NBER WORKING PAPER SERIES

ON THE POLITICAL ECONOMY OF EDUCATIONAL VOUCHERS

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Working Paper 17986
http://www.nber.org/papers/w17986

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
April 2012

The authors thank Stephen Coate for comments, but we retain responsibility for errors. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

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NBER Working Paper No. 17986
April 2012
JEL No. D72,H44,I22

ABSTRACT

Two significant challenges hamper analyses of collective choice of educational vouchers. One is the multi-dimensional choice set arising from the interdependence of the voucher, public education spending, and taxation. The other is that household preferences between public and private schooling vary with the policy chosen. Even absent a voucher, preferences over public spending are not single-peaked; a middling level of public school spending may be less attractive to a household than either high public school spending or private education coupled with low public spending. We show that Besley and Coate's (1997) representative democracy provides a viable approach to overcome these hurdles. We provide a complete characterization of equilibrium with an endogenous voucher. We undertake a parallel quantitative analysis. For income distributions exhibiting substantial heterogeneity, such as the U.S. distribution, we find that no voucher arises in equilibrium. For tighter income distributions, however, a voucher arises. For example, with the income distribution of Douglas County, Colorado, where a voucher was recently adopted, our model predicts a positive voucher. Public support for a not-to-large voucher arises because the cross subsidy to public school expenditure from those switching to private schools outweighs the subsidy to those that attend private school without a voucher.

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On the Political Economy of Educational Vouchers

1. Introduction.

Vouchers that can be used to finance education at private schools are frequently advocated and regularly proposed as a policy to improve education in the U.S. With a few exceptions, these proposals fail politically. Critics of vouchers decry the loss of funding for public-school students that would arise by public educational monies being diverted to finance vouchers. Without the support of households that would remain in public schools, voucher proposals are unlikely to be politically feasible. As other researchers have investigated, however, vouchers below per student public expenditure might increase that expenditure as students take up vouchers and exit the public sector in spite of the subsidy to students initially in private schools.[1] We investigate political equilibrium that permits vouchers in light of this possibility.

Finding public choice equilibrium with vouchers is nontrivial because the relevant policy vector is a triplet: the tax rate, per student public expenditure, and the amount of the voucher. Using the government budget constraint, the policy vector can be reduced to two variables, but the standard multidimensional voting problem (Plott, 1967) precludes existence of a majority choice equilibrium over all feasible policy vectors. We resolve this problem by using the representative democracy model of Besley and Coate (1997). Voters elect a member of the population anticipating that the office holder will implement his/her preferred policy vector, which is known. The implied restriction on equilibrium policies implies existence of a Condorcet winner in our model and a population member with such preferences is elected.

We examine equilibrium in a computational model, calibrated to the data. Equilibrium has the “ends against the middle” property that arises in Epple and Romano (1996a,1996b).

[1] Related research is discussed below.

Whether or not a voucher is chosen, a coalition of the poorest voters whose children attend public school and those rich voters that send their children to private school prefer lower tax and public expenditure, balanced by an equal-sized coalition of middle-income households with children in public school that advocate the opposite. With the income distribution calibrated to the U.S. population, no voucher arises in equilibrium. However, with the income distribution calibrated to that in Douglas County, Colorado, where a voucher was recently unanimously approved by the locally elected district school board, a voucher does arise in equilibrium. The equilibrium with a voucher is Pareto improving relative to equilibrium with no voucher allowed. A lower tax rate and higher per student expenditure arise in the equilibrium with a voucher. While Douglas County is wealthy relative to the U.S., it is the lower variance in income rather than the higher mean that is relevant to finding a positive voucher in equilibrium.

Ireland (1990) provides the first formal model of public-private provision of a good with a voucher as a centerpiece. Ireland showed theoretically that some policy vectors Pareto dominant others, in particular that public expenditure might rise with a voucher for fixed tax system. In addition to being the first to make this observation (to our knowledge), his framework has been the point of departure for further research. Rangazas (1995) identifies three effects of a voucher on majority choice of public expenditure. A voter with a child in public school faces a lower tax price of increasing public expenditure because the voucher induces some students to switch from public to private schools. Thus, when the voucher is less than per student public expenditure, those that switch schools cross subsidize students in public schools. Of course, tax revenues must also finance the voucher including students that would attend private school with no voucher. In addition to the latter two effects, the median voter's wealth would decline with a positive voucher as relatively wealthy households take up the voucher and exit public schools.[2] Assuming voters ignore the effect of vouchers on school sector choice when voting for public expenditure, Rangazas employs parameter estimates to conclude the net effect of a voucher would be to increase support for public expenditure. Like Ireland, Rangazas does not examine equilibrium determination of a voucher. The most closely related paper to ours is Hoyt and Lee (1998). They also investigate political support for vouchers in a model with the same technological elements as do we, but differ with respect to their analysis of equilibrium. Most of their analysis holds constant public expenditure. They show that vouchers can lower tax rates given public expenditure, which would imply a Pareto improvement and thus political support for a voucher. Their analysis of an endogenous voucher assumes two stages, with the voucher determined first followed by median preferred choice of public expenditure (with tax that balances the budget).[3] They provide conditions involving endogenous variables such that a positive voucher would be majority preferred to no voucher. Our contribution is to provide a full equilibrium analysis, including demonstration of existence computationally, and to examine equilibrium outcomes in a realistically calibrated model.

Other research on vouchers is a bit more distant. Chen and West (2000) and Bearse, Cardak, Glomm, and Ravikumar (2009) consider majority approval of voucher regimes that provide every student with a voucher, i.e., with no distinct public alternative available. Voucher programs that do not permit a public alternative have diminished political support because the cross subsidy (discussed above) to public school students from those that switch to private schools disappears. These papers both then consider political support for vouchers that vary with income. Epple and Romano (2008) examine voucher design that would eliminate cream skimming of classmates and would lead to (near) Paretian gains if competition for students

[2] Majority choice of public expenditure has "ends against the middle."
[3] The second stage equilibrium also has "ends against the middle."

improves outcomes.[4] The present paper focuses on voucher programs that permit expenditure per pupil in public schools to differ from the amount of the voucher, as is more common.[5]

Section 2 presents the model and some preliminary results. Section 3 develops the main theoretical results. Section 4 provides the computational analysis of equilibrium. Section 5 concludes. An appendix provides some of the technical analysis.

2. The Model and Preliminary Results

We refer to the decision makers in the economy as "households" or "voters." A household has an endowed income y, a child in school, and utility function U(x,q), where x is numeraire consumption and q is the quality of education. Educational quality is measured by per student expenditure in the student's school. U is increasing, twice differentiable, and quasi-concave in (x,q), and satisfies the standard Inada property. Ordinary demand for educational quality is normal. The population of households is characterized by a continuous distribution on income F(y), with density f(y), positive on $[y_{min},y_{max}]$. Denote mean income Y.

Households will choose to send their child to a public or private school. Let g denote expenditure per student in the public sector, which is the same for every student attending a public school. Public finance is by a proportional income tax denoted t. Utility of household y if their child attends a public school is then: $U^P = U(y(1-t),g)$.[6] Relevant to household preferences over (t,g), we make the following assumption:

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[4] Nechyba (1999,2000) examines the effects on educational quality of inter-district household mobility of various voucher designs. See Epple and Romano (2011) for discussion of more models of vouchers and other references.

[5] As one example, the California state-wide voucher proposal (Proposition 38) that was defeated by referendum, supported by only 30% of the population, would have provided a $4,000 voucher, one-half the per student public expenditure there. The Douglas County School District voucher equals 75% of state funding, which is about 55% of per student public funding. We do not mean to suggest that voucher programs do not vary substantially. Many proposals are means tested and/or targeted to students at failing schools.

[6] By "household y," we mean household with income y. As well, we sometimes refer to "voter y."

(A1) $\left.\frac{dt}{dg}\right|_{U^P=\text{const.}} = \frac{U_q/U_x}{y}$ increases with y.

The single-crossing assumption regarding voter indifference curves drawn in the (g,t) plane says that the marginal willingness to bear a tax increase for higher g rises with income; indifference curves steepen as income rises. This implies that, among those that choose public schools, higher income voters support higher educational expenditure despite their higher tax price. Empirical evidence supports this assumption.[7]

Let v ≥ 0 denote a voucher provided to any household that attends private school. Policy requires that all of v is spent on education if private school is attended. Private schooling is competitively provided with constant returns to scale. Thus a household that sends its child to private schools obtains utility: $U^R = MAX_{s\geq 0}\, U(y(1-t)-s, v+s)$; where s is supplemental expenditure above the voucher. Denote the solution to the latter optimization $s^*(t,v,y)$.

For given policy (t,v,g) with g > v, there will exist a threshold income value $y_T(t,v,g) > 0$ satisfying $U^P = U^R$, such that households with income y > (<) y_T will choose private (public) education.[8] Realistic parameters and policies that have g > 0 will result in consumption of both the public and private alternative. To avoid a tedious presentation, we then assume:

(A2) Policy vectors with g > 0 have $y_T \in (y_{min}, y_{max})$, thus consumption of both public and private education.

Simple comparative static properties are:

(1) $\frac{\partial y_T}{\partial t} > 0; \frac{\partial y_T}{\partial g} > 0;$ and $\frac{\partial y_T}{\partial v} < 0.$

[7] Early empirical evidence is discussed in Epple and Romano (1996a). Epple and Sieg (1999) and Brunner and Ross (forthcoming) provide alternative evidence supporting such an assumption. An appendix to Epple and Romano (1996a) shows that (A1) will be satisfied if the income elasticity of demand for educational quality is higher than the absolute value of the price elasticity of demand, provided the expenditure share on education is not too large. This theoretical characterization of the assumption derives from Kenny (1978).

[8] This is straightforward to confirm and "well known," so we omit proof. See Rangazas (1995).

If $g \leq v$ and/or $g = 0$, then specify that $y_T = 0$, consistent with the fact that no household would prefer the public alternative.

The government budget must be balanced:

(2) $$tY = F(y_T)g + (1 - F(y_T))v.$$

Public choice of the policy vector is modeled using a version of Besley and Coate's (1997) representative democracy model. Our model has the technical difference that we assume a continuum of households, while Besley and Coate assume discreteness. The central assumption in Besley and Coate is that voters elect a policy maker correctly anticipating implementation of the policy maker's preferred policy, which is known. In addition to the latter, assume: (A3) Any voter can become a candidate at 0 cost.[9] (A4) If no voters become candidates, a terrible policy results, worse for everyone than if any voter is elected. (A5) Voting is costless and voters maximize their utility in Nash equilibrium, but never choosing weakly dominated voting strategies. (A6) Assuming entry into the election, a candidate receiving a plurality of votes is elected, with equal probability tie breaking if multiple candidates tie for the win.

Equilibrium has rational expectations with the following sequence of choices. First, households decide whether to become candidates. If no one enters, the terrible policy is implemented (that satisfies balanced budget for optimal household choices). Otherwise, a candidate is elected as described, whom we refer to as the superintendent. The superintendent then implements his preferred policy vector, which must be consistent with the next stage. Last, households optimize, choosing the public or private alternative, the latter with optimal

[9] Besley and Coate focus on cases with positive entry cost, though consider cases with vanishingly small entry cost.

supplement, and the government budget balances. When households optimize, they take as given the balanced budget policy vector, this consistent with their atomism.[10]

We examine cases where there is a Condorcet winner among the preferred policies of households. This property is satisfied in our computational model. Let ($t^*(y),v^*(y),g^*(y)$) denote the preferred policy vector of household y, which we assume to be unique. It satisfies:

$$
\text{(3)} \qquad \begin{aligned} &\mathrm{Max}_{t\geq 0, v\geq 0, g\geq 0}\left[\mathrm{Max}\{U^P, U^R\}\right] \\ &\quad \text{s.t. (2) and } y_T = y_T(t,v,g). \end{aligned}
$$

Let p = (t,v,g) denote a policy vector, $p^*(y)$ = ($t^*(y),v^*(y),g^*(y)$) a preferred policy vector, and $P^* = \left\{ p*(y) \in R^3_+ \middle| f(y) > 0 \right\}$ the set of preferred policy vectors. Given the continuum of types, a Condorcet winner is a policy $p^w \in P^*$ that is weakly preferred by at least one-half the measure of all voters y over all policies $p^* \in P^*$. Given existence of a p^w, let y^w denote a voter that prefers p^w; i.e., satisfies $p^w = p^*(y^w)$.

Proposition 0 is an adaptation of Besley and Coate's Corollary 1 to our problem with a continuum:

Proposition 0 (Besley and Coate): Assuming a Condorcet winner p^w: (i) a single candidate equilibrium with candidate y^w exists, with that candidate elected; and (ii) a single candidate equilibrium must have a y^w elected.

Formal proof follows closely follows Besley and Coate, though we provide a proof in the appendix for convenience. Intuitively, entry by just a y^w will lead to his election, to avoid the terrible alternative. Entry by household with alternative policy preference would induce entry by a y^w, who would defeat the former and thus get his preferred policy.

[10] It is equivalent to require that the superintendent sets any two variables of the (t,v,g) policy vector, with the other determined in the last stage under rational expectations. These are equivalent because households are atomistic policy takers, i.e., cannot affect the policy vector through their unilateral choices.

Motivated by Proposition 0, we henceforth focus on equilibrium with policy vector that is a Condorcet winner among preferred policies. While existence holds under Proposition 0, uniqueness of political equilibrium is not implied, as Proposition 0 does not rule out multiple candidate equilibria. The appendix provides a modified two-party version of the model with also uniqueness of the Condorcet winner as the policy outcome.

3. Theoretical Results

Assuming equilibrium exists, we develop a series of results concerning the character of equilibria that might arise, including when equilibrium has a voucher.

Proposition 1. If the superintendent chooses private schooling, then $t^* = v^* = g^* = 0$ *and the superintendent's income exceeds the mean.*

Proof of Proposition 1. Suppose, first, that the superintendent's income exceeds the mean. Consider the choice of g. If g < v, then no one chooses public school, and v = tY. Setting g = v also implies v = tY. Setting g > v is suboptimal, since this would drain funds from finance of the voucher and the superintendent cares not about the quality of public education. In any potentially optimal case (i.e., with g ≤ v), the superintendent's preferred policy then satisfies: $U^R = \text{Max}_{t\geq 0, s\geq 0}\, U(y(1-t)-s, tY+s)$. The latter has solution t = 0 since the tax price of financing education with a voucher exceeds 1. In turn, g must equal 0. Now suppose the superintendent has income less than or equal to the mean. We show that such a superintendent prefers the public alternative, a contradiction. By the same argument as for a superintendent with income above the mean, the optimal policy would solve: $U^R = \text{Max}_{t\geq 0, s\geq 0}\, U(y(1-t)-s, tY+s)$. In this case, s = 0 would be optimal since the superintendent here has tax price no higher than 1. But, by instead choosing public school and the same t that solves the latter problem, the superintendent would obtain higher school quality g and thus higher utility provided any households would select private school. The result then follows from (A2). ■

In our computational analysis, we find no equilibria of the type in Proposition 1. Hence, we consider further only equilibria that public sector (g > v). Now consider the policy choice of a superintendent y that would choose public education.

Proposition 2. A superintendent that selects public school chooses (t,v) that solves the problem:

$$(4)\qquad \begin{aligned} &\text{MIN}_{t\geq 0, v\geq 0}\ t \\ &\text{s.t. } tY = F(y_T(t,v,g^*))g^* + [1-F(y_T(t,v,g^*))]v; \end{aligned}$$

where g^* is the superintendent's preferred g.

Proof of Proposition 2. Since the superintendent's utility is given by $U(y(1-t),g^*)$, his objective in choosing (t,v) is to minimize the equilibrium tax rate, which solves (4). ■

Proposition 2 is a version of the result that is at the heart of the earlier discussed research on vouchers of Ireland (1990), Rangazas (1995), and Hoyt and Lee (1998). The incentive of households using public schools to provide a voucher is to increase the cross subsidization of households that select private schools while still having to pay taxes. This logic applies, of course to any household choosing public school:

Corollary 2. Given any equilibrium g that would be chosen by a superintendent, all households that choose public education prefer (t,v) satisfying problem (4).

Toward providing a complete description of equilibrium with public provision, let $t^M(g)$ denote the solution to (4) for t for any g ≥ 0. Let $v^M(g)$ denote the solution for v.

Proposition 3. Assuming choice of public school by the superintendent, equilibrium (t^*,g^*) occurs at a tangency between an indifference curve U(y(1-t),g) = const. of the superintendent and the $t^M(g)$ locus, with equilibrium $v^* = v^M(g^*)$.

Proof of Proposition 3. Using Proposition 2, this follows immediately from the fact that the superintendent maximizes utility given public attendance. ■

Figure 1 depicts the choice of (t^*,g^*) by the superintendent. Note that Proposition 3 implies $dt^M/dg > 0$ at the equilibrium point. Using (A1), we have immediately:

Corollary 3. Among those choosing public education, their preferred g and y are strictly increasing in y, $g^{*\prime}(y) > 0$ and $t^{*\prime}(y) > 0$.

Let y^w denote the income of the superintendent in equilibrium. A necessary condition for global equilibrium is that the allocation is also a "local equilibrium" in the following sense. A household with income infinitesimally higher or lower than y^w could not defeat household y^w, i.e., prefer a policy that would garner a strict majority relative to y^w's preferred policy. We show next that the requirement that equilibrium is a local equilibrium implies it satisfies the "ends against the middle" property given (A1) and a condition we now describe. Let:

(5) $$y_T^e \equiv y_T(t^*(y^w), v^*(y^w), g^*(y^w)),$$

which equals the threshold income in equilibrium delineating those that consume public and private education. Equilibrium utility for those that consume private education is given by: $U = U(y(1-t^*(y^w)) - s^*(\cdot), v^*(y^w)) + s^*(\cdot))$, where s* is evaluated at the equilibrium policy vector. The additional condition for the "ends against the middle" property of equilibrium is:

(A7) $$\frac{dU}{dy^w} = -U_x y t^{*'} + U_q v^{*'} < 0 \text{ for all } y > y_T^e,$$

where the arguments of the functions are evaluated at equilibrium values. (Recall that x denotes the numeraire and q school quality.) We know that $t^{*\prime} > 0$ in an equilibrium with a public sector, implying $v^{*\prime} \leq 0$ is a sufficient condition for the assumption to hold.[11] Assumption

[11] If v* = 0 in the vicinity of equilibrium, then the condition is satisfied. When v* = 0, the "ends against the middle" result is particularly analogous to the case of Epple and Romano (1996a) where vouchers are not a policy choice as discussed further below. This case, is, however, of less interest since no voucher arises

(A7) implies those in private schools would vote for a candidate with lower income than the superintendent, this driven at least in part by such a candidate's preference for a lower tax.

Proposition 4: Ends-Against-the-Middle. Under (A1), (A2), and (A7), an equilibrium with superintendent y^w that chooses public education must satisfy:

(i) $\int_{y^w}^{y_T^e} f(y)dy = .5;$ and

(ii) households with $y \in (y^w, y_T^e)$ prefer a superintendent with slightly higher y than y^w; and those with incomes $y < y^w$ and $y > y_T^e$ prefer a superintendent with slightly lower y.

<u>Proof of Proposition 4</u>. The preferences in part (ii) for those in the public sector ($y < y_T^e$) follows by Corollary 3 and (A1). The preference in part (ii) for those in the private sector ($y > y_T^e$) follows by (A7), and (A2) implies some households do choose private education in equilibrium. Part (i) must then hold or a household with marginally different income would become a candidate and defeat household y^w in the election. ■

Thus, such an equilibrium has superintendent with income below the median and a coalition of rich and poor preferring lower tax and public expenditure on education opposed by middle-income types that favor higher tax and public expenditure.[12]

To consider the issue as to when a positive voucher arises in equilibrium, form the Lagrangian function for problem (4) and examine the Kuhn-Tucker conditions:

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in equilibrium. Corollary 2 implies $v^*(y) = v^M(g^*(y))$ among superintendents that would choose public school. We find in our computational model, however, that v^M is increasing when v^M is positive. (A7) then needs to be verified computationally. We find this condition to be satisfied in our computations.

[12] If equilibrium has no voucher, then it is generically equivalent to equilibrium if no voucher is allowed. This is in spite of the fact that some households might prefer a voucher if they were elected. The reason is that the equilibrium conditions include satisfaction of the local equilibrium conditions and the feasible (t,g) pairs – given by the $t^M(g)$ locus – will be the same generically in the vicinity of equilibrium as when no voucher is allowed. The exception is when the superintendent is just indifferent to providing a voucher, but this arises with probability 0. The possibility of providing a voucher by nonelected households could, however, preclude existence when equilibrium would arise with no voucher allowed.

(6) $$L = t + \lambda \cdot \{tY - [(1 - F(y_T(t, v, g^*))v + F(y_T(t, v, g^*))g^*]\}.$$

Along with the constraint in (4), the Kuhn-Tucker conditions are:

(7a) $$L_t = 1 + \lambda[Y + (v - g^*)f(y_T)\frac{\partial y_T}{\partial t}] = 0;$$ and

(7b) $$\begin{aligned} &L_v = -\lambda[1 - F(y_T) + (g^* - v)f(y_T)\frac{\partial y_T}{\partial v}] \geq 0; \\ &L_v \cdot v = 0; \\ &v \geq 0. \end{aligned}$$

We specify (7a) with equality since t > 0 must arise in an equilibrium with a public sector. The issue is whether v = 0 is consistent with the set of conditions, in particular those in (7b). Since the maximand in (4) obviously decreases with Y, we know by the usual Envelope Theorem argument that $\lambda < 0$. Using this and setting v = 0, it follows from the top line of (7b) that v is positive if:

(8) $$\begin{aligned} &1 - F(y_T) + g^* f(y_T)\frac{\partial y_T}{\partial v} < 0 \text{ given } v = 0,\ y_T = y_T(t, 0, g^*), \text{ and} \\ &\qquad t \text{ satisfying } tY = F(y_T)g^*. \end{aligned}$$

We have shown:

Proposition 5: In an equilibrium with a public sector, condition (8) implies a positive voucher.

The inequality in (8) indicates the trade off in increasing the voucher above zero to public sector participants. The term 1-F equals the marginal cost of providing the voucher to students in the private sector, equal to the proportion in private school. The remaining term is the negative of the marginal benefit, which equals the marginal cost saving from inducing students to enter the private sector, thus spending less on them in public schools. While one needs more specific elements of the model to evaluate (8), we can see that the condition is "more likely" to be satisfied if there are few students in the private sector in equilibrium assuming no voucher and if g is "high" in such an equilibrium. Note, too, that the inequality condition in (8) is sufficient for v > 0, though also necessary if (4) has a unique local minimum.[13]

To investigate why a positive voucher arises for some but not all income distributions, we will examine a change in the income distribution where all households y have proportional income change to ky, k > 0. Thus, if k > (<) 1, the economy becomes richer (poorer). The baseline economy has k = 1, and we refer to the generalized economy allowing $k \neq 1$ as the k-economy.

Proposition 6. If U(x,q) is homothetic, all results about the baseline economy apply to the k-economy for redefined consumption vector $(x_k,q_k) \equiv (kx,kq)$.

Proof of Proposition 6. The primitives in the baseline model are the utility function U(x,q), F(y), the prices of one for (x,q), and the definition of equilibrium. Letting $y_k \equiv ky$, the economy with $F_k(y_k) \equiv F(y)$ and $U = U(x_k,q_k)$ is isomorphic to the economy F(y) and U(x,q). The latter follows since: (i) for all y, household y's preference ordering over (x,q) and consumption possibilities are the same as household y_k's preference ordering over (x_k,q_k) and consumption possibilities by the definition of homotheticity (see e.g., Mas-Colell, Whinston, and Green, 1995, Definition 3.B.6, p. 45); (ii) the income transformation implies $F_k(y_k) \equiv F(y)$ for all y; and (iii) prices and the definition of equilibrium are invariant to k. ■

Proposition 6 is very powerful. If equilibrium exists (does not exist) for k = 1, then it exists (does not exist) for all $k \neq 1$. Taking a case where equilibrium exists for k = 1, the equilibrium values in the k economy satisfy: $(t_k^*, v_k^*, g_k^*) = (t^*, kv^*, kg^*)$; $(y_k^w, y_{Tk}) = (ky^w, ky_T^e)$; and consumption of type ky in the k-economy is equal to (kx,kq) for (x,q) consumption of type y in the baseline economy. For example, if household y chooses private school in the baseline economy and consumes (x,q) = ((1-t)y-s,v+s), then household ky in

[13] The condition for uniqueness of the local maximum is developed in the appendix.

the k economy consumes (x_k,q_k) = ((1-t)ky-ks,kv+ks). Perhaps most importantly for our purposes, if there is no voucher in the baseline economy, then there will be no voucher in the k-economy. And, if there is a voucher in the baseline economy of v, then there will be a voucher in the k-economy of kv. We illustrate this in our computational model, where we adopt a homothetic utility function.

4. Computational Analysis

To perform the computational analysis, we must calibrate the household utility function and the income distribution. We assume the income distribution is lognormal. We use the U.S. household income distribution from 2008 in the calibration, which had mean of $68,164 and median of $50,112. The implied mean and standard deviation of ln(y) are μ = 10.822 and σ = .784.

We adopt the CES utility function:

(9) $$U = [\beta q^{-\rho} + (1-\beta)x^{-\rho}]^{-1/\rho}.$$

We calibrate by choosing the two parameters of the utility function so that the equilibrium values of public school expenditure per household and the public school enrollment share match the empirical values in the U.S. for 2007/08. Public educational expenditure per household that school year was $5,066. The public school enrollment share was .892. Parameters that yield the above expenditure and public share in the equilibrium we find below are ρ = 35 and β = .0433. Using (9), one finds that (A1) is satisfied whenever $\rho > 0$. We find (A2) and (A7) are satisfied as well, so the calibration implies an "ends against the middle" equilibrium.

The equilibrium tax rate is .066. The income of the superintendent that is elected is $40,530, and the income of the household indifferent between public and private school is $133,026. Figure 2 shows the vote in favor of the equilibrium policy relative to the policy preferred by every other potential candidate. This confirms that the superintendent's preferred policy is a Condorcet winner among all preferred policies, and Proposition 0 applies. In this equilibrium, however, the majority-preferred voucher is zero. The 10.8% that attend private school deters the superintendent from providing a voucher. The inequality condition in (8) is not satisfied. Intuitively, the cost to the district of providing a voucher to households that choose private school with no voucher exceeds the benefits from the reduction in expenditure on g from the households that would be induced by a voucher to move from public to private school. The model then predicts no voucher if the population income distribution has the extent of heterogeneity in incomes reflected in the U.S., as in states (California, Michigan) with state-level voucher proposals that have typically failed.[14]

Now we recalibrate the income distribution to match that in Douglas County, Colorado (DCC henceforth), where a voucher was recently unanimously approved by the locally elected school board. For DCC, the U. S. Census reports median and mean household income to be \$99,522 and \$118,373 respectively. With lognormally distributed income, the implied mean and standard deviation for ln(y) are $\mu = 11.508$ and $\sigma = .589$. Note that DCC is richer and has lower variance income distribution than the U.S. distribution. We retain the utility function parameters from the U.S. calibration.

Table 1 reports equilibrium values for the DCC income distribution. The top row allows a voucher and the bottom row assumes vouchers are not allowed. Here a voucher equal to \$1684 arises in equilibrium if permitted. Compared to the case with no voucher allowed, the voucher equilibrium has the income of the superintendent and the household indifferent to public versus private school decline, and the proportion attending private school rise from 6.5% to 8%. The tax rate declines slightly and public expenditure rises slightly. Thus, those that

[14] We also calibrated to the California and Michigan income distributions and found the equilibrium voucher to be zero in both cases.

attend public schools and private schools with and without a voucher are better off in the voucher equilibrium, as well as those that switch by revealed preference. In addition to there being a Pareto improvement, every household gains in school quality.[15]

Figure 3, analogous to Figure 2, shows the proportion favoring the elected superintendent (who has income of $88,371), if matched against a candidate with any other income. The figure confirms the superintendent's preferred policy is a Condorcet winner and Proposition 0 applies. The panels of Figure 4 show the policy vectors that alternative households would select if elected. Households with income below about $282,245 would send their child to public school if elected. For these households, their preferred policy would have increasing tax and public expenditure as income rises, as implied by (A1). The preferred voucher would be 0 as income rises until income of about $60,000 is reached, and then rise up to over $6,000 with income for this group. From (7b), the marginal value of providing the voucher is proportional to: $-[1-F(y_T)+(g^*-v)f(y_T)\frac{\partial y_T}{\partial v}]$; where g* is the preferred g of the household in power. As depicted in Figure 5, the proportion in public schools increases as g and t increase with income of the household in power. This effect increases the marginal value of providing the voucher and it increases.

Households with income above $282,245 would send their child to private school if in power, and would choose the (t,v,g) = (0,0,0) policy vector (Proposition 1). This discontinuity in policy is why there is a discontinuity as well in the vote against such a candidate in Figure 3. Figure 6 shows the incomes of the voting coalitions that would favor or oppose the elected superintendent if matched against alternative-income candidates. We know that for every

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[15] In some analyses of school policies, welfare gains based on the household utility function are associated with declines in educational quality and achievement. See, for example, some of the policies effects in Epple and Romano (1998). If the household utility function is really a reduced form that reflects borrowing constraints on financing education or if there are externalities from educational achievement, then it is important to examine effects on educational quality per se.

income of alternative candidates, the proportion that would favor the elected superintendent is a majority. The left vertical line is drawn at the income of the elected superintendent ($88,371) and the right vertical line at the lowest income household who, if in power, would send their child to private school and choose the (t,v,g) = (0,0,0) policy vector. To the left of the right vertical line, the upper locus in the figure follows the minimum income of the household that would send their child to private school if the alternative candidate is in power. Households with incomes below the elected superintendent would choose a lower (t,v,g), but with positive (t,g) and perhaps v (see Figure 4). These alternative candidates would be supported by a minority coalition of poor and rich voters (the "oppose groups"), with the latter sending their children to private school. Households with incomes above the elected superintendent, but not too far above, would send their child to public school and choose higher (t,v,g) if in power (see Figure 4 again). These candidates would be supported by a minority of households with middle incomes (the "oppose group"), but with income higher than the elected superintendent and not high enough that they would send their child to private school.[16] A very high income candidate who would choose (t,v,g) = (0,0,0) would find support from only high income households, with incomes above $122,279. This group includes all households who would also choose (t,v,g) = (0,0,0) if in power, as well as some less wealthy households who would choose public provision if in power but prefer private provision to the elected superintendent's moderate (t,g) values.[17]

Why does the DCC income distribution lead to a voucher in equilibrium while no voucher arises for the U.S. income distribution? The DCC and U.S. distributions differ in two

[16] Those high income households that would send their child to private school if the alternative higher-income candidate is in power would receive an increased voucher, but they prefer the elected superintendent's policy due to the lower tax rate. The out-of-equilibrium analogue to Assumption (A7) holds for these households.

[17] Given that income is taxed, it is perhaps surprising how high a household's income must be ($282,245) before they would choose (t,v,g) = (0,0,0) if in power. All households with income above the mean are taxed disproportionately for public provision. But we find the subsidy to public education from wealthy households that select private school has a strong effect on policy preferences.

respects. Households in DCC are richer, e.g., have substantially higher mean income, and have lower income heterogeneity (lower σ). The former is not the reason for the difference in voucher preferences. As implied by Proposition 6, if we increase or decrease everyone's income proportionally relative to the U.S. distribution, no voucher will arise. If we do the same beginning with the DCC distribution, then the voucher will change by the same proportion.[18] Thus, it is not wealth of the economy that is relevant, at least by the "factor k definition" of wealth.

A reduction in income heterogeneity holding mean income constant changes the incentives to introduce a voucher. To exhibit the effect of income heterogeneity, we vary the standard deviation of income while holding mean income constant at the DCC level. The standard deviation of income in DCC equals 76,219. Figure 7 shows that the equilibrium voucher increases as income heterogeneity decreases, while public school spending per pupil is only moderately affected. The intuition is as follows. Voters attending public school face the following tradeoff in considering a marginal change in the voucher. An increase in the voucher induces some households to switch to private schooling, increasing public school spending (for vouchers less than public school spending). This increase in public school spending is offset by the increased voucher payments to those already attending private school. Holding mean income constant, an increase in the standard deviation of income increases the percentage choosing private school for any voucher including zero. Hence, the higher is the standard deviation of income, the greater the number of incumbent private school attendees who will be voucher recipients if a voucher is introduced or increased. For sufficiently high standard deviation, this cost is high enough to offset the gain from inducing additional public school attendees to switch to private school.

[18] We did verify this computationally, which serves as a check of our computational model. The effects are exactly as implied by Proposition 6.

Figure 8 illustrates the interdependence of private school attendance and vouchers. The top curve shows equilibrium public school attendance when vouchers are not permitted as a function of the standard deviation of income. When the population is relatively homogeneous, almost all households use public schooling. As income variance rises, with an associated increase in the proportion of households with quite high incomes, equilibrium private school attendance rises and the public share falls. When vouchers are permitted, a very high voucher is chosen when incomes are relatively homogeneous, leading a substantial proportion of households to opt for private schooling. As income variance rises, the proportion in public school absent the voucher falls, while public school attendance rises if a voucher is allowed as the voucher itself declines in magnitude. The two curves in the figure meet when income heterogeneity becomes sufficiently high that the equilibrium voucher is zero.

5. Concluding Remarks

Building on the research of Ireland (1990), Rangazas (1995), and Hoyt and Lee (1998), we have analyzed provision of a voucher in political equilibrium. Public support for not-to-large vouchers is strong if the cross subsidy to public school expenditure from those switching to private schools outweighs the subsidy to those that attend private school without a voucher. The difficulty in finding political equilibrium to assess the latter is the multidimensionality of the policy vector, which leads to nonexistence of a Condorcet winner among all feasible policy vectors. We appeal to Besley and Coate’s (1997) representative democracy model to resolve the existence problem, which requires policies that are implemented to be those actually preferred by the policy maker and implies existence in our parameterization. For income distributions with heterogeneity as exhibited by the U.S. distribution, no voucher arises in equilibrium. For tighter income distributions, however, a voucher arises. We find a voucher with income distribution calibrated to the case of Douglas County, Colorado, where a voucher was recently adopted.

Our model provides a complete characterization of equilibrium with endogenous voucher level. Whether or not a voucher arises, equilibrium has the "ends against the middle" property, where a coalition of rich and poor prefer lower taxes and public expenditure balanced by middle-income households that prefer the opposite.

The model is very simple with just two goods, a numeraire and education quality equated to expenditure, and with households differing only by income. In addition to being tractable, this simple model gets to the core issue of fiscal effects of vouchers. Extensions of interest include alternative tastes for private schooling, introduction of housing markets and property taxation, and peer effects in education. Some thoughts about these extensions are as follows. We think results will be very similar in a model with housing markets and property taxation, since normality of demand for housing will imply similar incentives across the income distribution. Peer effects in education will induce resistance to vouchers associated with cream skimming. Our finding here that a tight income distribution is needed to obtain vouchers in equilibrium may be reinforced, as cream skimming will then be less of a concern. Introducing taste differences is more difficult because resolution of the existence problem will be a challenge.

Appendix

A. Representative Democracy Model with a Continuum of Types. This part of the appendix is largely an adaptation of Proposition 2 and Corollary 1 in Besley and Coate (1997) to the case of a continuum of types. Their central assumption is that the policy preference of every population member is known and, if a population member is elected, then that policy will be implemented. Their Corollary 1 states roughly that existence of a Condorcet winner among preferred policy vectors in the population implies single candidate equilibrium exists for sufficiently low cost of becoming a candidate, with the individual having the Condorcet winning policy vector the candidate (and winner). Besley and Coate assume an integer number of voters, any of whom can be a candidate. Our model assumes a continuum of voters and thus potential candidates, indexed by endowed income y, with continuous distribution F(y) and density f(y), the latter positive on the support of y. We make analogous assumptions about preferences and equilibrium as do BC. We next summarize those assumptions and introduce a bit more notation, and then report the results of interest. We provide an additional result about uniqueness of equilibrium, but under a strong modification to BC's model.

A population member has indirect utility function V = V(p,y), where p is a policy vector. In the voucher-model application, a voucher, income tax rate, and per student level of public expenditure arise in equilibrium, but the policy vector in the indirect utility function V is bivariate as one variable is eliminated by the government balanced-budget requirement. Let p*(y) denote the preferred policy choice of voter y, which we assume is unique. Let P^* denote the set of p* values; i.e., $P^* \equiv \{p^*(y) | f(y) > 0\}$. The results regard the case where there is a Condorcet winner p^w:

p^w is a Condorcet winner if $p^w \in P^*$ and $V(p^w,y) \geq V(p,y)$ for at least one-half the measure of voters for all $p \in P^*$.

Let y^w satisfy $p^w = p^*(y^w)$. Income y^w may or may not be unique though it is unique in the voucher application. However, we have multiple voters with income y^w, consistent with the notion that f(y) is positive. Let Y^w denote the set of y^w values.

Equilibrium assumes voters first decide whether to become candidates, followed by voting. Any voter can become a candidate at 0 cost, and voters choose to be candidates or not simultaneously. Given the slate of candidates, assumed non-empty at the moment, voters simultaneously and costlessly vote by voting for one candidate, though any voter can abstain. If a voter is indifferent between candidates and votes, then the voter randomizes with equal probabilities among them. The candidate receiving the highest measure of votes is the winner and that candidate's preferred policy is implemented. If there is a tie among the highest vote getters, then a winner is selected among them with equal probabilities. If no candidate enters the race or if a positive measure of votes fails to materialize, then a lousy policy p^0 is implemented, which is worse for everyone than any $p \in P^*$.[19] It is also assumed that voters never choose a weakly dominated strategy when voting.

Two preliminary results are:

Result 1: If two candidates enter, then a candidate that is majority preferred will win.

Result 2: If one candidate enters, then that candidate is elected.

Result 1 is implied by the assumption that voters never choose a weakly dominated strategy. Given that it is costless to vote, a voter is never worse off and sometimes better off voting for

[19] The notion is that chaos results if no one is elected (though this assumption is becoming increasingly difficult to defend). One can weaken the assumption. Note, too, that BC assumed, if only one candidate enters, that candidate is automatically the winner (as that candidate could vote for himself if no one else votes). Since we require a positive measure of votes to win given the continuum, we must modify the assumption a bit.

their preferred candidate if there are just two candidates.[20] As well, sincere voting is implied with two candidates. Result 1 and the sincerity implication are results in BC.

Result 2 follows since everyone prefers the election of any candidate to the lousy default outcome. It is not an equilibrium for a zero measure of voters to vote.

The main result is as follows:

Result 3: Assuming a Condorcet winner among preferred policies: (i) a single candidate equilibrium having a candidate y^w exists, with that candidate elected; and (ii) a single candidate equilibrium must have a y^w elected.

Proof of Result 3: (i) If only a y^w becomes a candidate, then that candidate will be elected by Result 2. A y^w becoming a singleton candidate is an equilibrium, since, by Result 1, any $y \notin Y^w$ would not be elected and then gains nothing by also entering; nor would another y^w entering gain since his preferred policy arises anyway. (ii) It is not an equilibrium for any $y \notin Y^w$ to be the only entrant, since, by Result 1, a y^w would enter and win the election.

■

We emphasize that Result 3 is a simple adaptation of BC's Corollary 1.

We can modify the BC model to generate uniqueness of equilibrium with equilibrium policy p^w. Assume two parties that simultaneously offer their party's candidacy to any voter. Only party candidates run. Once the slate is set, voters simultaneously vote as above. Preferences are as above, in particular party affiliation of a candidate does not affect preferences. Such a political process might arise if running for election is prohibitively costly for a non-affiliated candidate, while the party bears all running costs from exogenous funds for their

[20] If the two candidates are equally preferred by everyone, then everyone still votes in equilibrium to avoid the possibility that no one votes and the lousy default policy arises.

affiliated candidate. A party wants to win the election. Under these assumptions and assuming a Condorcet winner:

Result 4:[21] Equilibrium has each party offer their candidacy to a y^w, at least one accept the offer, and resulting policy p^w.

Obviously, the parties offer a candidacy to a y^w. At least one accepts the candidacy offer to avoid the default policy if neither runs. Whether one or both potential candidates run, voting equilibrium obviously implies that p^w is implemented.

B. Uniqueness of the Minimum of the Problem in (4). One can see by inspection of (4) that the minimum requires the constraint to hold with equality. Thus the minimum is the minimal t that satisfies: $tY = (1-F(y_T))g+F(y_T)v$ for $v \geq 0$, where we drop the * on g. Let $t^m(v)$ satisfy the latter equation. If and only if $t^m(v)$ is convex whenever $dt^m/dv = 0$ is the local minimum unique. Straightforward calculation implies:

$$\text{(a1)} \qquad \left.\frac{d^2t^m}{dv^2}\right|_{\frac{dt^m}{dv}=0} = \frac{-2f\,\frac{\partial y_T}{\partial v} + (g-v)[f'\left(\frac{\partial y_T}{\partial v}\right)^2 + f\,\frac{\partial^2 y_T}{\partial v^2}]}{Y + f\,\frac{\partial y_T}{\partial t}(v-g)}.$$

From (7a), we know the denominator of the RHS of (a1) is positive (using that $\lambda < 0$ as discussed in the text). The convexity condition then holds if the numerator is positive whenever $dt^m/dv = 0$. While we know the first term in the numerator (with sign) is positive, the rest of the numerator depends on the specifics of f and the utility function.

[21] Jackson, Mathevet, and Mattes (2007) provide a similar result. See their Propositions 1 and 2.

References

Bearse, Peter, Buly Cardak, Gerhard Glomm, and B. Ravikumar, “Why Do Education Vouchers Fail?” 2009, working paper.

Besley, Timothy and Stephen Coate, “An Economic Model of Representative Democracy,” *Quarterly Journal of Economics*, 1997, 112, February 1997, 85-114.

Brunner, Eric and Stephen L. Ross, “Is the Median Voter Decisive? Evidence from Referenda Voting Patterns,” *Journal of Public Economics*, forthcoming.

Chen, Zhiqi and Edwin G. West, “Selective versus Universal Vouchers: Modeling median Voter Preferences in Education,” *American Economic Review*, 90**,** December 2000, 1520-1534.

Epple, Dennis and Richard Romano, “Ends Against the Middle: Determining Public Service Provision when there are Private Alternatives,” *Journal of Public Economics*, 62, 1996a, 297-325.

____________________, “Public Provision of Private Goods,” *Journal of Political Economy*, 104, February 1996b, 57-84.

__________________, “Educational Vouchers and Cream Skimming, *International Economic Review*, 49, 2008, 1395–1435.

__________________, “Economic Modeling and Analysis of Educational Vouchers,” 2011, mimeo.

Epple, Dennis and Holger Sieg, “Estimating Equilibrium Models of Local Jurisdictions,” *Journal of Political Economy*, 107, 1999, 645-681.

Hoyt, William and Kangoh Lee, “Educational Vouchers, Welfare Effects, and Voting,” *Journal of Public Economics*, 69, 1998, 211-228.

Ireland, Norman, “The Mix of Social and Private Provision of Goods and Services, *Journal of Public Economics*, 43, 1990, 201-219.

Jackson, Matthew, Laurent Mathevet, and Kyle Mattes, “Nomination Processes and Policy Outcomes,” *Quarterly Journal of Political Science*, 2, 2007, 67-94.

Kenny, Lawrence, “The Collective Allocation of Commodities in a Democratic Society,” *Public Choice*, 33, 1978, 117-120.

Mas-Colell, Andreu, Michael D. Whinston, and Jerry R. Green, *Microeconomic Theory*, 1995, Oxford University Press, New York, New York.

Nechyba, Thomas, “School Financed induced Migration Patterns: The Case of Private School Vouchers,” *Journal of Public Economic Theory*, 1,1999, 5-50.

_________, “Mobility, Targeting, and Private School Vouchers,” *American Economic Review*, 90, 2000, 130-146.

Plott, Charles, “A Notion of Equilibrium and its Possibility under Majority Rule,” *American Economic Review*, 57, September 1967, 787-806.

Rangazas, Peter, “Vouchers and Voting: An Initial Estimate Based on the Median Voter Model,” *Public Choice*, 82, 1995, 261-279.

Table 1

	Superintendent Income (y^w)	Income Indifferent Household (y_T)	Percent in Public	Public Expend. (g)	Tax Rate (t)	Voucher (v)
Equilibrium Allowing Voucher	$88,371	$227,726	92.0%	$9203	.0726	$1,684
Equilibrium Not Allowing Voucher	$90,418	$243,142	93.5%	$9199	.0727	__

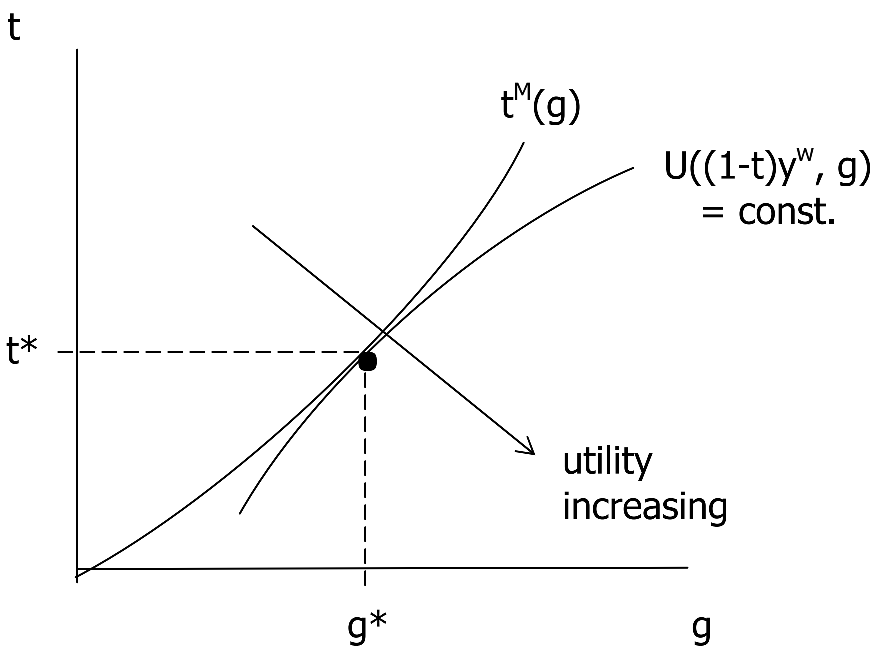


Figure 1

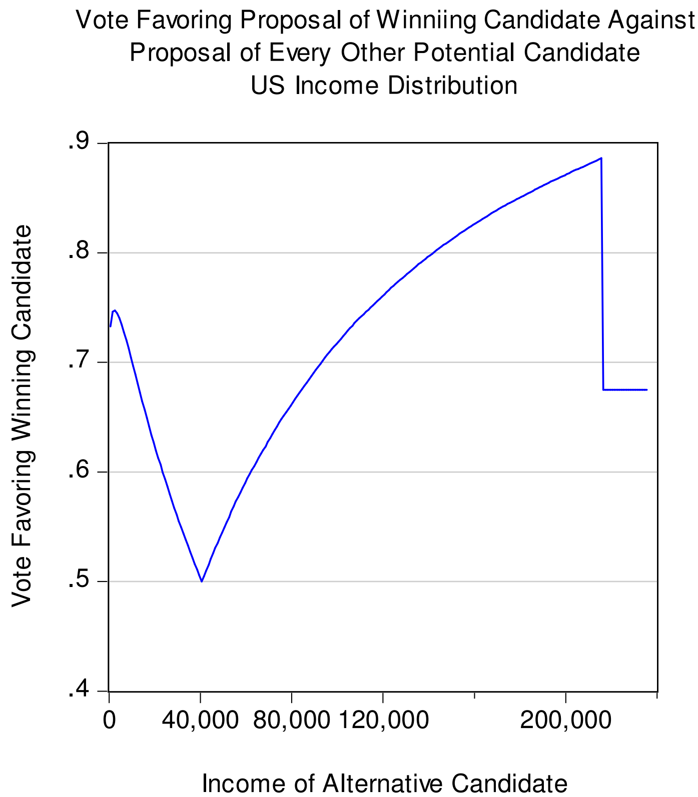

Vote Favoring Proposal of Winniing Candidate Against
Proposal of Every Other Potential Candidate
US Income Distribution
Vote Favoring Winning Candidate
.9
.8
.7
.6
.5
.4
0
40,000
80,000
120,000
200,000
Income of Alternative Candidate

Figure 2

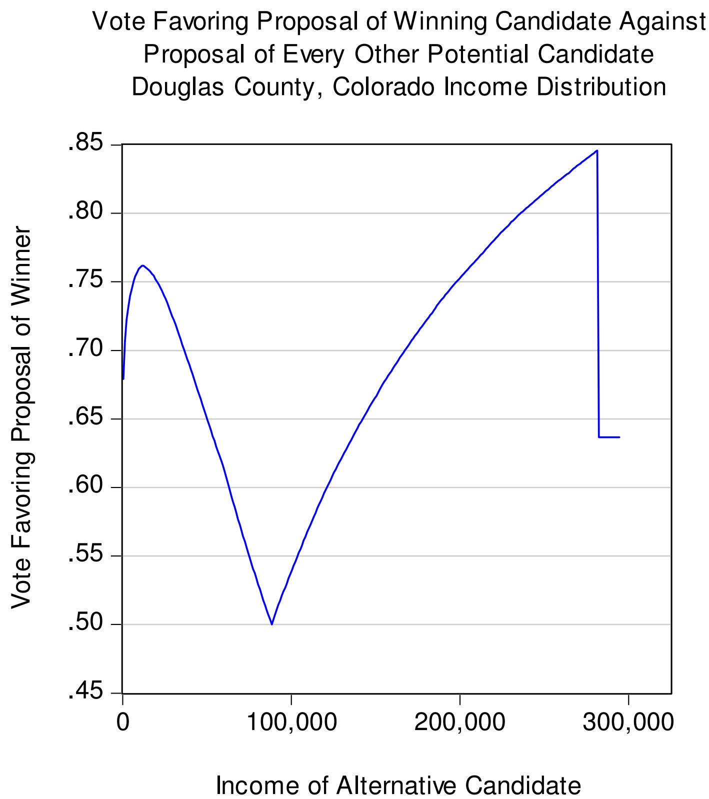
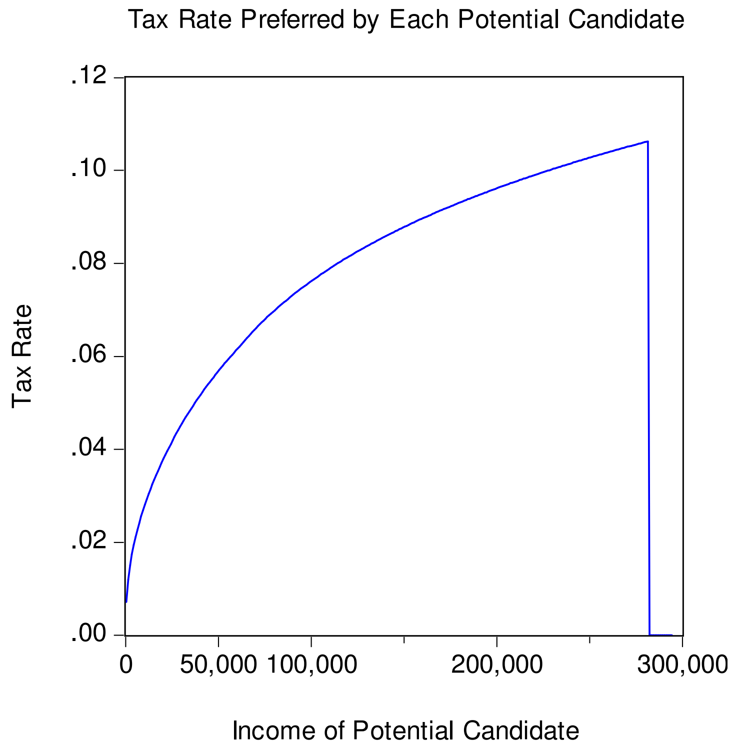

Vote Favoring Proposal of Winning Candidate Against
Proposal of Every Other Potential Candidate
Douglas County, Colorado Income Distribution
Vote Favoring Proposal of Winner
.85
.80
.75
.70
.65
.60
.55
.50
.45
0
100,000
200,000
300,000
Income of Alternative Candidate

Figure 3


Tax Rate Preferred by Each Potential Candidate
.12
.10
.08
.06
.04
.02
.00
Tax Rate
0
50,000 100,000
200,000
300,000
Income of Potential Candidate

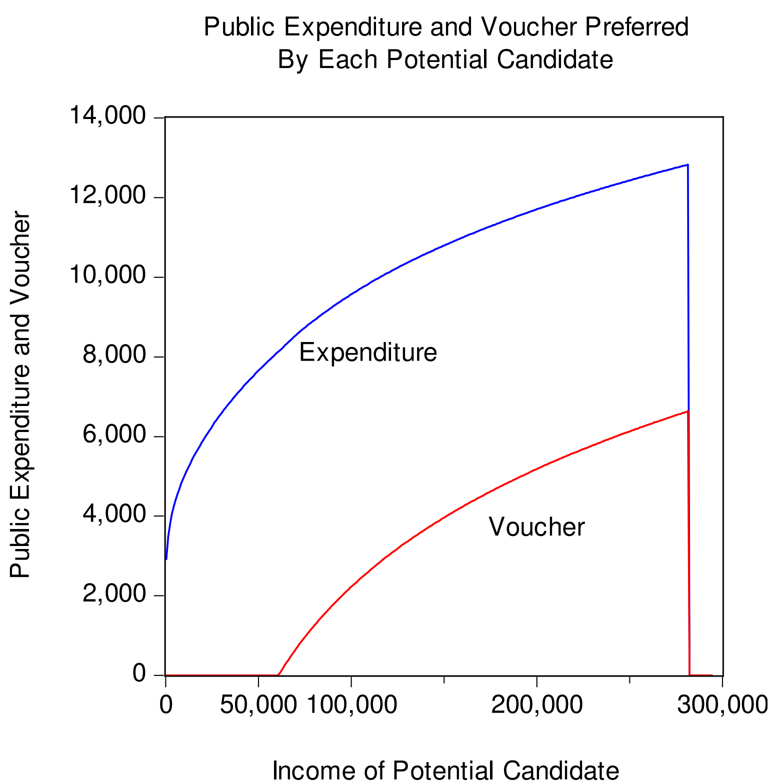

Public Expenditure and Voucher Preferred
By Each Potential Candidate
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Public Expenditure and Voucher
Expenditure
Voucher
0
50,000 100,000
200,000
300,000
Income of Potential Candidate

Figure 4

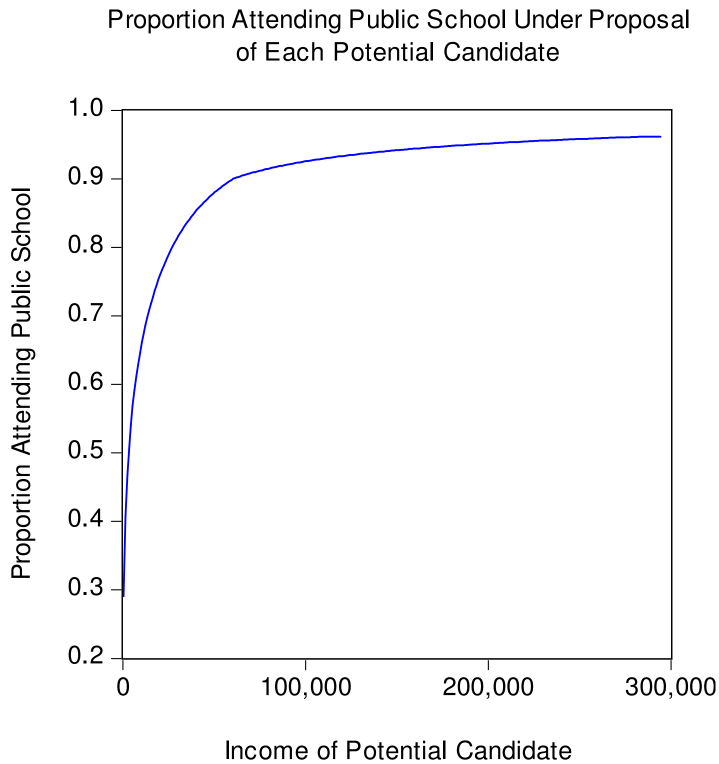

Proportion Attending Public School Under Proposal
of Each Potential Candidate
Proportion Attending Public School
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0
100,000
200,000
300,000
Income of Potential Candidate

Figure 5

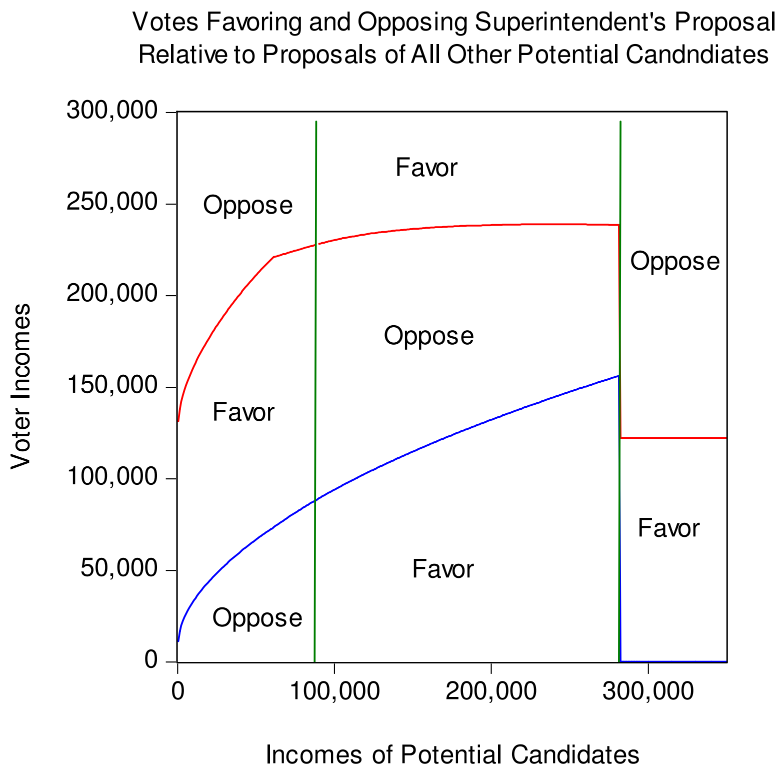


Figure 6: Voting Coalitions

Effect of Income Heterogeneity on Majority-Preferred Public Spending and Voucher
Mean Income Held Constant

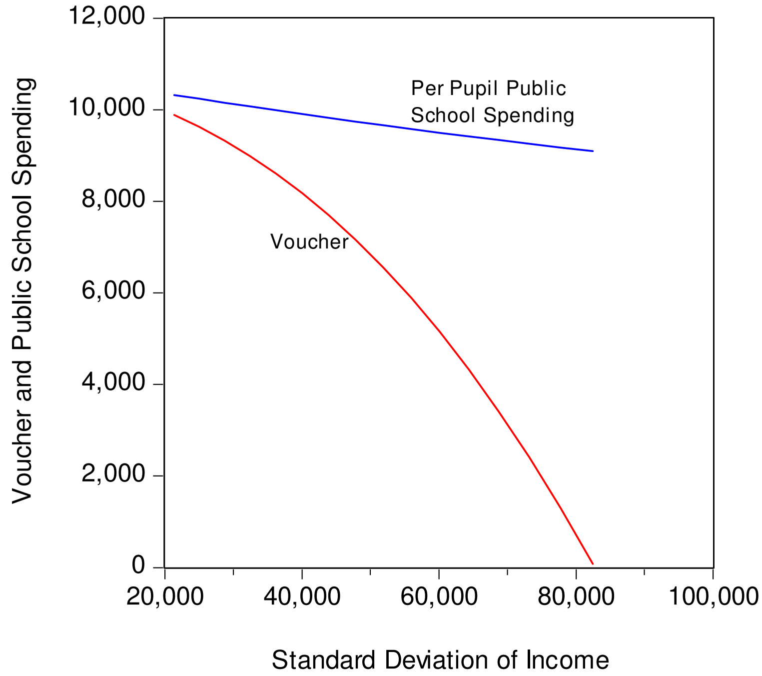


Figure 7

Equilibrium Public Share When Vouchers Permitted and When Prohibited
Mean Income Held Constant

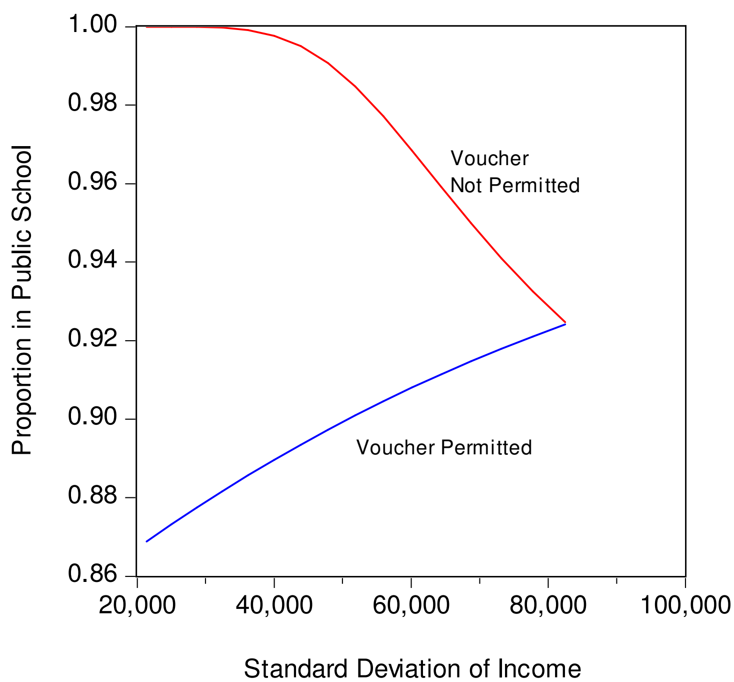


Figure 8