

# RELIGIOUS EDUCATION AND SCHOOL VOUCHERS

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## ABSTRACT

We derive and calibrate a political economy model of education finance and school choice that explicitly incorporates a distinction between secular and religious households, and between non-sectarian and religious private schools. It leads us to conclude that religious households view tuition dollars paid to religious schools as almost twice as effective as education tax dollars. These findings indicate that vouchers restricted to non-sectarian schools, unless they are very large, will not have a significant impact on enrolment. However, smaller means-tested vouchers unrestricted to nonsectarian schools can, without raising taxes, induce large numbers of low-income families to switch to private religious schools while simultaneously increasing spending per pupil in public schools.

*Keywords:* public education, private education, religious schooling, school vouchers

*JEL classification:* H42, I22, I28

## 1. INTRODUCTION

In the United States, approximately 10% of schoolchildren (K-12) attend private schools, and five of every six private school pupils are enrolled in religious schools.<sup>1</sup> Opting out of public education in the United States does not reduce one's school-tax liabilities, hence parents who choose to send their children to private schools must view them as providing a better education. Yet average tuition in private religious schools is considerably lower than spending per pupil in public schools.<sup>2</sup> This suggests that parents who send their children to private religious schools implicitly value a dollar paid for tuition at a religious school as considerably more effective than a tax dollar spent on public education.

These observations bear directly on positive analyses of the impact of proposed school voucher programs on enrolment and spending. A lack of direct evidence on school vouchers has resulted in substantial effort being directed to gauging their likely effect by using observed patterns of school spending and enrolment to estimate the parameters of household utility functions.<sup>3</sup> However, to the best of our knowledge all previous efforts in this vein have ignored the religious dimension of private education in the United States. This must bias any such estimates, and undermine their accuracy in anticipating the impact of future reforms, especially if constitutional constraints prohibit the use of tax revenues to support religious education.

In this paper we address this issue directly, extending a political economy model of education finance and school choice to explicitly incorporate a religious dimension. It recognizes two types of households: religious and non-religious,<sup>4</sup> and three types of schools: public, private-religious and private-nonsectarian, and stipulates that religious households value a dollar of tuition for religious education differently than a dollar spent on secular education. Public spending levels are determined by majority voting that anticipates its impact on private enrolment rates, and a political-economic equilibrium is derived. The

model is then calibrated to observed empirical values, which yields an elasticity of substitution between education quality and other spending of  $-1.44$ , implying an equilibrium in which the median-income household is decisive. It further indicates that religious households view a tax dollar spent on (secular) public schooling as only 54% as effective as a dollar spent on tuition at a private religious school.

These results are then applied to assess the impact of school vouchers programs on enrolment, and on spending per pupil in public education. We find that when vouchers are restricted to non-religious schools they must be very large to have a significant effect on private enrolment, and their fiscal effect on public school spending per pupil is always very small, whether or not the vouchers are means-tested. The case for or against such vouchers thus needs to be made on other grounds, such as the competitive pressure they bring to bear on the public school system, the peer group effects that are generated by the movement of pupils between public and private schools, their cultural impact, etc.

Vouchers that are not restricted to non-sectarian schools should have more substantial fiscal effects. If the tax rate is held constant at its current rate, offering vouchers to all households for use in all schools can induce a substantial proportion of low-income households to switch to private religious schools and thus increase spending per pupil in public schools by as much as 9.5%.<sup>5</sup> Using a means test to limit the allocation of vouchers to lower-income families can further increase the fiscal benefits of the program, and without raising taxes generate an increase of as much as 15% in spending per pupil in public schools.<sup>6</sup>

Our emphasis on the religious dimension of private education is supported by many econometric estimates of the demand for private schooling that attribute a prominent role to religious factors (Clotfelter, 1976; James, 1987; Long and Toma, 1988; Hamilton and Macauley, 1991; Buddin et al., 1998). The theoretical model we use to analyze its implications extends the political economy model of education finance and school choice

developed by Rangazas (1995), Epple and Romano (1996) and Glomm and Ravikumar (1998). Our calibration of the perceived advantage of private religious schooling bears on Sonstelie's (1983) econometric estimate of the general advantage of private schools, and on direct comparisons of the relative efficiency of public and parochial schools by Coleman et al. (1982), Evans and Schwab (1995), Witte (1996) and Sander (1997), among others. Finally, our application of the model to school vouchers sheds light on similar applications by Hoyt and Lee (1998), Barse et al. (2000) and Chen and West (2001), from which the religious dimension is absent.

The structure of the paper is as follows: Section 2 defines and analyzes the model and derives its political-economic equilibrium, Section 3 calibrates it to United States data, Section 4 applies it to examine the effect of various school voucher programs, and Section 5 concludes.

## **2. FORMAL ANALYSIS**

### **2.1 Basic definition of the model**

Consider a population of households of measure one, indexed by  $i$ , with heterogeneous income levels  $y_i$ , and assume that each household comprises one parent and  $m$  children. The population is divided into two groups: a religious group  $R$  of measure  $r$ , and a non-religious group  $N$  of measure  $1 - r$ . We assume that both groups have the same income distribution, and denote its cumulative density function by  $F$ , its probability density function by  $f$ , its mean by  $\bar{y}$  and its median by  $y_m$ . Households derive utility from a consumption good  $c$ , our numeraire, and from the perceived quality of their children's education  $x$ , which we constrain to be uniform within the household. The utility function is

$$U(c, x) = \alpha c^{\delta/\delta} + (1 - \alpha) x^{\delta/\delta} \quad (1)$$

where  $\delta$  and  $\alpha$  are fixed, common parameters.

Public education is available free of charge to all households at a uniform quality  $\bar{x}$ , funded by a proportional income tax rate  $t$  levied on all households and determined by majority vote.<sup>7</sup> Private nonsectarian and religious schooling are available as alternatives to public schooling, and can be purchased from a competitively priced private sector in any desired quality, but doing so does not reduce one's tax liability.<sup>8</sup> We assume that education quality is proportional to spending-per-pupil within each school system,<sup>9</sup> and specifically stipulate that religious households view religious schools as providing more quality-per-dollar than secular schools, while non-religious households view them as providing less quality-per-dollar. The cost per pupil of a unit of education quality in a secular school, whether public or private, is assumed to be the same for both groups, and we denote it by  $p$ . Denoting by  $q$  the proportion of households that send their children to public schools, and assuming that it is always positive, the government's balanced budget constraint implies that the quality of public schooling is given by

$$\bar{x} = t \bar{y} / (q m p) \quad (2)$$

As we have assumed that  $m$  is uniform across households and unchanging, to simplify the exposition we choose education quality units in such a way that  $p = 1 / m$ .

The two groups differ in their assessment of religious schooling. We let  $\gamma < 1$  denote the relative advantage of religious schooling for religious households, i.e., religious households perceive the quality obtained by spending  $\gamma$  dollars on tuition for private religious schooling equal to that obtained by spending one dollar on (public or private) non-religious

schooling.<sup>10</sup> The cost of a unit of quality in religious schooling as perceived by religious households is then  $\gamma p$ . Non-religious households view religious instruction as a drawback. Hence for them the cost of a unit of quality in religious schooling is greater than  $p$ , and so they always send their children to secular schools, whether private or public.<sup>11</sup>

## 2.2 School choice

A household that sends its children to public school expects to have indirect utility:

$$U_{pu}(t, q^e, y_i) = \alpha [(1-t)y_i]^\delta / \delta + (1-\alpha) [\bar{x}]^\delta / \delta \quad (3)$$

where  $\bar{x} = t\bar{y}/(q^e m p)$  from equation (2), and  $q^e$  is the level of public enrolment that the household anticipates when choosing a school.

As non-religious households consider non-religious schools to be better than religious schools with similar spending levels, non-religious households always prefer private secular schooling to religious schooling. A non-religious household that sends its children to a secular private school solves:

$$\begin{aligned} \text{Max}_{c, x} U(c, x) &= \alpha c^\delta / \delta + (1-\alpha) x^\delta / \delta \\ \text{s.t. } c + x m p &= (1-t)y_i \end{aligned}$$

and has indirect utility<sup>12</sup>

$$U_{sp}(t, y_i) = g_0(\delta, \alpha) [(1-t)y_i]^\delta / \delta \quad (4)$$

Similarly, religious households consider religious schools to be better than non-religious schools with similar spending levels, and so always prefer religious schooling to private secular schooling.<sup>13</sup> A religious household that sends its child to a religious private school solves:

$$\begin{aligned} \text{Max}_{c,x} U(c,x) &= \alpha c^{\delta}/\delta + (1-\alpha) x^{\delta}/\delta \\ \text{s.t. } c + \gamma p m x &= (1-t)y_i \end{aligned}$$

and has indirect utility<sup>14</sup>

$$U_{rp}(t, y_i, \gamma) = g_1(\gamma, \delta, \alpha) [(1-t)y_i]^{\delta}/\delta \quad (5)$$

As opting out of public education does not reduce a household's tax obligations it must be aimed at obtaining a higher quality of education, and as education quality is a normal good, the households that opt out of public schooling will be those with higher incomes. Comparing (3) and (4), we find that for a given tax level  $t$  and anticipated public enrolment  $q$ , either all non-religious households prefer public education, or there exists a threshold income level  $y_N$  implicitly defined by

$$U_{pu}(t, q, y_N) = U_{sp}(t, y_N) \quad (6)$$

such that all non-religious households with income below  $y_N$  send their children to public schools and all those with income above  $y_N$  send their children to (secular) private schools.

The public enrolment rate in the non-religious group is then

$$q_N = F(\underline{y}_N(t, q)) \quad (7)$$

Similarly, religious households choose between public and religious schooling, and so for a given tax level  $t$  and anticipated public enrolment  $q^e$ , either all religious households prefer public education, or there exists a threshold income level,  $\underline{y}_R$ , implicitly defined by

$$U_{pu}(t, q^e, \underline{y}_R) = U_{rp}(t, \underline{y}_R, \gamma) \quad (8)$$

such that all religious households with income below  $\underline{y}_R$  send their children to public schools, and all those with income above  $\underline{y}_R$  send their children to private religious schools. Public enrolment among religious households is then

$$q_R = F(\underline{y}_R(t, q^e, \gamma)) \quad (9)$$

and total public enrolment is<sup>15</sup>

$$q = r q_R + (1 - r) q_N \quad (10)$$

Substituting (7) and (9) in (10) we obtain the equilibrium condition

$$q = r F(\underline{y}_R(t, q, \gamma)) + (1 - r) F(\underline{y}_N(t, q)) \quad (11)$$

which stipulates that the actual public enrolment rate equals the anticipated rate.

Partial differentiation of (6) and (8) reveals that  $y_N$  and  $y_R$  are both decreasing in  $q$ , and as  $F(y(t, 0)) \geq 0$  and  $F(y(t, 1)) \leq 1$  there exists an equilibrium value of public enrolment  $q$  that equates anticipated and actual enrolment rates, implicitly defined by (11). Partial differentiation of (6) and (8) reveals also that  $y_N$  and  $y_R$  are both increasing in  $t$ . Total differentiation of (11) then yields

$$\begin{aligned} dq/dt &= [r f(y_R) \partial y_R / \partial t + (1-r) f(y_N) \partial y_N / \partial t] / \\ &[1 - r f(y_R) \partial y_R / \partial q - (1-r) f(y_N) \partial y_N / \partial q] > 0 \end{aligned} \quad (12)$$

so (11) implicitly defines public enrolment as an increasing function of the tax rate.

### 2.3 Political equilibrium

The education tax rate is determined politically by a majority vote of households, each household voting so as to maximize its anticipated utility. A tax rate is in political equilibrium if there is no other tax rate that is preferred to it by a majority of households in pairwise comparison. We characterize such equilibrium tax rates.<sup>16</sup>

We can derive the tax rate preferred by each household by comparing the greatest utility it can derive from private schooling—secular or religious—at a zero tax rate, with the maximal utility it can obtain from public schooling at the tax rate of its choice.<sup>17</sup> This tax rate is characterized by the first-order condition

$$dU_{pu} / dt = -\alpha (1-t)^{\delta-1} y^\delta + (1-\alpha) \{ \bar{y} / [q(t) p m] \}^\delta t^{\delta-1} [1 - \eta_{qt}] = 0 \quad (13)$$

where  $q(t)$  and  $\eta_{qt} = (dq/dt)/(q/t)$  are derived from equations (11) and (12). Taking the partial

derivative of  $dU_{pu}/dt$  with respect to  $y$ , we find that when the preferred tax rate decreases with income among all households that prefer a positive tax rate, i.e., when  $\delta > 0$ , existence of an equilibrium is assured by the single-crossing property (Gans and Smart, 1996), and the decisive household, earning an income of  $y_d$ , is the median income household.<sup>18</sup>

$$F(y_d) = 1/2 \tag{14}$$

Conversely, when  $\delta < 0$  the preferred tax rate increases with income among all households that prefer a positive tax rate, leading to the formation of an “ends against the middle” coalition. The poor, in opposition to the middle class, prefer less schooling for their children and join forces with the rich who would rather send their children to private schools and set a zero tax rate.<sup>19</sup> When this is the case the income of the decisive household,  $y_d$ , satisfies:

$$r [F(y_R) - F(y_d)] + (1 - r) [F(y_N) - F(y_d)] = 0.5$$

Rearranging terms and applying equation (11) we obtain:<sup>20</sup>

$$F(y_d) = q - 0.5 \tag{15}$$

As long as there is some private education, i.e., as long as  $q < 1$ , this decisive household earns less than median income.

Thus in equilibrium three equations determine the three unknowns  $t$ ,  $q$ , and  $y_d$ : equation (11) identifies the margin between public and private education; equation (14) or (15) identifies the decisive voter; and equation (13) characterizes the preferred tax rate of the decisive voter, provided it is positive. We will assume that these equations have a unique

solution, and that the chosen values of  $t$  and  $q$  are strictly positive. We allow the data to determine which type of equilibrium holds: median income or ends against the middle.

### 3. CALIBRATION

We calibrate the model to average United States data on public spending and on religious and private non-religious enrolment. Positing a lognormal distribution of income,  $\ln y \sim N(\mu, \sigma^2)$ , median income is  $y_m = \exp(\mu)$  and mean income is  $\bar{y} = \exp(\mu + \sigma^2/2)$ , which we solve for  $\mu$  and  $\sigma$ . In 1998, mean United States household income was \$52,513 and median household income was \$38,885,<sup>21</sup> implying  $\mu = 10.568$  and  $\sigma^2 = 0.6009$ . Denoting the probability density function of the standardized normal distribution by  $\phi$  and its cumulative density function by  $\Phi$ , and incorporating the lognormal specification in the equilibrium equations, (11) and either (14) or (15), we have:

$$q = r \Phi\{[\ln(\underline{y}_R(t, q, \bar{y}, \gamma)) - \mu] / \sigma\} + (1 - r) \Phi\{[\ln(\underline{y}_N(t, q, \bar{y})) - \mu] / \sigma\} \quad (11a)$$

and either

$$y_d = y_m \quad (14a)$$

if a median income equilibrium holds; or, if an ends against the middle equilibrium holds

$$\Phi\{[\ln(y_d) - \mu] / \sigma\} = q - 1/2 \quad (15a)$$

Setting  $q = 90.1\%$ , the public enrolment share in school year 1997/8,<sup>22</sup> we substitute the

observed values of  $q$ ,  $\mu$  and  $\sigma$  in equations (14a) and (15a) to obtain the income of the decisive voter under the two alternative equilibria. The income of the decisive voter under an ends against the middle equilibrium is  $y_d = \$32,015$ , and under a median income equilibrium it is  $y_d = y_m = \$38,885$ . We set  $r$  equal to 40%, the share of the population 18 years old and over who “attended a church or synagogue in the last seven days” (Statistical Abstract of the United States, 2000, Table 75).<sup>23</sup> In addition, we set the share of households that opted for religious education equal to its value in 1997/8,

$$r(1 - q_R) = r[1 - F(y_R(t, q, \gamma))] = 0.08357 \quad (16)$$

and set the share of households opting for private non-religious education equal to its value in 1997/8,

$$(1 - r)(1 - q_N) = (1 - r)[1 - F(y_N(t, q))] = 0.01543 \quad (17)$$

Public expenditure per pupil in 1997/8 was  $p\bar{x} = \$6,189$ , and  $m$ , the ratio of pupils to households, was approximately 0.5 (Digest of Educational Statistics, 2000, Tables 41, 63, 169) implying a tax level of  $t^* = p\bar{x}m/q/\bar{y} = 5.31\%$ .

Substituting (6) in (16) and (8) in (17), and requiring that  $t^* = 0.0531$  must satisfy equation (13) under either (14a) or (15a), we now have three equations in the three unknowns  $\alpha$ ,  $\delta$  and  $\gamma$ , under the alternative equilibrium assumptions, “median income” and “ends against the middle.” Solving under the assumption that the median income household is decisive yields a positive value of  $\delta$ , which is consistent with this type of equilibrium. (Solving under the alternative assumption that the decisive household satisfies  $F(y_d) = q - 1/2$

also yields a positive  $\delta$ , which is not consistent with an ends against the middle equilibrium.) The calibrated values of the household preference parameters are then:  $\delta = 0.31$ ,  $\alpha = 0.87$  and  $\gamma = 0.54$ , implying that religious households perceive religious schools to be 46% more effective than non-religious schools in providing education quality. Our value of  $\delta$  implies an elasticity of substitution of  $-1.44$ , which is somewhat larger in magnitude than Fernandez and Rogerson's (1999) range of values, based on variation in spending levels among school districts in California, of between  $-0.80$  and  $-0.95$ .<sup>24</sup>

#### **4. SCHOOL VOUCHERS**

In this section we apply our results to gauge the effect of a selection of hypothetical school voucher programs on taxes, enrolment rates, public spending per pupil, and household welfare. We allow these programs to vary in three dimensions: the size of the voucher; whether its use is restricted to non-sectarian schools or it is "unrestricted"; and whether it is offered to all households ("universal") or only to households below some income threshold ("means tested").

##### **4.1 Unrestricted universal vouchers**

Consider a voucher of exogenously specified magnitude  $s$  funded from the same tax base as expenditure on public schools and available to all households that opt out of public education. In equilibrium, the balanced budget constraint requires that the tax rate funds both local expenditures on public schooling and the cost of the voucher program. Spending per pupil in public schools is then

$$p \bar{x} = [\bar{t}y - (1 - q)s \cdot m] / (qm) \quad (18)$$

Holding the tax rate fixed, a voucher program is a Pareto improvement over the no-voucher case if it increases public spending per pupil. This obtains if savings to the public system as a result of the reduced pupil load are greater than the cost of vouchers paid to pupils who would have attended private schools without the vouchers. Given our initial private enrolment rate of 9.9%, an unrestricted universal voucher of \$1,000, equal to 16.15% of public spending per pupil, increases spending per pupil in the public schools if it reduces public enrolment by at least 1.9 percentage points.<sup>25</sup>

Recalling that education quality units are chosen so that  $p = 1 / m$  the (indirect) utility of a household that chooses public education is

$$U_{pu}(t, q, y_i, s) = \alpha [(1 - t)y_i]^\delta / \delta + (1 - \alpha) [(t\bar{y} - (1 - q)sm) / q]^\delta / \delta \quad (19)$$

Under an unrestricted voucher program, a religious household that chooses private schooling always chooses a religious school, and vice versa, a non-religious household that chooses private schooling always chooses a non-sectarian school. The threshold income level between public and religious schooling,  $y_{RS}$ , is then implicitly defined by

$$\alpha [(1 - t)y_{RS}]^\delta / \delta + (1 - \alpha) [\bar{x}(t, q, s)]^\delta / \delta = g_1(\gamma, \delta, \alpha)[(1 - t)y_{RS} + sm]^\delta / \delta \quad (20)$$

and the threshold income level between public and private non-sectarian schooling,  $y_{NS}$ , is defined by

$$\alpha [(1-t)\underline{y}_{NS}]^{\delta}/\delta + (1-\alpha) [\bar{x}(t, q, s)]^{\delta}/\delta = g_0(\delta, \alpha)[(1-t)\underline{y}_{NS} + sm]^{\delta}/\delta \quad (21)$$

Public enrolment is then

$$q = r F(\underline{y}_{RS}) + (1-r) F(\underline{y}_{NS}) \quad (22)$$

The model is the same otherwise, and we solve three equations (20), (21), (22) in the three unknowns  $q$ ,  $\underline{y}_{NS}$ ,  $\underline{y}_{RS}$ , for the tax rate  $t = 5.31\%$  and the parameter estimates from the preceding section.<sup>26</sup>

Table 1 presents the effect of unrestricted universal vouchers in varying amounts, from \$1,000 to \$5,000, holding the tax rate fixed at 5.31%.<sup>27</sup> It indicates that the four smaller vouchers increase public spending per pupil and increase private enrolment, especially in religious schools. The \$4,000 voucher effects an increase of 9.5% in public spending per pupil, holding the tax rate fixed, and is sufficient to induce all religious households to choose private religious schooling. Vouchers of \$5,000 or more cause a fall in public spending per pupil relative to the no-voucher case, and ultimately undermine the viability of the public system.

#### **4.2 Universal vouchers restricted to non-sectarian schools**

The constitutional separation of church and state would seem to prohibit the use of tax dollars to finance vouchers for religious schools. Our framework allows us to consider the effect of voucher programs restricted to non-sectarian schools.

Restriction of the voucher to non-sectarian schools raises the possibility that religious households may prefer subsidized non-sectarian private education to unsubsidized religious education. However, numerical analysis indicates that this occurs only for large voucher

amounts. For vouchers of \$5,000 and less, no religious household chooses non-sectarian private schooling: lower-income religious households prefer public schooling while higher-income religious households prefer religious private schooling (Figure 1). Only at very high voucher levels, approaching the level of public spending per pupil, is there a middle-income group that takes advantage of the voucher program and opts for non-sectarian private schooling (Figure 2).<sup>28</sup>

The impact of different sized vouchers restricted to non-sectarian schools, holding the tax rate fixed at  $t = 5.31\%$ , is presented in Table 2. Although the relative effect on private non-sectarian enrolment is significant—a \$3,000 voucher more than doubles it—the effect on public enrolment is slight, except for very large vouchers that reduce public spending per pupil. In no case do vouchers restricted to non-sectarian schools have a significant positive effect on public expenditure per pupil.

#### **4.3 Means-tested vouchers restricted to non-sectarian schools**

Means-tested vouchers are arguably the type of voucher policy most likely to be implemented in practice. They are targeted at low-income families, which these policies are principally designed to help; and they are not likely to support households that would have chosen private education anyhow, thus increasing the likelihood that the voucher program will not be a drain on the public purse (Chen and West, 2000; Barse et al, 2000).<sup>29</sup> However, if use of the voucher is restricted to non-sectarian schools, even if the voucher amount is very close to public spending per pupil, lower-income households are not likely to use it. Even a \$6,000 voucher restricted to non-sectarian schools, while sufficiently large to induce some religious households to use it to finance non-sectarian private education, has a negligible effect on lower income households (Table 3).<sup>30</sup> Moreover, because the voucher is so close in value to public spending per pupil, it cannot significantly increase public spending per pupil. Means-

tested vouchers that exactly equal spending per pupil in the public system, on which Chen and West (2000) focus, rule out any such gain or loss to those who remain in the public school system.<sup>31</sup> However, unrestricted means-tested vouchers can generate substantial gains, as we next show.

#### 4.4 Unrestricted means-tested vouchers

Unrestricted means-tested vouchers have a far greater effect on private enrolment than restricted vouchers, inducing extensive enrolment in private religious schools among low-income households; and they can substantially increase public spending per pupil without raising taxes. Recall that under an unrestricted voucher program, religious households that choose private schooling choose religious schooling, while non-religious households that choose private schooling choose non-religious schooling. We then have two threshold income levels for each group determining private enrolment: one for lower-income households who meet the means test and are eligible for the voucher, and another for higher-income households not eligible for a voucher. The threshold income level between public and private schooling for religious households that are eligible for the voucher,  $y_{RS}$ , is implicitly defined by equation (20), above, while the threshold income level between public and private schooling for religious households that are not eligible for the voucher,  $y_R$ , is implicitly defined by

$$\alpha [(1-t)y_R]^\delta / \delta + (1-\alpha) [\bar{x}]^\delta / \delta = g_1(\gamma, \delta, \alpha) [(1-t)y_R]^\delta / \delta \quad (23)$$

with public enrolment and the quality of public schooling (i.e., the definition of  $\bar{x}$ ) depending on where the means test is in relation to four threshold values (details of the derivation are provided in Appendix E.). Similarly, the threshold income level between

public and private schooling for non-religious households that are eligible for the voucher,  $y_{NS}$ , is defined by equation (21) while the threshold income level between public and private schooling for non-religious households not eligible for a voucher,  $y_N$ , is defined by

$$\alpha [(1-t)y_N]^\delta / \delta + (1-\alpha) [\bar{x}]^\delta / \delta = g_1(\gamma, \delta, \alpha) [(1-t)y_N]^\delta / \delta \quad (24)$$

again with  $\bar{x}$  suitably defined.

Holding the tax rate fixed at  $t = 5.31\%$ , we evaluate the impact of a means-tested voucher by solving these four equations and equation (2) in the five unknowns  $y_{NS}$ ,  $y_{RS}$ ,  $y_N$ ,  $y_R$  and  $q$ , conditioned on the means test. The results are presented in Table 4 for vouchers of \$3,000 and \$4,000, and different means tests. Only religious enrolment gains from means-tested vouchers, and it increases dramatically, while also raising public spending per pupil (which incidentally causes a slight decline in nonsectarian private enrolment). The largest increase in public spending per pupil is achieved by a \$4,000 voucher, which raises public spending per pupil by 15% when the means test is set at \$80,000. Clearly, in terms of the model, an unrestricted means-tested voucher of 4,000 is a Pareto improvement over no voucher: households that choose to remain in the public school system benefit from a substantial increase in quality (without an increase in taxes); households that take advantage of the voucher clearly gain; and those that do not meet the means test are no worse off than before.<sup>32</sup> Moreover, it should command a majority over both smaller and larger vouchers of this type that are less effective in increasing public spending per pupil.<sup>33</sup>

## 5. CONCLUDING REMARKS

There is growing recognition of the need to examine alternative modes of education finance as a means of improving the quality of education, especially in low-income communities. The difficulties of experimentation imply that evaluating the impact of proposed reforms on enrolment and spending must rely on estimates of the underlying parameters of household utility derived from observations on school choice and public spending, absent reform. By incorporating a religious dimension in a political economy model of education finance and school choice, the present paper offers an improved methodology for calibrating these parameters, as well as a framework for assessing the financial implications of allowing only non-sectarian private schools to benefit from public support.

Calibrating the model to United States data on public school spending and enrolment rates in public, religious and other private schools indicates an elasticity of substitution between education quality and other goods of 1.41, which implies a political equilibrium in which the median income voter is decisive. It further indicates that religious households implicitly perceive a tax dollar spent on public education as just over half as effective as a tuition dollar paid to a private religious school.

These results are then applied to evaluating the impact of different school voucher programs. We find that means-tested vouchers restricted to non-sectarian schools have very little effect on public enrolment unless the voucher accounts for a very high proportion of public school spending per pupil, and then they have little or no effect on public school spending per pupil. Unrestricted means-tested vouchers, available for religious and non-sectarian education alike, can achieve a substantial increase in public school spending per pupil. A \$4,000 voucher, equal to approximately two-thirds of public spending per pupil, offered to households earning \$80,000 or less, raises public spending per pupil by 15% (holding the tax rate fixed), and induces the large majority of low and middle income

religious households to opt for private religious education.

Our focus on the public finance aspect of school vouchers ignores other important dimensions of such programs such as the competitive pressures they exert on public schools and peer-group effects that result from the changing composition of school populations. The growing role of the states in funding local public school systems is also absent from our analysis, as are many institutional details of the political decision-making process. Farther afield, religious (and ethnic) dimensions of education could be introduced in multi-community models with migration and competition between local jurisdictions, along the lines indicated by Epple and Sieg (1999) and Nechyba (2000). Finally, concerns that a greater role for private schooling might deepen religious, ethnic and ideological divides in society, which inform the constitutional separation of church and state, could also be addressed explicitly. These various avenues leave wide scope for further research.

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**Table 1. Universal, unrestricted vouchers, tax rate = 5.31%**

Voucher amount	Public spending per pupil	Public enrolment	Non-religious private enrolment	Religious enrolment
\$1,000	\$6,232	87.5%	1.89%	10.65%
\$2,000	\$6,286	83.4%	2.36%	14.2%
\$3,000	\$6,376	76.3%	2.97%	20.7%
\$4,000	\$6,776	56.8%	3.23%	40%
\$5,000	\$6,097	52.5%	7.50%	40%

**Table 2. Universal vouchers restricted to non-sectarian schools, tax rate = 5.31%**

Voucher amount	Public spending per pupil	Public enrolment	Non-religious private enrolment	Religious enrolment
\$1,000	\$6,193	89.7%	1.93%	8.35%
\$2,000	\$6,197	89.2%	2.48%	8.34%
\$3,000	\$6,198	88.4%	3.28%	8.34%
\$4,000	\$6,194	87.1%	4.59%	8.35%
\$5,000	\$6,177	84.6%	7.06%	8.39%
\$6,000	\$6,087	72.6%	19.27%	8.11%

**Table 3. Means-tested \$6,000 voucher restricted to non-sectarian schools, tax rate = 5.31%**

Maximum qualifying income	Public spending per pupil	Public enrolment	Non-religious private enrolment	Religious enrolment
\$60,000	\$6,189	90.1%	1.54 %	8.36 %
\$70,000	\$6,191	89.4%	2.29 %	8.35 %
\$80,000	\$6,183	85.6%	6.31%	8.11%

**Table 4. Means-tested, unrestricted vouchers, tax rate = 5.31%**

Maximum qualifying income	Public spending per pupil	Public enrolment	Non-religious private enrolment	Religious enrolment
<b>\$3,000 voucher</b>				
\$20,000	\$6,189	90.1%	1.54 %	8.36 %
\$40,000	\$6,259	88.0%	1.49 %	10.53 %
\$60,000	\$6,459	82.4%	1.36%	16.28%
\$80,000	\$6,559	79.4%	1.29 %	19.29 %
<b>\$4,000 voucher</b>				
\$20,000	\$6,357	82.8%	1.42 %	15.79 %
\$40,000	\$6,697	71.0%	1.21 %	27.82 %
\$60,000	\$6,963	63.7%	1.07 %	35.20 %
\$80,000	\$7,138	59.6%	0.99 %	39.36 %

## Appendix A.

### Sensitivity of the parameters to the share of religious households

**Table A1. Calibration results for different values of  $r$**

$R$	$\alpha$	$\delta$	<i>elasticity of substitution</i>	$\gamma$
0.4	0.871	0.31	1.44	0.539
0.5	0.881	0.27	1.36	0.596
0.6	0.897	0.20	1.25	0.652
0.7	0.920	0.08	1.09	0.724

## Appendix B.

### Unrestricted universal vouchers with endogenous tax rate

If the tax rate is determined endogenously by majority vote, and the decisive household  $y_d$  favors a positive tax rate, the first-order condition that the chosen tax rate satisfies is

$$dU_{pu}/dt = -\alpha y_d[(1-t)y_d]^{\delta-1} + (1-\alpha) \bar{x}^{\delta-1} [\bar{y}q + dq/dt(sm - t\bar{y})] / q^2 = 0 \quad (B1)$$

The model is the same otherwise, and we solve five equations (15a), (20), (21), (22), (B1) in the five unknowns  $t$ ,  $q$ ,  $y_{NS}$ ,  $y_{RS}$  and  $y_d$ , using the parameter estimates from the preceding section.

**Table B1. Universal, unrestricted vouchers, varying tax rate**

Voucher amount	Tax rate	Public spending per pupil	Public enrolment	Non-religious private enrolment	Religious enrolment
No voucher	5.31%	\$6,189	90.1%	1.54 %	8.36%
\$1,000	5.30%	\$6,227	87.4%	1.90%	10.67%
\$2,000	5.31%	\$6,289	83.5%	2.36%	14.18%

Table B1 presents the effect of two exogenously determined vouchers, of \$1,000 and \$2,000, roughly equal to one sixth and one third of public expenditure per pupil, on the tax rate, on spending per pupil, and on enrolment rates, along with the highlighted benchmark case of no voucher. For either voucher, the tax rate hardly varies at all, or declines very slightly, while public spending per pupil increases by 1-2%, generating a Pareto improvement. At the same time, there is a substantial relative impact on private enrolment, with the \$2,000 voucher increasing non-sectarian private enrolment by 50% and religious school enrolment by 70%. This corresponds to a point elasticity of private enrolment with respect to the amount of the voucher of 0.41, at a voucher equal to approximately 25% of public spending per pupil.<sup>34,35</sup>

## Appendix C.

### Private enrolment with a universal voucher restricted to non-sectarian schooling.

When the voucher is not large enough to induce religious households to send their children to non-sectarian schools (Figure 1), so that only non-religious households send their children to these schools, public enrolment is

$$q = (1 - r) F(\underline{y}_{NS}) + r F(\underline{y}_R) \quad (C1)$$

the quality of public education (setting  $p = 1 / m$ ) is given by

$$\bar{x}(q, s, t) = [t \bar{y} - (1 - F(\underline{y}_{NS})) (1 - r) s m] / [(1 - r) F(\underline{y}_{NS}) + r F(\underline{y}_R)] \quad (C2)$$

and utility from public schooling is

$$U_{pu}(t, q, y_i, s) = \alpha [(1 - t) y_i]^\delta / \delta + (1 - \alpha) [\bar{x}]^\delta / \delta \quad (C3)$$

The threshold income between public and religious schooling,  $\underline{y}_R$ , is then implicitly given by

$$\alpha [(1 - t) \underline{y}_R]^\delta / \delta + (1 - \alpha) [\bar{x}]^\delta / \delta = g_1(\gamma, \delta, \alpha) [(1 - t) \underline{y}_R]^\delta / \delta \quad (C4)$$

and the threshold income between public and secular private schooling,  $\underline{y}_{NS}$ , is implicitly given by

$$\alpha [(1-t)\underline{y}_{NS}]^{\delta}/\delta + (1-\alpha) [\bar{x}]^{\delta}/\delta = g_0(\delta, \alpha)[(1-t)\underline{y}_{NS} + sm]^{\delta}/\delta \quad (C5)$$

The three equations (C1), (C4) and (C5) can then be solved in the three unknowns  $q$ ,  $\underline{y}_{NS}$ , and  $\underline{y}_R$  for the tax rate  $t = 5.31\%$  and our calibrated parameter values. Derivation of the model for vouchers restricted to non-sectarian schools with a varying tax rate is available from the authors on request.

If the voucher amount is large enough some religious households will choose private non-sectarian schooling to take advantage of the subsidy (Figure 2). The utility of a religious household from non-religious private education is

$$U_{sp}(t, y_i, s) = g_0(\delta, \alpha) [(1-t)y_i + sm]^{\delta}/\delta \quad (C6)$$

and from religious schooling it is

$$U_{rp}(t, y_i, \gamma) = g_1(\gamma, \delta, \alpha) [(1-t)y_i]^{\delta}/\delta \quad (C7)$$

Then, for a given voucher amount,  $s$ , and tax rate,  $t$ , there exists a threshold income

$$\underline{y}_{RR} = sm / \{[(g_1/g_0)^{1/\delta} - 1](1-t)\} \quad (C8)$$

such that all religious households with income below  $\underline{y}_{RR}$  prefer private non-religious schooling to religious schooling and those with income above  $\underline{y}_{RR}$  prefer religious schooling to private non-religious schooling.

When the voucher is large enough to induce religious households to send their children to non-sectarian schools (Figure 2) religious enrollment is

$$rel = r [1 - F(\underline{y}_{RR})] \quad (C9)$$

and secular private enrolment is

$$sec = (1-r) [1 - F(\underline{y}_{NS})] + r [F(\underline{y}_{RR}) - F(\underline{y}_{NS})] \quad (C10)$$

Public enrollment is then given by

$$q = 1 - rel - sec \quad (C11)$$

and the quality of public education is given by

$$\bar{x}(q, s, t) = \{t\bar{y} - [r(F(y_{RR}) - F(y_{NS})) + (1-r)(1 - F(y_{NS}))]sm\} / q \quad (C12)$$

The model is the same otherwise and the three equations (C5), (C8) and (C11) can then be solved in the three unknowns  $q$ ,  $y_{NS}$ , and  $y_{RR}$  ( $y_R$  is not relevant) for the tax rate  $t = 5.31\%$ , and our calibrated parameter values.

#### **Appendix D. Public enrolment and public expenditure per pupil with a means-tested voucher restricted to nonsectarian schools**

In this case for the non-religious group we now have two threshold income levels that determine private enrolment: one for lower-income households who meet the means test and are eligible for the voucher, and another for higher-income households who choose private education though not eligible for a voucher. The threshold income level between public and private schooling for non-religious households who are eligible for the voucher,  $y_{NS}$ , is implicitly defined by equation (C5), above, while the threshold income between public and private schooling for non-religious households who are not eligible for the voucher,  $y_N$ , is implicitly defined by

$$\alpha [(1-t)y_N]^\delta / \delta + (1-\alpha) [\bar{x}]^\delta / \delta = g_0(\delta, \alpha) [(1-t)y_N]^\delta / \delta \quad (D1)$$

The threshold income level between public and religious schooling for religious households,  $y_R$ , is defined by equation (C4), with public enrolment and public expenditure per pupil (the definition of  $\bar{x}$ ) depending on where the means test is in relation to these three threshold values.

For voucher amounts less than \$5,000 the threshold income between voucher supported secular and religious private schools derived in equation (C8),  $y_{RR}$ , is smaller than  $y_{NS}$ , and therefore the voucher is not large enough to induce religious households to send their

children to non-sectarian schools (Figure 1). Then, public enrollment is given by

$$q = \left\{ \begin{array}{ll} (1-r) \cdot F(\underline{y}_N) + r \cdot F(\underline{y}_R) & \underline{meanstest} < \underline{y}_{NS} < \underline{y}_N \\ (1-r) \cdot [F(\underline{y}_{NS}) + F(\underline{y}_N) - F(\underline{meanstest})] + r \cdot F(\underline{y}_R) & \underline{y}_{NS} < \underline{meanstest} < \underline{y}_N \\ (1-r) \cdot F(\underline{y}_{NS}) + r \cdot F(\underline{y}_R) & \underline{y}_{NS} < \underline{y}_N < \underline{meanstest} \end{array} \right\} \quad (D2)$$

and public expenditure per pupil is given by:

$$p\bar{x} = \left\{ \begin{array}{ll} \bar{t}\bar{y} / (qm) & \underline{meanstest} < \underline{y}_{NS} < \underline{y}_N \\ \{\bar{t}\bar{y} - (1-r) \cdot [F(\underline{meanstest}) - F(\underline{y}_{NS})]sm\} / (qm) & \underline{y}_{NS} < \underline{meanstest} < \underline{y}_N \\ \{\bar{t}\bar{y} - (1-r) \cdot [F(\underline{meanstest}) - F(\underline{y}_{NS})]sm\} / (qm) & \underline{y}_{NS} < \underline{y}_N < \underline{meanstest} \end{array} \right\}$$

where  $q$  is defined as above. The model is the same otherwise and the four equations (C4), (C5), (D1) and (D2) can then be solved in the four unknowns  $q$ ,  $\underline{y}_{NS}$ ,  $\underline{y}_N$  and  $\underline{y}_R$  ( $\underline{y}_{RR}$  is not relevant) for the tax rate  $t = 5.31\%$ , and our calibrated parameter values.

However, when the voucher is large enough, the threshold income between voucher-supported secular and religious private schools,  $\underline{y}_{RR}$ , is greater than  $\underline{y}_{NS}$ , and therefore there are religious households that prefer non-sectarian schooling to sectarian schooling, to take advantage of the voucher program. (See Figure 2; in this case  $\underline{y}_{NS}$  is relevant also for the religious group). Denoting religious enrolment by  $rel$  and secular private enrolment by  $sec$ ,

$$q = 1 - sec - rel \quad (D3)$$

is the share of public enrolment, where

$$rel = \left\{ \begin{array}{ll} r \cdot [1 - F(\underline{y}_R)] & \underline{meanstest} < \underline{y}_{NS} < \underline{y}_R < \underline{y}_{RR} < \underline{y}_N \\ r \cdot [1 - F(\underline{y}_R)] & \underline{y}_{NS} < \underline{meanstest} < \underline{y}_R < \underline{y}_{RR} < \underline{y}_N \\ r \cdot [1 - F(\underline{meanstest})] & \underline{y}_{NS} < \underline{y}_R < \underline{meanstest} < \underline{y}_{RR} < \underline{y}_N \\ r \cdot [1 - F(\underline{y}_{RR})] & \underline{y}_{NS} < \underline{y}_R < \underline{y}_{RR} < \underline{meanstest} < \underline{y}_N \\ r \cdot [1 - F(\underline{y}_{RR})] & \underline{y}_{NS} < \underline{y}_R < \underline{y}_{RR} < \underline{y}_N < \underline{meanstest} \end{array} \right\}$$

and

$$sec = \left\{ \begin{array}{ll} (1-r) \cdot [1 - F(\underline{y}_N)] & \underline{meanstest} < \underline{y}_{NS} < \underline{y}_R < \underline{y}_{RR} < \underline{y}_N \\ F(\underline{meanstest}) - F(\underline{y}_{NS}) + (1-r)[1 - F(\underline{y}_N)] & \underline{y}_{NS} < \underline{meanstest} < \underline{y}_R < \underline{y}_{RR} < \underline{y}_N \\ F(\underline{meanstest}) - F(\underline{y}_{NS}) + (1-r)[1 - F(\underline{y}_N)] & \underline{y}_{NS} < \underline{y}_R < \underline{meanstest} < \underline{y}_{RR} < \underline{y}_N \\ r \cdot [F(\underline{y}_{RR}) - F(\underline{y}_{NS})] + (1-r)[F(\underline{meanstest}) - F(\underline{y}_{NS}) + 1 - F(\underline{y}_N)] & \underline{y}_{RR} < \underline{meanstest} < \underline{y}_N \\ r \cdot [F(\underline{y}_{RR}) - F(\underline{y}_{NS})] + (1-r)[1 - F(\underline{y}_{NS})] & \underline{y}_N < \underline{meanstest} \end{array} \right.$$

Public expenditure per pupil is then given by

$$p\bar{x} = \left\{ \begin{array}{ll} \frac{\bar{t}\bar{y}}{qm} & \underline{meanstest} < \underline{y}_{RS} < \underline{y}_R < \underline{y}_{NS} < \underline{y}_N \\ \frac{\bar{t}\bar{y} - r[F(\underline{meanstest}) - F(\underline{y}_{NS})]sm}{qm} & \underline{y}_{RS} < \underline{meanstest} < \underline{y}_R < \underline{y}_{NS} < \underline{y}_N \\ \frac{\bar{t}\bar{y} - r[F(\underline{meanstest}) - F(\underline{y}_{NS})]sm}{qm} & \underline{y}_{RS} < \underline{y}_R < \underline{meanstest} < \underline{y}_{NS} < \underline{y}_N \\ \frac{\bar{t}\bar{y} - r[F(\underline{y}_{RR}) - F(\underline{y}_{NS})] - (1-r)[F(\underline{meanstest}) - F(\underline{y}_{NS})]sm}{qm} & \underline{y}_{RS} < \underline{y}_R < \underline{y}_{NS} < \underline{meanstest} < \underline{y}_N \\ \frac{\bar{t}\bar{y} - r[F(\underline{y}_{RR}) - F(\underline{y}_{NS})] - (1-r)[F(\underline{meanstest}) - F(\underline{y}_{NS})]sm}{qm} & \underline{y}_{RS} < \underline{y}_R < \underline{y}_{NS} < \underline{y}_N < \underline{meanstest} \end{array} \right.$$

where  $q$  is defined as above. The model is the same otherwise and we solve four equations (C5), (C8), (D1) and (D3), in the four unknowns  $\underline{y}_{NS}$ ,  $\underline{y}_N$ ,  $\underline{y}_{RR}$  and  $q$  (verifying that  $\underline{y}_R$  is not relevant).

**Appendix E. Public enrolment and public expenditure per pupil with means tested unrestricted vouchers.**

Public enrolment is given by:

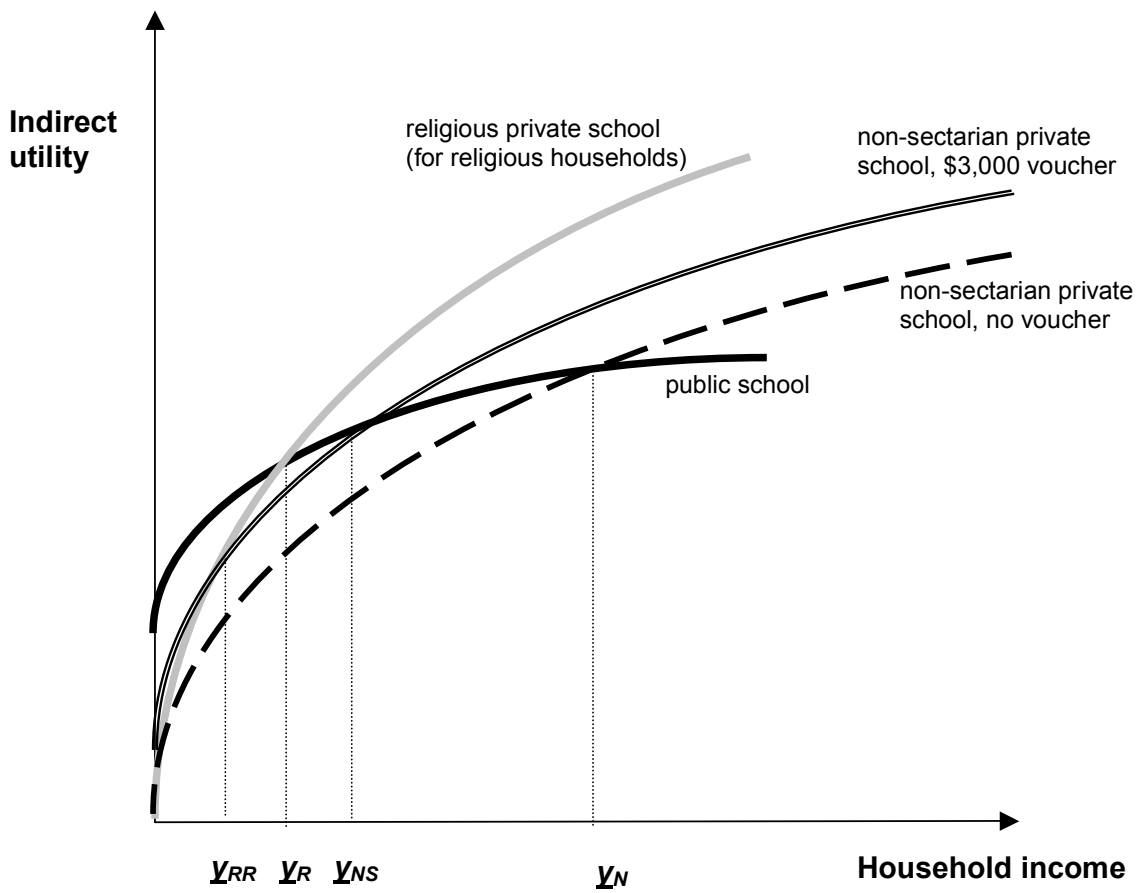
$$q = \left\{ \begin{array}{ll} (1-r) \cdot F(\underline{y}_N) + r \cdot F(\underline{y}_R) & \underline{meanstest} < \underline{y}_{RS} < \underline{y}_R < \underline{y}_{NS} < \underline{y}_N \\ (1-r) \cdot F(\underline{y}_N) + r \cdot [F(\underline{y}_{RS}) + F(\underline{y}_R) - F(\underline{meanstest})] & \underline{y}_{RS} < \underline{meanstest} < \underline{y}_R < \underline{y}_{NS} < \underline{y}_N \\ (1-r) \cdot F(\underline{y}_N) + r \cdot [F(\underline{y}_{RS})] & \underline{y}_{RS} < \underline{y}_R < \underline{meanstest} < \underline{y}_{NS} < \underline{y}_N \\ (1-r) \cdot [F(\underline{y}_{NS}) + F(\underline{y}_N) - F(\underline{meanstest})] + r \cdot F(\underline{y}_{NS}) & \underline{y}_{RS} < \underline{y}_R < \underline{y}_{NS} < \underline{meanstest} < \underline{y}_N \\ (1-r) \cdot F(\underline{y}_{NS}) + r \cdot F(\underline{y}_{RS}) & \underline{y}_{RS} < \underline{y}_R < \underline{y}_{NS} < \underline{y}_N < \underline{meanstest} \end{array} \right.$$

and public expenditure per pupil by

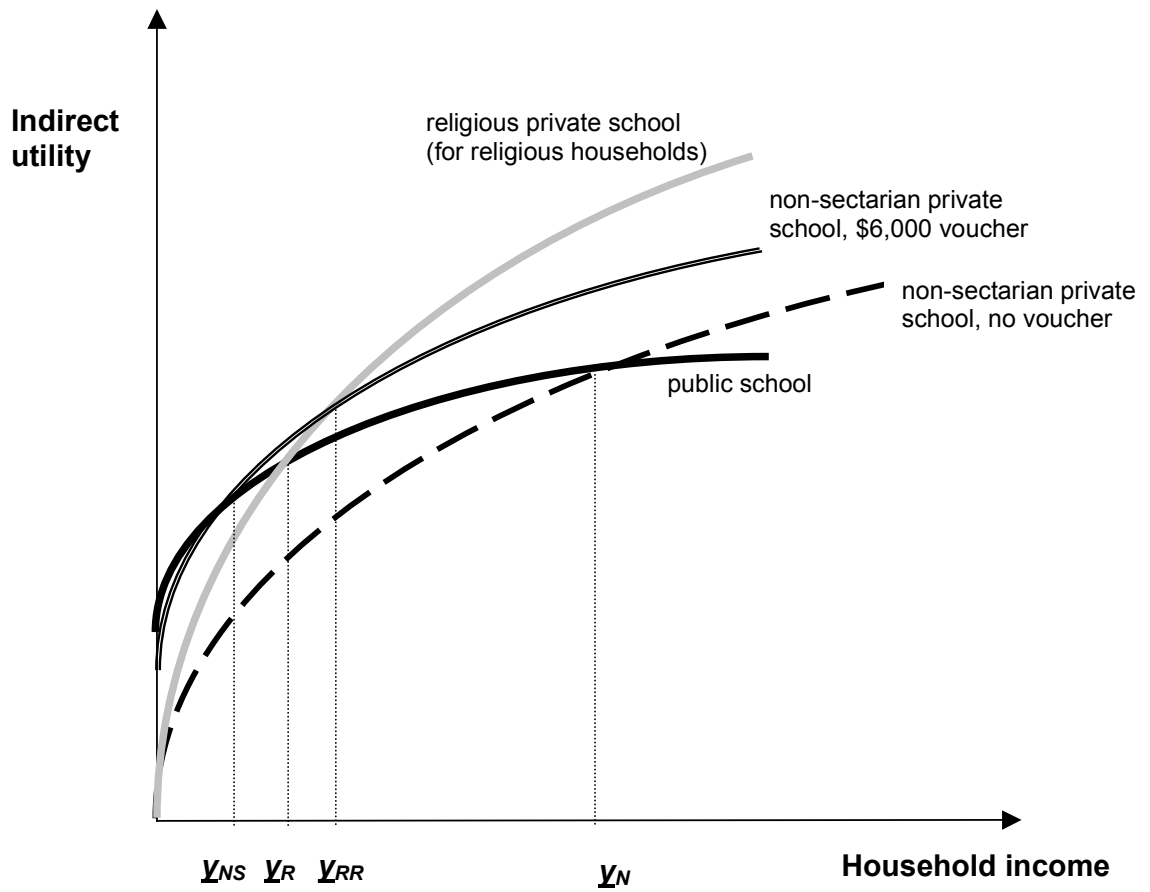
$$p\bar{x} = \left\{ \begin{array}{ll} \frac{\bar{t}\bar{y}}{qm} & \underline{meanstest} < \underline{y}_{RS} < \underline{y}_R < \underline{y}_{NS} < \underline{y}_N \\ \frac{\bar{t}\bar{y} - r[F(\underline{meanstest}) - F(\underline{y}_{RS})]sm}{qm} & \underline{y}_{RS} < \underline{meanstest} < \underline{y}_R < \underline{y}_{NS} < \underline{y}_N \\ \frac{\bar{t}\bar{y} - r[F(\underline{meanstest}) - F(\underline{y}_{RS})]sm}{qm} & \underline{y}_{RS} < \underline{y}_R < \underline{meanstest} < \underline{y}_{NS} < \underline{y}_N \\ \frac{\bar{t}\bar{y} - [F(\underline{meanstest}) - r \cdot F(\underline{y}_{RS}) - (1-r) \cdot F(\underline{y}_{NS})]sm}{qm} & \underline{y}_{RS} < \underline{y}_R < \underline{y}_{NS} < \underline{meanstest} < \underline{y}_N \\ \frac{\bar{t}\bar{y} - [F(\underline{meanstest}) - (1-r) \cdot F(\underline{y}_{NS}) - r \cdot F(\underline{y}_{RS})]sm}{qm} & \underline{y}_{RS} < \underline{y}_R < \underline{y}_{NS} < \underline{y}_N < \underline{meanstest} \end{array} \right.$$

where  $q$  is defined as above.

**Figure 1. Indirect utility, by school type, given a voucher restricted to non-sectarian schools that is not large enough to induce religious households to choose non-sectarian schools**



**Figure 2. Indirect utility, by school type, given a voucher restricted to non-sectarian schools that is large enough to induce religious households to choose non-sectarian schools**



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<sup>1</sup> Of the 5,076,119 students enrolled in all private schools in 1997/8, 2,514,699 students were enrolled in Catholic parochial schools and 1,764,447 were enrolled in other religious private schools, comprising altogether 84.2% of total private enrolment (Digest of Educational Statistics, 2000, Table 60).

<sup>2</sup> In 1993/4 spending per pupil in public elementary and secondary school was \$5,767; average tuition in Catholic schools was \$2,178; and average tuition in other religious schools was \$2,915 (Digest of Education Statistics, 2000, Tables 170, 62). The perceived advantage of religious schools presumably reflects a combination of charitable subsidization by teachers, religious organizations and external donations; religious parents' specific preference for the religious instruction and environment these schools offer; and differences in efficiency. It is not accurately reflected by tuition levels to the extent that parents are expected to supplement tuition with donations of their own time or money. Hoxby (1998) estimated that charitable subsidies from all sources reduce tuition costs by as much as 50%. Sonstelie (1982) estimated that tax dollars spent on education are only 37% as effective as private tuition dollars, without distinguishing between religious and non-sectarian schools.

<sup>3</sup> Direct evidence on school vouchers is especially scant: prohibitive costs limit the scope for private experimentation while public experimentation is politically controversial, and international experience is also limited and inconclusive (West, 1997). Rangazas (1995) and Epple and Romano (1996), among others, evaluate school vouchers by reconstructing the utility function, as we do in this paper. Experience with state finance reform is more extensive, but despite the wide attention it has received, direct conclusions have been largely qualitative in nature (Murray, Evans and Schwab, 1998; Downes and Figlio, 1999). Fernandez and Rogerson's (1995) quantitative analysis of school funding reform in California is an exception that also relies on calibrating the parameters of the utility function.

<sup>4</sup> Of course, in practice there are many religious groups and many gradations of religious devotion, implying an almost continuous variation in the special advantage that parents attribute to religious education. A theoretical extension of the present model that accommodates multiple religious groups is fairly straightforward, but it was not clear to us how it should be calibrated.

<sup>5</sup> Any voucher that increases public spending per student (while holding taxes constant) is a

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Pareto improvement over the no-voucher case. As long as a majority of households chooses public education, a voucher that maximizes public spending per student commands a popular majority over other vouchers.

<sup>6</sup> The voucher program's impact on low-income households is especially significant because the point of departure for most voucher proposals is that low-income families are poorly served by public education and have the most to gain from switching to private schools (Chen and West, 2000).

<sup>7</sup> Public schooling in the United States is largely financed by a combination of property taxes and state grants, with local taxes determined by referenda on proposals set by a school board (Romer et al., 1992). We ignore these important institutional factors in the analysis, and implicitly assume that incomes are perfectly correlated with property values.

<sup>8</sup> Thus we abstract from the possibility of purchasing private education as a supplement to public schooling. We also ignore the fixed costs of education, which limit the variety of private schooling options in smaller communities.

<sup>9</sup> There is substantial empirical evidence that material resources, especially reduced class size—on which there is an extensive literature—do indeed have a significant effect on scholastic achievement and classroom behavior (Krueger, 1998, Card and Krueger, 1996, among many others). Of course, this does not imply that spending increases in themselves are an effective strategy for improving public education (Hanushek, 1986, 1996).

<sup>10</sup> More generally, households view the school as meeting two different purposes: producing cognitive achievements and imparting ethical values. Our model collapses these two dimensions into one, to which we refer as education quality.

<sup>11</sup> That religious households value a dollar spent on religious schooling more than a dollar spent on public schooling is evident from the substantial levels of enrolment in private religious schools despite lower spending per student in these schools (notes 1 and 2, above). That non-religious parents do not generally share this valuation is evident, e.g., from the high rate of Catholic children in Catholic schools, 87.9% in 1989/90 (National Catholic Educational Association, 1990).

<sup>12</sup>  $g_0 = (1 - \alpha) \cdot [(\alpha / (1 - \alpha))^{\frac{1}{1-\delta}} \cdot (pm)^{\frac{\delta}{1-\delta}} + 1]^{1-\delta} (pm)^{-\delta}$  and  $p m = 1$  by our choice of quality units.

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<sup>13</sup> However, some religious households may chose secular private schooling if offered vouchers that can only be used in non-sectarian schools, as we show below.

$$^{14} g_1 = (1 - \alpha) \cdot [(\alpha / (1 - \alpha))^{1-\delta} \cdot (\gamma pm)^{\frac{\delta}{1-\delta}} + 1]^{1-\delta} (\gamma pm)^{-\delta} < g_0 \text{ as } \gamma < 1, \text{ so } U_{sp}(t, y_i) < U_{rp}(t, y_i, \gamma)$$

<sup>15</sup> Religious enrolment is  $r(1 - q_R)$  and private secular enrolment is  $(1 - r)(1 - q_N)$ .

<sup>16</sup> See Epple and Romano (1996) for a detailed derivation of the political choice of tax rate for an ideologically uniform population, of which this is a straightforward extension.

<sup>17</sup> The notion of households preferring a zero tax rate abstracts from the indirect effect of public schooling on crime rates, property values, etc., and from altruistic concern for the children of others. For our purpose it is sufficient that households that do not intend to send their own children to public schools prefer lower tax rates than the tax rate that is chosen.

<sup>18</sup> It follows from our previous analysis that the religious and non-religious households that prefer a zero tax rate comprise upper tails of their respective distributions. Careful inspection reveals that equation (14) holds only if  $\underline{y}_R > y_m$ , which is necessary to ensure that the median income household in both groups chooses a positive tax rate; this tax rate will then be decisive as  $r F(y_m) + (1 - r) F(y_m) = 0.5$ . This would appear to be the case. If  $\underline{y}_R \leq y_d$  then  $1 - F(y_R) \geq 0.5$ , and as the share of religious school enrolment in the population at large,  $r(1 - F(y_R)) = 8.35\%$ , this would imply  $r < 16.7\%$ . In our calibration we set  $r$  equal to the share of households surveyed as having “attended church or synagogue in the last week,” which is reported as 40% (see below). If  $\underline{y}_R < y_m$  then the income of the decisive household is implicitly defined by  $r F(\underline{y}_R) + (1 - r) F(y_d) = 1/2$

<sup>19</sup> There is however an interval of households just below the threshold income  $\underline{y}$  who prefer a zero tax over any positive tax, but sometimes choose the higher of two nonzero tax rates. See Epple and Romano (1996) for a detailed derivation of this equilibrium.

<sup>20</sup> As Epple and Romano (1996) observed, this is only sufficient for a local equilibrium, and a global equilibrium may not exist. However, institutional restrictions that set a minimal threshold for public spending per student may rule out rival equilibria

<sup>21</sup> Per capita money income was 20,120 and there were 2.61 persons per household (Statistical Abstract of the United States, 2000, Tables 737, 753, 63).

<sup>22</sup> The number of children enrolled in public schools in 1997/8 was 46,126,897 (Digest of

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Educational Statistics 2000, Table 41). The corresponding number for private schools was 5,076,119, implying a public enrolment rate of 90.1%. Of these, 2,514,699 students were enrolled in Catholic parochial schools and 1,764,447 were enrolled in other religious private schools, comprising together 8.357% of total enrolment (Digest of Educational Statistics, 2000, Table 60). Enrolment in non-sectarian private schools, 796,973, accounted for 1.543 % of total enrolment.

<sup>23</sup> Appendix A presents a sensitivity analysis of the calibration results to values of  $r$  between 40% and 70%. A median-income equilibrium is indicated for all  $r \leq 70\%$ .

<sup>24</sup> Empirical estimates of the elasticity of substitution that draw on variation in private enrolment as a function of tuition levels are generally difficult to interpret because of the difficulty in controlling for variation in private school quality.

<sup>25</sup> The threshold value,  $1 - q^*$ , is calculated from  $t\bar{y} / q_0 = [t\bar{y} - (1 - q^*)s] / q^*$  where  $q_0 = 90.1\%$  and  $s / [t\bar{y} / q_0] = 16.15\%$ . Hoyt and Lee (1998, p. 224) calculate a related threshold for a voucher of similar size, concluding that, “in the U.S. a decrease in public enrolments exceeding only 2.3% would reduce taxes,” holding school quality fixed. Table 1 indicates that an unrestricted voucher of this relative size induces a response of this magnitude.

<sup>26</sup> These calculations, which focus on the impact of vouchers on public-school spending per student, clearly ignore other important aspects that weigh heavily in the public debate on education vouchers, such as the effect of increased competition on education efficiency (Friedman, 1962); peer-group effects (Epple and Romano, 1998); household location choice (Nechyba, 2000); and the dangers of polarization, which may result from increased private enrolment (Gradstein and Justman, 2001). We also ignore the effect of supply side factors that may raise private school costs in some cases (when teachers are in short supply) and lower them in others (when economies of scale can be exploited).

<sup>27</sup> Analysis of the effect of unrestricted universal vouchers in varying amounts, for variable tax rate is provided in Appendix B. It reveals very little variation in the chosen tax rate.

<sup>28</sup> Detailed derivations are provided in Appendix C.

<sup>29</sup> In our model there is absolute separation by income. In practice, presumably there are always some lower income households that meet the means test and would have chosen private schooling anyhow, though they are probably few.

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<sup>30</sup> Detailed derivations of restricted means-tested vouchers are provided in Appendix D.

<sup>31</sup> Of course, there may be other benefits or losses, through peer-group effects, competitive pressures, greater curriculum choice, etc., which our present framework does not address. Moreover, school choice may itself expend substantial resources. Schools must increase their marketing efforts to attract students (Wilgoren, 2001). And parents must take on new responsibilities—gathering information, exercising judgment, monitoring school performance—which may deter all but the most committed and enterprising from opting out of the public system they know, even if offered a voucher equal to public spending per student. Parents of weaker pupils are especially wary of privately managed schools, as was evident in the recent electoral defeat of a New York City initiative to transfer five failing schools to private-sector management (Wyatt and Goodnough, 2001).

<sup>32</sup> The large majority of households prefer means-tested vouchers to universal vouchers, as they generate a greater improvement in public school quality.

<sup>33</sup> Further detailed calculations are available from the authors on request.

<sup>34</sup> In comparison, Epple and Romano's (1996) estimates imply an elasticity of 0.14 for a voucher of this relative size that is available for use in all schools, religious or nonsectarian.

<sup>35</sup> As in Table B1, other calculations of variable tax rates similarly revealed little variation in the chosen rate, when it was positive. This occurs because the median income household is always decisive and the elasticity of substitution is fairly close to one.