school choice reforms (such as charter schools) are discussed, certain worries arise. Will children with disabilities or limited English proficiency be barred from exercising choice because every school will find them too expensive to educate? Will choice increase the isolation of poor or minority children because it enables other children to choose schools that are inaccessible to them by virtue of high tuition or discrimination in admissions? Will there be rewards for good schools and will they be able to expand? Will there be safeguards against bizarre curricula? What will happen to children whose parents are so disengaged that they do not make an active school choice, even when it is fairly obvious that their current school is a failure?

These problems are not specific to school choice, they are generic problems of elementary and secondary schooling. Much of current school law focuses on these issues, and we do not have good solutions for most of them, despite years of legislation and court action. For instance, the isolation and inadequate education experienced by many poor children are the subject of perennial court battles, in which states are sued by parents who want them to revise their systems of school finance.[1] Also, although desegregation plans have been in effect for 25 to 30 years in most big cities, big cities' black students are no more integrated with white students than they were in the early 1960s.[2] In short, the right question is not whether these issues arise in school choice. The right question is whether school choice will make it harder or easier to address these issues.

This paper argues that it is inherently easier to solve a wide variety of problems with vouchers than with the traditional system of local public schools that receive revenues from local property taxes and state and federal grants. The reason is simple: the problems that arise are generated largely by

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[1] See Ladd, Chalk, and Hansen [1999] for an overall review or Hoxby [forthcoming] for an economic treatment.

[2] See Orfield [1996] and Reber [2001].

externalities and market failures. Vouchers offer greater opportunities to resolve the problems because vouchers are *prices* set by policy. Prices can be set so as to internalize externalities, thereby inducing families and schools to make decisions (in their own self-interest) that remedy what are essentially social problems. In this paper, I describe vouchers that take advantage of the problem-solving capacity of prices. In particular, I describe externalities and market failures that need to be solved; I describe the voucher for solving each; I show how one can obtain an initial set of externality-internalizing vouchers from current property price data; I describe an algorithm that adjusts the initial vouchers to ensure that externalities are actually internalized; I describe a mechanism that allocates students to their preferred schools and rewards schools that do a better job of attracting parents, given the same resources and access to students. I then take up less central problems: passive parents who do not make choices for their children, optimal school composition, rewards for schools that follow state guidelines, and allowing vouchers to be topped up.

A. A Practical Approach

I attempt to confine the paper to voucher procedures that are *feasible*. The title is "Ideal Vouchers," but the paper really focuses on vouchers that are as nearly ideal as is practical. Also, although the discussion is phrased in terms of "vouchers," everything could be written with charter schools in mind. Simply substitute "charter school fee" for "voucher." The voucher systems I discuss are universally available to students within a district, not (say) given to 1000 lucky students who win a lottery. Vouchers with enrollment constraints are not enacted because they have desirable qualities. They are enacted because they are cheap as policy experiments and because vested interests (such as teachers' unions) insist upon enrollment constraints in order to limit their own losses.

A side-effect of constraining the paper to be practical is that I give some weight to minimizing disruption to the current environment. For instance, I accept as much of the structure of current school finance as possible. I focus on the district as the unit that controls local finance and the state as the unit that controls categorical aid for the disabled, limited English proficient, *et cetera*.

Moreover, once one begins to consider the capacity of vouchers, it is tempting to describe vouchers that solve any number of social problems, including problems that currently seem so intractable that no one has tried to remedy them. This paper resists that temptation and has the more modest goal of describing vouchers that deliver the productivity benefits of competition while guaranteeing that social problems are, at a minimum, made no worse. In fact, the vouchers I describe would probably improve social problems somewhat, but there are good reasons for setting the standard at "do no harm" on the social front. First, the productivity of American schools is worsening, whereas problems like desegregation and adequate funding for poor students are either stable or improving.[3] Second, vouchers that attempted to internalize numerous externalities not contemplated by current school law would produce significant changes in the true prices faced by households. Such changes might create chaotic movement among schools and in property prices. The transition will be smoother if vouchers map into current school law. Third, I wish to avoid entering the debate over which social problems deserve to be remedied. The set of externalities that I consider are those, and only those, that one can identify in current school law. For instance, I consider racial externalities because race-based programs and formulas do currently show up in many districts' and states' laws. If such laws are overturned in the future, as seems possible, it may be less appropriate to consider racial externalities.

B. Vouchers and Mandates Differ, as Means of Solving Social Problems

There is an essential difference between how externalities are handled by a voucher system and the traditional public school system. Vouchers can be set to price externalities, so that someone who has a negative externality imposed upon him receives compensation for it. The traditional public system allows largely unpriced externalities to be imposed on parents who are incumbents in some school. The hope is that these parents will find it so expensive to switch schools that they will allow themselves to be imposed

[3] See Hanushek [1994] or Hoxby [2001].

upon and (thereby) permit the burden to be distributed. In fact, the reliance of the current system on unwary incumbent parents is obvious in the debate over school choice. Opponents of choice routinely suggest that there are parents who would, if they were able, escape the burden that they are bearing for society.

To make this point concrete, consider the education of disabled children, who impose an externality on their school fellows because they are unusually expensive to educate. The addition of disabled children tends to reduce the regular per-pupil spending experienced by non-disabled children in their district (or increase the taxes required to fund a given level of regular per-pupil spending).[4] In the traditional public system, a district must accommodate all disabled children who reside in its attendance area by providing them with the services listed in their Individual Education Plans. Mandatory accommodation translates into forcible imposition of the costs on the district's population. There is no procedure for redress or compensation of parents who experience a negative shock to the inputs their children experience.

There are two problems with the traditional system of imposing externalities. First, it is *ex post* inequitable. Households are arbitrarily selected to bear a burden that should be spread more optimally across society. In fact, household selection is not just arbitrary: it is regressive. It is regressive because savvy, well-off people are least likely to let themselves be imposed upon and are least constrained by their economic circumstances to bear unforeseen burdens. Second, while the traditional system of imposing externalities works in the short-run, it works poorly in the long-run. As soon as people register the fact that residents of a certain school's or district's attendance area are being imposed upon, people take the burden into account when they consider moving into the area. Property prices fall, monetizing the loss of wealth imposed on the incumbents and making it impossible to fund regular per-pupil spending and the services in the Individual Education Plans at the previous level. The system is out of equilibrium and someone will

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[4] For an introduction to the finances of education for the disabled, see Cullen [1999].

move, plunging the system into another round of trying to impose the externalities.[5]

II. Simple Externalities

In this section, I describe several externalities that can be identified in a typical state's school law. All of these externalities are "simple externalities," where a student is defined as imposing a simple externality if his presence imposes a cost that does not vary with the enrollment composition of the school. For instance, it might cost a school $10,000 to fulfil a disabled student's Individual Education Plan. The externality is simple if the $10,000 amount does not vary with the school's number of students, percentage of students who are black, and so on. In truth, many externalities are probably not simple, but there are two reasons for focusing initially on simple externalities. (I take up complex externalities in a later section.) First, states apparently believe it would be impractical to incorporate anything but simple externalities into school law. For instance, a school's compensation for a disabled child typically depends on that disabled child's presence, not on interactions between that child's presence and the presence of other children. Focusing on simple externalities is, thus, in keeping with my goal of being practical. Second, one can think of a simple externality as being an average value of the true externality imposed by a student. As will be seen below, the problem-solving capacity of vouchers mainly relies on getting these average values right. It will become clear that the voucher procedure can work reasonably well when there is actually variation, from school to school, in how externalities function.

I focus on "protected categories" of students. Students who belong to a protected categories are those (1) whom states recognize as imposing a negative externality and (2) for whom states can be bothered to prescribe an allocation of the burden, even an arbitrary allocation. A disabled student belongs to a protected category. A student who is simply naughty does not, even if he is universally recognized as a

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[5] The last few sentences contain straightforward implications of the Tiebout [1956] model. A good formal treatment may be found in Epple, Filimon, and Romer [1984].

pain in the neck. Students who convey positive externalities are rarely if ever protected. Therefore, I do not consider vouchers that make students pay for the privilege of being exposed to a positive externality-generating student.[6]

A. Disability

The disabled are the most obvious example of negative externality-imposing students. This is because they are entitled to services, spelled out in their Individual Education Plans, that are generally more costly than those to which non-disabled students are entitled. (An Individual Education Plan is a legal agreement about the services that a school must provide to a specific disabled student. It is written with the advice of school administrators, counselors, psychologists, parents, and attorneys.) One can price, with reasonable accuracy, the extra cost of fulfilling an Individual Education Plan. The externality imposed is a simple function of this extra cost.

In most states, disabled students are classified according to the type and intensity of their disability. These classifications tend to be reasonably good indicators of how much a disabled student will cost, although the details of Individual Education Plans make costs vary within classifications. From now on, I describe disabled students as though their classifications corresponded closely to the cost of educating them. To the extent that current classifications do not fulfil this condition, I assume that the classifications could be altered. In my examples, I describe learning disabled students and physically disabled students as though each group had one cost associated with it. This is obviously a simplification.

B. Limited English Proficiency

Limited English proficiency is, essentially, a special case of disability. Like disabled children, children with limited English proficiency are entitled to a variety of services that exceed those to which

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[6] There is no reason, except for political feasibility, why such vouchers that internalize positive externalities could not exist. An alert reader can construct them by making a few alterations to the vouchers described below.

regular students are entitled. The level of services is related to a student's knowledge of English. For instance, students with partial English proficiency are often assigned to an English-as-a-Second-Language, while students with no English proficiency are often assigned to Bilingual Education. One can price the extra cost of providing the required language services. The externality imposed is a simple function of this extra cost.

One thing that makes English proficiency differ from disability is that the services to which a child is entitled often depend on how many other children belong to his language group in his district. In order to treat limited English proficiency as a simple externality, it is necessary to classify students by the services that they are entitled to receive, not just by their home language and knowledge of English.

C. Race

If one says that white parents discriminate against minority students as school fellows for their children, this is no more than saying that white parents act as though minority children impose negative externalities. Minority students may directly impose negative externalities if their racial background makes them systemically more expensive to teach. However, the discussion of race in schools suggests that the negative externalities associated with minority students may be largely or entirely indirect–that is, not emanating the students themselves. If school staff, say, have bad attitudes towards minority students and consistently under-perform in schools where minority students are enrolled, then externalities associated with minority students emanate from staff. If bureaucrats in charge of allocating school inputs routinely discriminate against minority students, then externalities associated with minority students emanate from bureaucrats. (Desegregation cases often cite evidence that suggests that black students were assigned worse buildings, less qualified teachers, and so on.) Any form of discrimination against minority students that spills over onto their school fellows is a negative externality. It may be useful to think of the externality as the cost of bribing people to provide a minority student with the same inputs as a non-minority student would receive.

Although it is difficult to name the sources of negative externalities associated with minority students, it is easy to find implicit claims about them in current school law. Minority students are a protected category in most states' school laws. I take this situation as given, simply declaring that school law suggests that there are negative externalities associated with protected minorities.

D. Poverty

Poor students impose negative externalities because their parents cannot afford to give them necessary services and inputs that well-off children receive from their parents. For instance, in order to concentrate in class, poor students may need to be provided with meals at school. Schools may need to buy books, supplies, and even computers for poor children that would be provided by well-off parents. Poor students are more likely to use after-school programs and health services provided by a school. Because their parents often lack stable housing and employment, poor students tend to move often among schools. This movement imposes administrative and teaching costs on schools.

For these reasons and more, poor students impose a negative externality, the size of which depends on the cost of making them equivalent to a student whose well-off parents provide a stable home that is more rich in inputs.

III. Obtaining Initial Amounts for the Vouchers

The key to obtaining initial amounts for the vouchers is recognizing that house prices capitalize externalities imposed upon residents. Consider two school attendance areas identical in all respects except that area A has a disabled population that makes up 10 percent of enrollees and area B has a disabled population that makes up 0 percent of enrollees. We expect house prices to reflect the difference in the costs imposed upon (and, thus, the lower regular per-pupil spending experienced by) households in area A. More precisely, suppose that households in area A pay $200 less per year in implied rent and property taxes based on their current house value. The savings of $200 per year should be exactly enough to

compensate them for the disproportionate burden they bear. If every household contains one school-aged child, then the "true" per-pupil spending experienced by a regular education student in area A is the school's statutory per-pupil spending minus $200. If the average household expects to have one school-aged-child-year for every two years it lives in the area, then the true per-pupil spending experienced by a regular education student in area A is the school's statutory per-pupil spending minus $400. A household's ratio of school-aged-child-years to living-in-area-years is a useful variable that I denote φ. Note that φ is a function of both the household's number of children and its expected stay in the area.

B. Hedonic Regressions for Obtaining Initial Add-Ons to the Basic Voucher

In the example above, it was easy to determine the value of the burden that special education imposes on local households because there was only one externality to consider and the two attendance areas were identical in every other respect. Needless to say, the real world is more complicated. One must try to sort out the effect of several externalities upon house prices while controlling for every other characteristic of houses. In other words, one must estimate a hedonic equation with annual housing costs (implied rent plus property taxes) as the dependent variable and measured externalities and house characteristics as the independent variables. Implied rent is usually estimated by multiplying the house's current market value by the sum of the interest rate and the house's depreciation rate. The basic hedonic equation is:

$$(1)\qquad [P_{ij}\cdot(r+\delta)] + P_{ij}\tau_j = \alpha_0 + \alpha_1\frac{PPS_j}{\varphi_j} + \alpha_2\frac{\%SpEd1_j}{\varphi_j} + \alpha_3\frac{\%SpEd2_j}{\varphi_j} + \ldots + \alpha_k SqFt_{ij} + \alpha_{k+1}Acres_{ij} + \ldots + \alpha_{k+m}DistanceCity_{ij} + \alpha_{k+m+1}DistancePark_{ij} + \ldots + \epsilon_{ij}$$

where i indexes the house and j indexes the school attendance area. P_{ij} is the house's current market value,

r is the interest rate, δ is the depreciation rate of housing, τ_j is the property tax rate, φ_j is the average φ among area households, PPS_j is the school's statutory per-pupil spending, $\%SpEd1_j$ is the share of students who are physically disabled, and $\%SpEd1_j$ is the share of students who are learning disabled. The omitted terms with coefficients α_4 through α_{k-1} are measures of the other externalities discussed in the previous section of this paper. The terms with coefficients from α_k through α_{k+m-1} record the value of house characteristics, such as a house's living area ($SqFt_{ij}$) and lot size ($Acres_{ij}$). The terms with coefficients starting with α_{k+m} record the value of a house's locational and neighborhood characteristics, such as a house's distance from the city ($DistanceCity_{ij}$) and the nearest park ($DistancePark_{ij}$).

In the above equation, the externalities are expressed in a way that has an assumption embedded in it and that allows their coefficients to be translated easily into add-ons for a basic voucher. The numerator of each externality measure is written in the following way: the externality-imposing students as a share of all other students. This numerator assumes that externalities are simple. It also assumes that what matters to students is their share of the costs of an externality, their probability of experiencing an externality, or the share of their time that they spend experiencing an externality.

The denominator of each measure is φ_j, the average value of the variable φ (the ratio of school-aged-child-years to expected living-in-area-years) for households in the area. If the average household expects to experience school-related externalities half of the years it lives it in the area, say, then an externality that it values at \$50 per year must be worth \$100 per school year *experienced*.

To see how this structure for the externality measures makes add-ons easy to calculate, suppose that a physically disabled student's presence raises a typical school's enrollment of physically disabled students (as a share of all students) by 5 percent. If one gives physically disabled students add-ons of $0.05 \cdot \alpha_2$, then their school fellows will typically be compensated for the externality.

B. Solving the Identification Problem

There is an identification problem that plagues hedonic regressions like (1): omitted variables that are correlated with right-hand-side variables can generate biased estimates of the value of externalities, house characteristics, and local amenities. In particular, one worries that there are unobserved neighborhood characteristics such as neighborhood norms about the value of education and treatment of public spaces. Such omitted neighborhood characteristics affect house prices and can be correlated with the measured right-hand-side variables. Naturally, the more informative the set of right-hand-side variables is, the less bias one expects from omitted variables.

Because the purpose of the regression is obtaining *initial* values for vouchers that will be adjusted using a market-like mechanism, one might decide that it was satisfactory to estimate regression (1) as it stands, using all available variables. Alternatively, as shown by Black [1999], one can restrict the sample of houses to those that are on the boundary of schools' attendance areas and can include boundary fixed effects in the regression:

$$(2)\qquad [P_{ij}\cdot(r+\delta)] + P_{ij}\tau_j = \beta_0 + \beta_1 \frac{PPS_j}{\varphi_j} + \beta_2 \frac{SpEd1_j}{\varphi_j} + \beta_3 \frac{SpEd2_j}{\varphi_j} + \ldots + \beta_k SqFt_{ij} + \beta_{k+1} Acres_{ij} + \ldots + I^{boundary}\,\gamma + \upsilon_{ij}, \quad \forall\, ij \in \{boundary\,1, \ldots, boundary\,N\}.$$

With this specification, one controls for all neighborhood characteristics, because houses on a boundary necessarily share the same neighborhood. Black, for instance, compares houses that are within 250 feet of a boundary. While equation (2) almost certainly produces estimates that are less subject to bias than equation (1) does, equation (2) is considerably more demanding of precise geographic information about the location of houses and boundaries. There is also a loss of precision when one estimates equation (2) because the restricted sample of houses is small. Obtaining initial voucher amounts that are precise and

unbiased has a benefit: the adjustment mechanism will require fewer iterations before it finds vouchers that successfully internalize externalities. We shall see that each iteration requires some action from schools (though not from parents), so it is useful to minimize the number of iterations. However, one must not over-emphasize the importance of the initial vouchers. They only need to be fed into the adjustment mechanism once, when the voucher scheme starts up. In subsequent years, the previous year's voucher amounts will probably be the best starting values for the adjustment mechanism.

C. Setting the Initial Vouchers

The state, having estimated a regression like equation (1) or (2), is left with a vector of estimated coefficients. The estimated coefficients on the externalities (α_2 through α_{k-1} in equation 1, β_2 through β_{k-1} in equation 2) are particularly important. The state declares this set of estimates to be add-ons that apply to each category of externality-imposing students. One can then back out the "true" basic per-pupil expenditure experienced by each student, using each school's share of students in each externality-imposing category. This "true" basic per-pupil expenditure becomes the basic voucher. For instance, if a school's only externality-imposing students were physically disabled students and b_2 was their add-on (based on β_2), then one would solve for the school's "true" basic per pupil expenditure by solving for x_j in the equation:

$$[x_j\,(1 - \%SpEd1_j)] + [(x_j + b_2)\,\%SpEd1_j] = pps_j \,. \tag{3}$$

More generally, one solves for the basic voucher by solving for x_j in the equation:

$$\begin{aligned}[x_j\,(1 - \%SpEd1_j - \%SpEd2_j - \ldots - \%Biling_j)] + [(x_j + b_2)\,\%SpEd1_j] + \\ [(x_j + b_3)\,\%SpEd2_j] + \ldots + [(x_j + b_{k-1})\,\%Biling_j] = pps_j \,.\end{aligned} \tag{4}$$

In equation (4), $\%Biling_j$ is the percentage of students in need in of bilingual education and the ellipses represent all of the other externalities discussed in Section II. Nothing in this formulation precludes the possibility that a given student belongs to more than one externality-imposing group. For instance, a

student could get a voucher equal to $x_j+b_2+b_{k-1}$ if he were physically disabled and in need of bilingual education.

It is important to note that the basic voucher incorporates all factors that affect school finance, apart from those based on categories of students. The basic voucher will reflect local demand for school spending. The basic voucher will also reflect non-categorical revenues that a district receives–for instance, school finance equalization revenues.

D. An Empirical Example of Initial Vouchers

In this section, I present an example of estimating initial vouchers based on schools in the Detroit metropolitan area.

[Preliminary drafts of this paper do not show this example, in order to minimize the possibility that preliminary estimates are used by the public. The example is presented in oral presentations.]

IV. The Voucher Adjustment Mechanism

In this section, I describe a market-like mechanism for adjusting the vouchers so that schools become indifferent to a student's category. I also show a simulation of how the mechanism works.

Start with a set of initial vouchers, obtained from estimating a regression like equation (1) or (2). That is, start with a basic voucher for each school attendance area plus a set of add-ons. Parents should know the basic voucher for their area. As we shall see, however, parents do not need to know the add-ons.

Require parents to rank local schools that accept vouchers, in order of preference. Also require them to "apply" to each school that they rank. Their application need only contain basic information (name, gender, and so on) and information about the student's externality-imposing categories, if any. As with any choice system, however, the more effort that parents devote to assessing schools (for instance, matching their child's needs to the school's curriculum, looking for effective administrators), the better the system will eventually work. (Later, I discuss a back-up system for students whose parents cannot or will

not take an active role in choosing a school for them.) In this case, it is not only useful for parents to have information about the schools; it is also useful for schools to have information about the students who are applying to them.

Require each school to rank the students in the order of its preference. If the initial vouchers happen to be exactly right, which is unlikely, the schools' lists will show that–while schools prefer specific students within each category–they do not prefer whole categories of students. That is, schools' preference orderings will show them to be generally indifferent between enrolling a physically disabled child with the larger voucher, say, and a regular education child with basic voucher. More precisely, if one tests each school's preference ordering against the multinomial distribution (in which the category shares are the true category shares among its applicants), each school's ordering will not reject the distribution *regardless of the part of the ordering that one tests*. For instance, suppose that one divides a school's ordering into, say, quarters. Then, none of the four quarters will reject the multinomial distribution. More generally, one needs a statistical test for the school having sampled from its multinomial distribution in a non-random order. There are non-parametric statistical tests for this problem that are based purely on rank. See Randles and Wolfe [1991]. In the spirit of practicality, however, I suggest the following test, which is easy to implement using multinomial logit estimation.

Assign each category of student an arbitrary number $c=0, ..., C$. The value of each number does not matter, since multinomial logit assumes that the categories are unordered. For ease of interpretation, though, basic students (students who do not fit into any externality-imposing category) should be assigned to category 0. The applicants of each school are its observations, and the category number assigned to each student is the data upon which the dependent variable for the multinomial logit regression is constructed. For instance, the category assignment vector for applicants $k=1,...,K$ to school j might look like:

$$Category_{kj} \equiv \begin{bmatrix} Basic \\ SpEd1 \\ Basic \\ SpEd2 \\ Biling \\ SpEd1 \\ Basic \\ Basic \\ \dots \end{bmatrix} \equiv \begin{bmatrix} 0 \\ 1 \\ 0 \\ 2 \\ C \\ 1 \\ 0 \\ 0 \\ \dots \end{bmatrix}$$

The above vector shows only the first eight students in the school's preference ordering; a real vector would obviously be longer. The preference rank assigned to each student is the sole independent variable in the regression, apart from the constant. The multinomial logit model lets the probability that a given student belongs to a group *c* depend on his rank, according to the following functional form:

$$Prob(Category_{kj} = c) = \frac{e^{lamba_0 + \lambda_1 \cdot rank_{kj}}}{1 + \sum_{c=1}^{C} e^{\lambda_0 + \lambda_1 \cdot rank_{kj}}} \quad for\ c = 1, 2, \dots, C,$$

$$Prob(Category_{kj} = 0) = \frac{1}{1 + \sum_{c=1}^{C} e^{\lambda_0 + \lambda_1 \cdot rank_{kj}}}.$$

Estimating the multinomial logit equation allows us to determine whether students' category assignments systemically affect their rank. Put another way, if rank has a statistically significant association with the probability that a student belongs to a certain category, then it must be true that the school is not indifferent among categories of students. In order to perform this test, we need only see whether the coefficient on the rank variable is statistically significantly different from zero for a category of students. This is because the probability that a student belongs to category *c*, as opposed to the basic category, is a simple function of the coefficients:

$$\ln\left[\frac{Prob(Category_{kj}=c)}{Prob(Category_{kj}=0)}\right] = lamba_0 + \lambda_1 \cdot rank_{kj} \ .$$

Moreover, the sign and size of the coefficient will tell us whether and how much the category is preferred to basic students. A positive, statistically significant coefficient on rank tells us that the category is preferred to basic students; the larger the coefficient, the more the category is preferred. A negative, statistically significant coefficient on rank tells us the opposite. Naturally, one can be more or less stringent about deviations from category-indifference by varying the level at which one declares a coefficient to be statistically significant. For instance, the 0.25 level of statistical significance requires schools to show more category-indifference than the 0.10 level.

Notice that, strictly speaking, schools do not even need to know which students applied in order to construct their orderings. Schools could order all possible students and the mechanism would work. However, the effort of school staff would be wasted if they were to order students who had not applied.[7]

Suppose that the add-ons are insufficient to make schools indifferent between regular education students and a particular type of externality-imposing students–say, physically disabled students. Then, the coefficient for that category of students will generally be negative and statistically significant in schools' multinomial logit results. The state should raise the add-on for this category and then adjust the basic voucher so that vouchers comply with the adding up constraint (equation 4). Then, the state should ask schools to re-order their applicants. This process should iterate until no school's ordering rejects the null hypothesis of category indifference. Alternatively, the state could set a more lenient threshold, such as only

[7] Also, the schools do not need to be supplied with parents' preference orderings. Indeed, the lack of parents' preference orderings will prevent parents and schools from engaging in complicated strategic behavior, such as the behavior that takes place in the early decision process for college admissions. For a description of such behavior, which requires verifiable information about students' preferences or an enforceable restriction that students apply to only one school, see Avery and Zeckhauser [1999]. It is quite easy to prevent such strategic behavior in a voucher program by having the voucher program refuse to supply verified information about parents' preferences.

5 percent of schools having orderings that reject the null of category indifference.

In summary, the algorithm for adjusting the voucher is as follows. It requires just a few seconds of computer time, except for the schools' having to order their applicants.

1. Set a significance level for the tests, such as 0.25. Set a threshold for the share of schools that will be permitted to reject the null hypothesis of category indifference in their multinomial logit regressions. This threshold may be zero percent. Set a factor for adjusting the vouchers add-ons in each iteration. The factor should be inversely related to the estimated multinomial logit coefficient for the category in question. (I give an example below.)
2. Run a multinomial logit equation using the data from each school's preference ordering of applicants.
3. For each category of students, record the share of schools that show a statistically significant preference for (against) the category.
4. If the share of schools that show a statistically significant preference for a category exceeds the threshold, proceed with the following steps. If not, stop.
5. If the category is preferred in the majority of schools that had statistically significant coefficients, lower the add-on for the category using the adjustment factor. If the category is disfavored in the majority of schools that had statistically significant coefficients, raise the add-on using the adjustment factor.
6. Back out the basic vouchers that are consistent with the new set of add-on vouchers.
7. Require schools to re-order students, taking into account the students' new voucher amounts.
8. Repeat steps 2 through 7 until standard for stopping in step 4 is met.

At this point, it is useful to step back and consider the preference orderings generated by the algorithm. The algorithm guarantees that the preference orderings exhibit category-indifference (or near

category indifference, if the thresholds and significance levels are lenient). That is, the basic voucher and add-ons must be such that schools do not systemically prefer to enroll one category of their applicants over another. The add-ons prevent discrimination against externality-imposing categories of students by counterbalancing (and thereby internalizing) the externality that schools perceive. There is no simple way for a school to "game" this algorithm because, as we shall see, the allocation mechanism described in the next section guarantees that a school's likelihood of enrolling a particular student depends on how highly it ranks him. If schools believe that a category of students is mis-perceived and that their add-on is too high, then the schools must give the category of students relatively high ranks in order to get them. This action will drive down the add-on. If a school does not rank students according to its true preferences, it runs the risk of enrolling numerous students whom it does not prefer. (See next section for detail on this point.)

Although the algorithm prevents discrimination against categories of externality-imposing students, it does not attempt to prevent other preferences from revealing themselves. In particular, schools may prefer certain students within each category: John Smith may be universally preferred to Tim Foster within the basic category of students. Also, students may prefer certain schools: there is nothing in the algorithm that pressures students to rank schools in a particular way. Benjamin Franklin School may be universally ranked above Thomas Edison School. As we shall see in the next section, it turns out to be very useful to allow preferences for individual students and for schools to be expressed.

The following simulation shows the algorithm in action. Suppose that the following conditions prevail.

(a) There are 500 students who must be allocated to 5 schools, each of which has 100 places.

(b) Each student has a desirability factor that is constant across schools. This desirability factor is drawn randomly from a normal distribution with mean 5 and variance 2.

(c) 100 of the students impose a small negative externality equal to -1. 50 of the students impose a large negative externality equal to -3. The remaining 350 students impose zero externalities.

Students are randomly assigned to an externality category.

(d) Each student has an idiosyncratic match quality with each school. This match quality is drawn randomly from a uniform distribution over [0,2).

(e) Schools rank students based on the sum of their desirability factor, the externality they impose, their idiosyncratic match quality, and their voucher add-ons.

Clearly, the externality-internalizing voucher add-ons in this situation are 1 for the students who impose an externality of -1, and 3 for the students who impose an externality of -3. Suppose that the initial add-ons, estimated using property value data, are 0.6 and 3.9. Let the threshold for rejecting a school's ranking be a stringent 0.25 level of significance. Let the add-ons be adjusted according to the rule: $\text{add-on}_{\text{this iteration}} = \text{add-on}_{\text{last iteration}} \bullet (1 - \text{multinomial logit coefficient} \bullet 100)$, where the multinomial coefficient is the one that applies to the category for which the add-on is being adjusted.

The results of the algorithm are as follows. In the first round of multinomial logit testing, every school's ranking is rejected–for both types of externality–at the 0.10 level. In other words, rank is a statistically significant predictor of category at the 0.10 level, in every school. Both add-ons are adjusted: 0.6 becomes 0.79 and 3.9 becomes 2.70. In the second round of multinomial logit testing, one school's ranking is not rejected, even at the 0.25 level. One school has its ranking for the -3 externality rejected, but does not have its ranking for the -1 externality rejected, even at the 0.25 level. The remaining three schools have their rankings rejected for both externalities, at the 0.10 level. Both add-ons are adjusted: 0.79 becomes 0.87 and 2.70 becomes 3.21. In the third round of multinomial logit testing, one school's ranking is not rejected, even at the 0.25 level. Two schools have their ranking for the -3 externality rejected, at the 0.25 level. Two other schools have their ranking for the -1 externality rejected, at the 0.25 level. Both add-ons are adjusted: 0.87 becomes 0.93 and 3.21 becomes 3.10. In the fourth round of testing, none of the schools' rankings are rejected, even at the 0.25 level. The procedure therefore stops.

How well does the algorithm work? One measure of the schools' category indifference is whether

externality-imposing students are spread evenly across schools' final rank-order lists. The following tables show how the students who impose externalities are spread.

Table 1: Number of -3 Externality Students in Each Quintile of Schools' Rank Order Lists

	school 1	school 2	school 3	school 4	school 5
rank of 1 to 100	11	9	10	10	9
rank of 101 to 200	7	13	10	7	8
rank of 201 to 300	11	7	10	12	13
rank of 301 to 400	14	12	12	12	13
rank of 401 to 500	7	9	8	9	7

Table 2: Number of -1 Externality Students in Each Quintile of Schools' Rank Order Lists

	school 1	school 2	school 3	school 4	school 5
rank of 1 to 100	22	15	26	23	20
rank of 101 to 200	25	23	18	15	24
rank of 201 to 300	17	25	16	22	15
rank of 301 to 400	18	18	16	22	17
rank of 401 to 500	18	19	24	18	23

Tables 1 and 2 show that the -3 and -1 externality students are spread quite evenly. In particular, externality-imposing students are not notably overrepresented in the lowest ranked quintiles, which is what one fears would happen if the add-ons were too small for category-indifference. They are also not notably overrepresented in the highest ranked quintiles.

V. Allocating Students to Schools and Rewarding Efficient Schools

At this point, most of my work has been completed for the simple externality case. This is because, having obtained school preference orderings that are category-indifferent, I can rely on a known mechanism to turn the preference orderings into an allocation of students to schools. The mechanism is

often called the Gale-Shapley mechanism, after Gale and Shapley's description of the mechanism with applications to college admissions and marriage. The mechanism is equally associated with Roth [1984], who demonstrated that the National Intern Matching Program used by hospitals and medical interns since 1953 is an example of the mechanism. Indeed, Roth presents evidence that the mechanism works very well in practice. It is good that the mechanism enjoys both familiarity and practical use because policy makers would be averse to exposing children to a mechanism that had even a small probability of becoming unstable or producing unexpected outcomes.

The mechanism is simple to describe. The spirit of school choice is to give students choice among schools, so I describe the version of the mechanism that produces an outcome in which each student is assigned to the school that he prefers the most among his achievable alternative schools. (In the alternative version, each school gets the students that it prefers the most among its achievable alternative students. The alternative version would be appropriate if the spirit of school choice were to allow schools to choose students.)

First, examine only the first choice of each student. A few schools may be especially sought after and thus heavily oversubscribed, looking just at the first choices. Most schools will probably be undersubscribed (looking just at the first choices). If school j is oversubscribed, then assign it its N_j most preferred students, where N_j is the total number of students it wants to enroll. If school j' is undersubscribed, then assign it all students whose first choice it was. Reset each school's "counter" for the number of school places it has left. A few schools will have no places left; most schools will have some, but fewer than N_j, places left; a few schools may have all of their N_j places left.

Some (perhaps many) students will not have been placed in the last step because their first choice school was filled before it got to their name on its preference ordering. Examine the second choice of all unassigned students. Again, some schools may be oversubscribed, looking at students' second choices and their remaining school places. Some schools will probably be undersubscribed. If school j is

oversubscribed, then assign its most preferred students to its remaining places. If school *j'* is undersubscribed, then assign it all students whose second choice it was. Reset each school's "counter" for the number of school places it has left.

Repeat the last step as many times as necessary, continuing at each stage with the next choice (third choice school, fourth choice school, and so on) of students who have not yet been placed. Needless to say, this mechanism would actually be performed by a computer, nearly instantaneously.

The basic properties of the resulting allocation are known. For proofs, see Roth [1984].

A. Stability

The allocation is stable. That is, there does not exist a student *k* and a school *j* such that the student *k* prefers school *j* to the school to which he was assigned, and school *j* prefers student *k* to one of the students that it actually admitted.

B. Students' Choice Maximized

The allocation is such that each student *k* is assigned his most preferred attainable school (where a school is attainable if there is a stable allocation in which the student could be assigned to the school). Put another way, every student does at least as well under this allocation mechanism as he could do under any other stable allocation mechanism.

This property is important because it tells us that the mechanism maximizes students' school choice, subject only to the constraint that students must inevitability crowd one another out at schools that are oversubscribed.

Note, as well, that nothing restrains students from making their choices freely. If many bilingual students want to attend a school with a special language emphasis, there is nothing to prevent all of them from listing it as their first choice. If many students want to attend a school with a core knowledge curriculum, there is nothing to prevent their listing it first. To the extent that students do not all get their first choices, it is purely because they displace one another.

The voucher adjustment mechanism guarantees that one category of students can never systemically displace another category. That is, no category of students can be segregated involuntarily. Voluntary self-segregation can exist, however, and may have benefits, as in the case of a school that emphasizes bilingual instruction or the arts.

What will the allocation look like? All schools will tend to have similar shares of students in each category, with a few dissimilarities driven by voluntary self-segregation. Because vouchers vary with a student's category, all schools will tend to have similar per-pupil spending–with a few dissimilarities also driven by voluntary self-segregation.

C. Rewards for and Expansion of Efficient Schools

The allocation is such that each school j is assigned its N_j lowest attainable students (where a student is attainable if there is a stable allocation in which the student could be assigned to the school). If school j is undersubscribed at the end of the allocation process and enrolls only N_j' students, then it is assigned its N_j' lowest attainable students.

This property might seem unfortunate for schools–even if it is an inevitable result of trying to maximize students' (as opposed to schools') welfare. This property is, however, very useful. It reminds us that schools can get more and less preferred allocations of students *within* each category, even though the voucher adjustment mechanism induces schools to be category-indifferent. A school that gets its more preferred students is rewarded in a myriad of ways relative to a school that get its less preferred students. More preferred students tend to be more able, less disruptive, more engaged, and more pleasant to teach. In other words, more preferred students are a *reward* for a school that is systemically preferred by parents in spite of its (the school's) getting no more resources than any other school. Such rewards are useful both because they give schools an incentive to raise productive efficiency and because they encourage efficient schools to expand and inefficient schools to contract.

Generating higher productive efficiency is a primary goal (probably the most important goal) for

school choice reforms, given American schools' parlous level of productive efficiency–compared either to other countries' schools or compared to their own productive efficiency in the recent past. Schools need incentives to be productively efficient–that is, to produce the maximum value given the budgets that they spend. If a school is not satisfied with its rewards under the allocation mechanism, it can improve its rewards, but only by improving its pool of attainable students. A school improves its attainable pool by raising its productive efficiency–that is, by making itself more attractive given the money it spends–so it ends up higher on students' preference orderings.

A school that is being rewarded is likely to find expansion attractive. The marginal students whom it would admit if it were to raise N_j would be students relatively high up on its preference ordering. A school that is not being rewarded is far less likely to expand; indeed, it may contract. Its marginal admits tend to be far down on its preference ordering. Notice that, if all schools reach high levels of productive efficiency and are approximately equally preferred by parents, then the allocation mechanism will assign approximately equal enrollees to each. There are two basic methods by which all schools might reach relatively high and equal productive efficiency. Inefficient schools might improve by offering more attractive programs, hiring better teachers, and reforming poor administrative rules. Alternatively, efficient schools might expand (perhaps to multiple campuses) and inefficient schools might contract.

D. Revealing True Preferences

The last property of the allocation is that students and schools have little or no incentive to give false preference orderings. More precisely, the allocation procedure gives no school an incentive to misrepresent its true first choice. It also gives no student an incentive to misrepresent his true first choice. If schools and students do not have much information about the preferences of other schools and students (as seems likely), then they will not be able to construct strategic preference orderings that will allow them to do better than their true preference orderings. Furthermore, in the case in which students and schools do

have enough information to strategically misrepresent a choice on their list, the allocation that obtains if they distort a choice in a rational, strategic manner is stable, given their true preferences. That is, if schools and students are highly informed about others' preferences, then it is not a dominant strategy for all of them to state all of their choices truly (except their first choices, for which it is always a dominant strategy to state truly). If, however, they misrepresent their preferences in order to be strategic, then the Nash equilibria which result will be stable, even when they scrutinize the equilibria in the light of their true preferences.

This final property is useful because it suggests that schools and students are not very likely to misrepresent their true preferences. Strategic behavior is likely to be limited, especially because it will be difficult for anyone to gauge the behavior of many students, a calculation which would be necessary if one were "play off" their preferences. Moreover, if anyone should engage in strategic behavior, it will not destabilize the allocation.

E. A Simulation

Recall the simulation of the last section, in which category-indifferent lists were obtained for five schools over 500 students. Recall also that the students had only idiosyncratic preferences, based on match quality, for the five schools. No school had higher productive efficiency and was therefore systematically preferred. If one runs the students' and schools' preference orderings through the allocation mechanism described above, 95 percent of the students are placed with their first choice school, 3 percent are placed with their second choice school, and the remaining 2 percent are placed with their third or fourth choice school. Externality-imposing students are spread quite evenly across schools in the final allocation of students, as shown in Table 3.

Table 3: Allocation of Students to Schools

Allocation if Students were Uniformly Distributed	school 1	school 2	school 3	school 4	school 5

-3 Externality Students	10	8	10	10	12	10
-1 Externality Students	20	17	21	16	25	21
0 Externality Students	70	75	69	74	63	69

Now consider the somewhat more interesting situation where the schools do not have equal productive efficiency. In particular, suppose that the value of school 5 to students is 4 plus their match quality with school 5 (randomly drawn from the uniform distribution over [0,2)). Suppose that the value of school 4 to students is 3 plus their match quality with school 4 (randomly drawn from the uniform distribution over [0,2)). And, so on. School 5 is generally preferred to school 4, which is generally preferred to school 3, and so on down the list of schools.

If one runs the students' new preference orderings and the schools' preference orderings through the allocation mechanism, 31 percent of the students are placed with their first choice school, 18 percent are placed with their second choice school, 18 percent are placed with their third choice school, 15 percent are placed with their fourth choice school, and remaining 18 percent are placed with their fifth choice school. Fewer students are placed with their first choice school because their preference rankings are highly correlated, owing to the large differences in productive efficiency among schools. Nevertheless, externality-imposing students are spread quite evenly across schools in the final allocation of students, as shown in Table 4. Table 4 also shows the average value of students in a school, from the school's point of view. School 5 is rewarded with the highest average value students, school 4 with the next highest average value, and so on down the list of schools.

Table 4: Allocation of Students to Schools

Allocation if Students were Uniformly Distributed	school 1	school 2	school 3	school 4	school 5

-3 Externality Students	10	11	10	11	9	9
-1 Externality Students	20	22	21	17	23	19
0 Externality Students	70	67	69	72	68	72
Average Student Value		4.58	5.91	6.23	6.91	8.06

F. Summary

In summary, the allocation has many desirable properties. The procedure is simple for students and schools. Students' choice is maximized. Through voluntary self-segregation, students can take advantage of targeted curricula or special programs that need economies of scale to be sustainable. Yet, students' voluntary and decentralized choices cannot generate involuntary segregation of a category of students. Schools are rewarded for productive efficiency, and efficient schools find expansion more attractive than inefficient schools do..

VI. Passive Parents

In principle, school law could mandate that all parents submit preference orderings for their children. Indeed, in systems with mandatory intra-district choice (such as Cambridge, Massachusetts), the share of parents who initially resisted making active decisions about preference orderings dwindled after only a few years. Parents quickly became more active once they realized that, by being passive, they were effectively making a choice, but just not one that they necessarily liked.[8] Even if one is optimistic about passive parents becoming active, however, there ought to be safeguards in a voucher system for children

[8] See Petronio [1995].

whose parents cannot or will not create a preference ordering for them. Consider how one might construct such a safeguard.

Suppose that a child whose parent has given up his right to construct the preference ordering is assigned to a counselor. The counselor should be able to construct a preference ordering, taking into account the child's education needs and locational constraints. On the one hand, counselors have an advantage over parents, in that they may know more about programs and staff at area schools. On the other hand, one worries that counselors could be neglectful, so that the children with passive parents could end up in schools largely populated by other children with passive parents.

The appropriate response to such a worry is a statistical test of whether counselors rank schools similarly to parents. Counselors' rankings could be tested before being submitted to the allocation mechanism. An appropriate test is based on the difference between F_1 and F_2 where F_1 is based on the coefficient of concordance among parents' rankings and F_2 is based on the coefficient of concordance once group of rankers includes not only parents but also one or more counselors. The coefficient of concordance for the parents alone is:

$$W_1 = \frac{12\,S_1}{K_1^2\,J\,(J^2 - 1)}$$

where K_1 is the number of parents ranking the schools (that is, the number of students whose rankings are being concorded), J is the number of schools being ranked, and S_1 is a sum of squared deviations, as follows. For each of the J schools, compute the sum of the ranks given by the K_1 rankers. Compute the mean of these J sums-of-ranks. Obtain S_1, the sum of the squares of the deviations of the J sum-of-ranks around their mean. Note that, if there were perfect agreement among parents, then W_1 would be equal to 1. Repeat the exercise when the pool of rankers is the K_2, the number of parents plus one or more counselors. Obtain W_2. In general, coefficients of concordance (W) range from 0 to 1. F_1 and F_2 are given by

$$F_1 = \frac{(K_1 - 1)W_1}{1 - W_1} \qquad F_2 = \frac{(K_2 - 1)W_2}{1 - W_2}$$

and are distributed according to the *F* distribution with *K-1-(2/J)* degrees of freedom for the numerator and *(J-1)(K-1-(2/J))* degrees of freedom for the denominator.[9]

The key element of the test is the sum-of-ranks for each school. Its importance is intuitive. Simply put, one is testing whether adding the counselors' ranks makes for greater deviation from the mean sum-of-ranks. Brook and Upton [1974] and Fligner and Verducci [1988] present refinements of this test, which allow rankers to have characteristics that legitimately influence their rankings (location is the obvious influence in this case).

VII. Optimal School Composition and Rewards for Schools that Follow State Guidelines

So far, I have considered simple externalities–that is, externalities that are a function of a child's presence, but not a function of how his presence interacts with the presence of other children in the school. There are, however, a set of issues in which the presence of students is thought to interact such that there are socially optimal school compositions. A few examples will make this point clear. Consider neighborhood schools. It may be social welfare enhancing to have schools that draw students disproportionately from their localities because such schools are a locus for neighbors to interact and bond so that they support a variety of non-school local public goods, such as neighborhood safety and recreational opportunities for children. If neighborhood schools are important, then the presence of one local child in a school is worth more if other local children are there too.

Alternatively, it may be social welfare enhancing to have siblings attend the same school. Having

[9] This test is due to Kendall [1948], a classic treatment of rank statistics.

siblings attend the same school minimizes certain parental costs, such as transportation costs, transaction costs, and opportunity costs of participating in school activities. Parents whose children are grouped in a school may be more likely to volunteer or become a trusted repository of information about the school, on whom other parents can rely. Thus, the presence of one child in a school may be worth more if his sibling is there also.

Finally, there may be socially optimal racial, disability, or ability compositions of schools. At least in the past, a popular racial desegregation goal was for all the schools in a district to have the same black-to-white ratio of students as the district as a whole. Although the courts appear to be increasingly wary of such goals, it may be presumed that matching the district's black-to-white ratio was considered socially optimal school composition. Today, many districts have the goal of mainstreaming disabled students to the maximum extent possible. In other words, many districts apparently believe that the optimal school composition has disabled students spread as evenly as possible across classrooms. It is not the purpose of this paper to take a stand on optimal racial composition, optimal meanstreaming, or any other type of optimal school composition. I simply wish to point out that some current school policies already amount to an implicitly claim about optimal school composition. From now on, I shall simply take for granted that some districts, through a judicial or political process, have resolved on what optimal school compositions are. Can the voucher procedure be adapted to take such resolutions into account?

A. The Need for Optimal Composition Vouchers

First, it is not clear that the voucher procedure needs to be adapted. To the extent that optimal school compositions are generated by voluntary self-segregation (or the lack thereof), parents' orderings have already taken optimal school composition into account. Consider, for instance, neighborhood schools. Families themselves face many of the costs of sending their children to distant schools. Even if school bus transportation is entirely free, children must spend time in transit and parents must travel further to get to

school events. Moreover, families directly receive many of the benefits associated with neighborhood schools. Thus, it is far from obvious that families' preference orderings will be much different than the preference orderings they would form if they were to internalize all of the social benefits of sending their children to neighborhood schools. Similarly, families are directly hit by most of the costs of dispersing siblings and directly receive most of the benefits of grouping them. Families' preference orderings may, therefore, be close to what is socially optimal.

Moreover, the voucher adjustment mechanism makes involuntary segregation of a category of students impossible. Thus, white families cannot, simply through careful construction of *their* preference orderings, keep their children's schools relatively free of black children. Families of regular education students cannot construct their preference orderings so as to keep their children out of schools in which disabled children are mainstreamed. Schools will differ in racial composition (mainstreaming of disabled children) only if families with black (disabled) chidren *elect* self-segregation by constructing preference orderings that differ systematically from those of white (regular education) families.

In short, one ought not to adapt the voucher system if one believes that:

(1) families can calculate the costs and benefits of having their children attend schools with various enrollment compositions, and

(2) at least for students in a protected category, families' private costs and benefits are similar to the social costs and benefits.

B. Optimal Composition Add-Ons

There are two cases to consider with regard to optimal school composition. In Case One, the policy maker has an optimal school composition that he wants every school to satisfy equally. Examples would be each school having a black/white ratio and disabled/non-disabled ratio equal to those of the district. Policies that are equally desirable for all schools need not be only about the composition of enrollment. Case One also covers policies such as: all schools should administer standardized tests, all

schools should publish school report cards, or all schools should offer algebra by the seventh grade.

Suppose that the district makes the basic voucher very small (perhaps zero) and gives a *school-specific* add-on that depends on the degree to which the school satisfies the district's policy resolutions. For instance, the add-on could vary (continuously) with the inverse of the absolute value of the difference between the school's percent white and the district's percent white. The more punitive is the add-on with respect to deviations from the percent white goal, the more families' preference orderings will be driven by the school-specific variation in the voucher. In the extreme, all families' preference orderings will be the same, with the school rankings perfectly correlated with the school-specific vouchers. In this extreme, all schools will achieve approximately the district's black-white ratio. The universally top-ranked school will take its N_j most preferred students, who necessarily approximate the district's black-white ratio because schools' rankings are required to be category indifferent. The next most highly ranked school will then take its $N_{j'}$ most preferred students out of the pool that remains. They, again, will approximate the district's black-white ratio. And so on. Thus, all schools will tend to achieve the district's goal.

In this extreme case, although vouchers exist, parental choice is not meaningful. Parents' choices are dictated by the district's goals, and schools are rewarded only for fulfilling the district's goals, not for achieving higher productive efficiency in parents' eyes. That is, although vouchers can be used to achieve social goals that are odds with parents' goals, there is a trade-off between advancing such goals and allowing parents to have meaningful choice. Of course, it is only in the extreme case that parents have no meaningful choice. More generally, districts can use add-ons that have the structure mentioned (the add-on for which a school qualifies rises as the school approaches the goal), but that fall short of being dictatorial. That is, parents can be given some, but not overwhelming, incentives to make choices according to social preferences, rather than their own preferences. A district might have one add-on for schools' approaching the desired racial composition, another for approaching the desired mainstreaming of disabled children, and yet another for administering and publicizing standardized exams designed to test compliance with the

district's curriculum.

Case Two is optimal school composition that varies with the school, such as a preference that each school enroll its local children or a preference that siblings attend the same school. For case two, the district need only create add-ons that are student-school-specific. For instance, a family could get a sibling add-on for sending a second child to a school or get a neighborhood add-on that would vary inversely with family's distance from a school. Such add-ons would induce siblings (neighbors) to have similar preference orderings–in the extreme, identical preference orderings. *Within*-family or *within*-neighborhood, one is back in Case One.

C. Cautious Use of Optimal Composition Add-ons

I have already emphasized that optimal composition add-ons are not necessary if families, especially those whose students are in protected categories, enjoy costs and benefits of school composition that are similar to social costs and benefits. Put another way, many problems that initially appear to be optimal composition problems really involve only simple externalities, and do not require optimal composition add-ons.

Moreover, there are several reasons to be cautious about introducing optimal composition add-ons. First, creating add-ons for optimal composition problems is fundamentally different than creating them for simple externalities. In the case of simple externalities, we can rely on markets for evidence on the value of the externalities (as in Section III). We can also use pseudo-market mechanisms (as in Section IV) to refine our evidence. Problems of socially optimal composition do not arise, however, unless families' private calculations differ from those of society. Thus, actual markets generate relatively little evidence about the value of various compositions. While it is not impossible to construct pseudo-market mechanisms to reveal the value of school compositions, such mechanisms require social experimentation on a grand scale.

We might turn to non-experimental evidence on the value of various school compositions, but even the best such evidence provides little guidance. There is paucity of credible empirical evidence about

optimal school composition because studies are plagued by self-selection. Families self-select into schools, and it is difficult to disentangle the effects of group composition from the effects of the factors that lead families to group together in the first place. Non-experimental studies that credibly eliminate self-selection biases necessarily rely on natural experiments. Almost by definition, natural experiments are rare and not controlled by evaluators. Thus, many interesting school compositions are never tested by natural experiments.[10] Also, even the best non-experimental estimates have standard errors that are so large that one would hesitate to conclude that optimal group composition could not be achieved by parents' choices, once vouchers were adjusted to account for simple externalities.

Finally, although the availability of optimal school compositions add-ons could tempt policy makers to undertake ambitious social interventions, they must remember that they are ultimately constrained by parents' willingness to remain within the current system. School composition add-ons attempt to move parents away from the choices that they (parents) consider optimal. At some point, parents will move to less interventionist districts or use private schools with no voucher, rather than use voucher add-ons and accept the conditions attached to them.

In short, vouchers add-ons can be used to accommodate resolutions about socially optimal school composition. The structure that the add-ons should take is clear: a school-specific (student-school-specific) add-on that varies continuously with the inverse of the distance between the school (student-school combination) and the goal. However, there are a variety of reasons why such add-ons may not be as necessary as might first appear and why it is difficult to size such add-ons correctly.

VIII. "Topping Up" to Take Vouchers Across District Lines and Elsewhere

[10] For recent evidence on the effects of group composition, see Zimmerman [1999], Sacerdote [2000], Hoxby [2000], and Katz, Kling, and Liebman [2000]. All of the papers listed go to considerable lengths to remedy the selection problem, but none of the papers could be said to identify socially optimal group composition.

Thus far, I have assumed that vouchers are financed by individual school districts, and I have set aside questions like whether vouchers can be taken across district lines and/or topped up. A related issue that I have set side is whether vouchers should be financed at the state, rather than the district, level. In a few states, some of these issues do not arise because all (or most) school finance is conducted at the state level and the distinction among districts is therefore unimportant. These states include Hawaii, California, New Mexico, and Michigan. In most states, however, local and state governments share responsibility for financing schools.

State governments typically bear the major responsibility for financing programs for externality-imposing categories of students: the disabled, those with limited English proficiency, the poor, and minorities. Delegating such responsibilities to the state is a straightforward application of basic fiscal federalist reasoning: districts have difficulty financing programs for externality-imposing students because a generous program is likely to draw additional externality-imposing students into the district. The resulting incentives could generate a "race to the bottom," in which every district is unduly stingy to externality-imposing students so that it gets no more than its fair share of them.

Local districts typically bear the remaining responsibility for setting per-pupil spending. Again, this responsibility is justified by basic local public finance reasoning. District finance results in increased allocative efficiency to the extent that families, by choosing among districts, can choose the level of human capital investment that is most appropriate for their child. District finance allows variation in per pupil spending (and thus human capital investment) among families, but it also provides a means by which each family can spread the burden of its investments over its lifetime, rather than having them entirely concentrated in the period in which its children attend schools. Problems in allocative efficiency do arise with district finance–for instance, there is a missing capital market for poor families who want to finance optimal human investments in their children. Such allocative efficiency problems are best solved by policies, such as school finance equalization, that are effectively behind the scenes in this paper. Such

policies are automatically incorporated in a district's basic voucher.

Consider the voucher procedure described above. How should one finance the vouchers--at the state or local level? And, should students should be allowed to carry vouchers across district lines or top them up? In addition to wishing to incorporate known results from fiscal federalism and local public finance, I wish to describe a voucher procedure that causes as little disruption as is possible. In particular, current property values reflect districts' current financing of local public schools. A voucher scheme that shocked school finance would shock the property market.

It is fairly obvious that add-ons for externality-imposing categories of students should be determined and financed at the state level. Making the state responsible for externality-internalizing add-ons would minimize disruption by keeping categorical programs at the state level. Moreover, if districts were to determine the add-ons, each district would have an incentive to create programs that served only the most marginal externality-imposing students–for instance, a program for limited English proficient students that worked only for students who already had some English skills. The families who would want to live in the district would naturally have children who were only marginally eligible for the externality-imposing categories. As a result, the district could "legitimately" claim that its voucher adjustment mechanism required only very small add-ons to make schools category-indifferent. Families whose children had more serious needs would be deterred from moving to the district because the add-on for their child would fall. In short, a race to the bottom (in program intensity) would be an equilibrium.

States are also the logical level for financing add-ons that encourage schools to use the state's curriculum, testing, *et cetera*. If such programs are socially beneficial, their benefits are presumably internalized at the level of the state, which is therefore in the best position to calculate their value.

What about the basic voucher, however? Except in states with state-level school finance, district-level finance of the basic voucher would minimize disruption. District-level financing of the basic voucher would also allow human capital investments to vary among students, increasing allocative efficiency.

(Note that we are *not* considering how human capital investments might vary among protected student categories, only within categories.) However, district-financed vouchers require topping up if they are to significantly increase parental choice without creating a race to the bottom in basic vouchers.

Existing inter-district choice programs that do not require topping up, such as that of Massachusetts, can clarify these issues. In such plans, schools are asked to accept out-of-district students who bring with them per-pupil spending that is a function of their home district's spending. Such programs give families an incentive to move to districts with low per-pupil spending even if they intend to send their children to schools in districts with high per-pupil spending. Indeed, some inter-district choice programs did begin races to the bottom in local per pupil spending. These races were halted only when districts were able to decline participating (so that inter-district choice effectively ended).[11]

Suppose that students are allowed to carry vouchers across district lines, so long as their own families top up the voucher so that it equals the voucher in their destination district. Giving families this option expands their choices and may be particularly important for families in which different siblings need different human capital investments. Yet, this option does not allow a family to underpay by living in a district that finances a basic voucher that is lower than the regular tuition of the schools they intend to use. In fact, because the "topping-up" payments are due when the child is in school (rather than being spread over the parents' taxpaying life), families still have an incentive to live in a district that finances basic vouchers close to the regular tuition of the schools they intend to use. A family loses the consumption smoothing properties of a district-financed voucher if it attempts to underpay by living in a district with a small basic voucher.

So far, I have focused on schools that accept the vouchers of the district in which they are located, without requiring topping up. This is the condition under which publicly financed voucher schools and

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[11] See Armor [1997].

charter schools now operate. Should one allow vouchers to be used at schools that *require* topping up? Suppose that a private school's regular tuition charge is far greater than any district's voucher, so that no student can attend it without his parents paying a significant additional fee on top of the voucher. In such a school, the topping-up amount could be set so that the school's pool of applicants were an exclusive group who included few or no externality-imposing students. On the one hand, such a situation cannot be inherently wrong because it is the natural extension of district-financed vouchers. Simply consider a district that supports only one school and that has one school-aged child in each household. In such a district, financing a higher basic voucher is no different than setting a higher topping up amount. In practice, however, there are reasons to distinguish between a school that accepts a district's voucher and a school in which every student must top up the voucher. First, districts in metropolitan areas are generally significantly larger than a single private school, and they therefore necessarily contain a greater variety of students than a single school's applicant group would have to contain. Second, families pay for the voucher over their entire taxpaying lives, whereas the topping up payments fall in a short period of time, when parents are generally too young to be in their peak earnings years. Thus, by setting a high topping up payment, a school can easily discourage low income families from applying (compared to district's ability to use a high basic voucher amount to discourage low income families from moving in). Third, one reason for district-financed vouchers is continuity with the current system: this argument cannot be used in favor of schools that require significant topping up from every applicant.

If one wants to allow exist voucher schools to exist that require topping up, it is reasonable to install a safeguard that ensures that the topping up amount is not used primarily to make the school inaccessible to protected categories of students. A simple safeguard would be following: a school could accept vouchers *and* require topping up only if its category indifference were tested against its district's population, not against its applicant pool. In order to pass this test, a school that required significant topping up might have to offer scholarships to some students who would otherwise not apply because they

found the school inaccessible. For instance, a school might have to offer scholarships to some local poor students whose parents could not pay the topping up amount.

X. Conclusions

In this paper, I describe a procedure for constructing vouchers that–on the one hand–greatly increase parents' choice and the competition faced by schools, and–on the other hand–include safeguards against a variety of social problems. In fact, the voucher procedure described is likely to alleviate certain problems, such as the isolation of poor or disabled children, because it takes advantage of the externality-internalizing capacity of prices. The procedure is entirely practical and accommodates many of the school laws and institutional details of the current system. Parents and schools both have relatively easy roles. Parents need only rank schools according to their preferences. Schools must be willing to re-rank students a few times. Once the externality-internalized vouchers are obtained, the procedure relies on a tried allocation mechanism for assigning students to schools. It is relatively straightforward to modify the procedure to provide for passive parents, optimal school composition, incentives for schools that follow state guidelines, and the need for "topping up" so that vouchers can cross district lines.

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