Majority Voting and Means-Tested Vouchers*

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December 6, 2001

Abstract

We develop a model of publicly funded means-tested education vouchers. In this model, the voucher received by each household is a decreasing function of household income. We prove the existence of a sequential majority voting equilibrium where households vote over both the level of public provision and the extent of means testing. In a setting calibrated to match characteristics of U.S. education data, we find that the means-tested voucher regime is majority preferred to the status quo mixed public-private regime, whereas a uniform voucher is not. We show that our results are robust to changes in preference parameters, income distribution and assumptions about voter turnout.

1 Introduction

In the year 2000, two U.S. states — California and Michigan — put proposals for large scale, statewide education vouchers on their ballots. Under

*We are thankful for helpful comments from V.V. Chari and from seminar participants at Ben Gurion University, Tel Aviv University, The Federal Reserve Bank of Minneapolis and the University of Illinois. All remaining shortcomings are entirely our own.

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the plan developed in California, each child, rich or poor, was to receive a \$4,000 voucher. Under Michigan's plan, children in under-performing public school districts would have received a voucher of \$3,300. Both proposals were soundly rejected in statewide elections with opposition at the ballot box in excess of 60%. These two cases are the most recent in a string of defeats involving vouchers. Tax credits for private schools and other measures of government support for school choice have been defeated in statewide ballots ten times in recent years. This phenomenon is not limited to the United States. In particular, education voucher plans of scope greater than that of an experimental level are rare in other countries as well.[1] The predominant institutional arrangement to provide education seems to be the coexistence of public and private education (see James, 1987).

In this paper, we examine why education voucher programs have been failures at the ballot box. We present a theory of political support for (or opposition to) education vouchers. The government, in our model, collects a tax on income and uses the tax revenue to finance sheets of paper called education vouchers. Each school age child receives one voucher. These vouchers can only be used for education. The government does not *provide* education; it only *finances* education. Given the amount of the voucher each child receives, households determine the level of educational services to provide for their children. Some households choose to supplement vouchers with own income, while others do not. The amount of public funding for these vouchers is determined through majority voting.

Our paper examines the conditions under which a voucher system will be majority-preferred to the current education regime involving a mix of public and private schools. We find that a uniform voucher system, similar to the one recommended by Friedman about 40 years ago, will not be majority-preferred to the current education regime. However, a means-tested voucher system, where the voucher amount is inversely related to household income, will defeat the current education regime at the polls.

To illustrate our findings, we use the model of Epple and Romano (1996) and Glomm and Ravikumar (1998) as our benchmark education finance regime. In that model, both public and private schools coexist. Public schools are free, whereas private schools charge tuition. All households pay taxes to fund education, but they can opt out of public schools to attend a

[1] For descriptions and differing interpretations of these experiments, see West (1997) and Carnoy (1997).

private school of their choice. As in the case of vouchers, the funding level for public education in this mixed public-private regime is determined by majority voting. We calibrate this mixed model to match US data. We then conduct computational experiments where we give voters a choice between the current mixed regime and a voucher regime. We think of this as a constitutional reform, where the regime is switched once and for all but future funding levels are still determined endogenously through majority voting.

We find that a regime where all households receive a uniform (i.e., identical) voucher, such as the scheme proposed in California, is unable to garner a majority of the vote. Under our parameterization, the bottom 68% of the income distribution stands to lose from such a voucher program and will oppose it at the ballot box. The richest 32% of the population gains due to the lower equilibrium tax rate under the uniform voucher regime. This finding is robust to various specifications for the preference and income distribution parameters, as well as for different specifications concerning voter turnout.

Given our finding that uniform vouchers are not likely to generate enough support at the polls, we next consider whether some form of a means-tested voucher program might.[2] In our model of means-tested vouchers, we simply make the voucher amount linear in income (subject to non-negativity). Everything else is identical to the uniform voucher regime described above. Under this means-tested voucher regime, the political variable is two-dimensional, involving (i) the total level of funding and (ii) the extent of means testing. To avoid well-known existence problems associated with multidimensional voting, we determine these political outcomes sequentially. In the first stage, the funding level is determined, while the extent of mean-testing is decided in the second stage.

We again give voters a choice between the current mixed public-private regime and the means-tested voucher regime. We now find that the means-tested voucher regime is chosen by a majority of voters. This majority consists of a coalition of the rich and poor. Under means-tested vouchers, the rich gain from lower taxes while the poor gain from larger vouchers. Again this result is robust to different specifications.

In related work, Chen and West (2000) study targeted education vouch-

[2] Many public subsidies around the world are targeted or means–tested (see van de Walle and Nead, 1995). Some of the more prominent voices in the public debate over education vouchers have argued that vouchers should be means-tested and, in fact, a number of the small-scale, experimental voucher programs in the US, such as the program in Milwaukee, are means-tested.

ers.[3] In their model, all households with income below a threshold receive the same voucher amount whereas households with higher income receive no voucher at all. In equilibrium, only households with incomes less than or equal to that of the decisive voter in the mixed public-private school regime receive a voucher. This leaves the tax rate and the redistribution of tax revenues unaffected by the regime switch. Absent any efficiency gains, all households are indifferent between the mixed and the targeted voucher regimes, so the choice of regime is indeterminate under majority voting. Under an *assumed* level of efficiency gains, they find that their targeted voucher regime is majority preferred to the mixed public-private regime whereas the uniform voucher regime is not. This latter conclusion depends heavily on the extent of the presumed efficiency gains in their model. However, the evidence on efficiency gains in voucher experiments is somewhat mixed (see, for instance, Parry (1997) on Chile, Ladd and Fiske (2000, 2001) on New Zealand, and Filer and Munich (2000) on the Czech Republic and Hungary).[4] We have instead chosen to abstract from production efficiencies entirely and focus just on the political support for different tax and (in-kind) transfer schemes. Despite the lack of efficiency gains, we find that means-tested vouchers are majority preferred to the mixed regime whereas uniform vouchers are not.

The structure of the paper is the following. In section 2, we develop our model of means-tested vouchers and prove that a sequential majority voting equilibrium will exist for this regime. In section 3, we calibrate the mixed public-private regime to match characteristics of the U.S. data in 1989. We then conduct computational experiments to examine the popular support for the different voucher regimes in binary comparisons with this benchmark mixed public-private regime. In section 4, we examine the welfare implications of the proposed voucher regimes. Section 5 examines the sensitivity of our results to alternative assumptions about preferences and the income distribution. In each of sections 3 through 5, we consider both the case where all households vote as well as one where the propensity to vote is an increasing function of income. Concluding statements are contained in section 6. Proofs of lemmata and propositions are in the appendix.

[3]Other work on education vouchers includes Hoyt and Lee (1998), Nechyba (1999, 2000), Rangazas (1995) and Bearse, Glomm and Ravikumar (2000). For a study of other institutional arrangements in education see, for example, Fernandez and Rogerson (1999).

[4]See also Hoxby (2000), Husted and Kenny (1996) and Angrist et al. (2001) for evidence on efficiency gains in education if public schools are exposed to more competition.

2 Model

The economy is populated by a large number of households. Households differ only by income, y, which is endowed across households according to the c.d.f. F (p.d.f. f). The support of F is nonnegative and mean income, Y, exceeds median income, y_m. Households derive utility from a numeraire consumption good c and a good e which we refer to as education. The common utility function is $u(c,e)$ which is strictly increasing in both arguments, strictly quasiconcave, and twice continuously differentiable. For technical convenience, we follow Epple and Romano (1996) and impose the following:

Assumption 1 *For $c_1 > 0$, $e_1 > 0$, $c_2 \geq 0$, and $e_2 \geq 0$,*

$$u(c_1, e_1) > \max\{u(c_2, 0), u(0, e_2)\}.$$

The market for e is assumed to be perfectly competitive with a large number of producers facing identical technologies exhibiting constant marginal costs. We measure units of e so as to normalize its consumption price to one.

The government collects a tax on income at the rate $\tau \in [0,1]$. Total tax revenue is given by τY. All tax revenue is used to finance education vouchers which are means-tested in the sense that the voucher amount depends inversely on income and there is an income threshold above which a household receives no voucher. Formally, the voucher amount going to a household with income y is given by

$$v(y;\alpha,\beta) = Max\{\alpha - \beta y, 0\}, \quad \alpha \geq 0, \quad \beta \geq 0. \tag{1}$$

Under this specification, the extent of means-testing is determined by β. We assume that the government runs a balanced budget; i.e.,

$$\int_0^\infty v(y;\alpha,\beta) f(y)\, dy = \tau Y.$$

Equivalently, since the voucher amount is 0 for a household with income larger than $\frac{\alpha}{\beta}$, we can write the balanced budget restrictions as

$$\alpha F(\alpha/\beta) - \beta \int_0^{\alpha/\beta} y f(y)\, dy = \tau Y. \tag{2}$$

We let $\widetilde{\alpha}(\tau,\beta)$ be the value of α satisfying (2) given (τ,β), and we refer to (2) as the government budget constraint (GBC).

2.1 Household Optimization

Each household treats α, β, and τ as fixed and chooses the pair (c, e) so as to maximize utility $u(c, e)$ subject to the household budget constraint

$$c + e \leq (1 - \tau) y + v(y; \alpha, \beta), \quad c \leq (1 - \tau) y. \tag{3}$$

The indirect utility of a household with income y is given by

$$V(\alpha, \beta, \tau, y) \equiv u((1 - \tau) y + v(y; \alpha, \beta) - \widehat{e}, \widehat{e}) \tag{4}$$

where

$$\begin{aligned} \widehat{e} &\equiv \widehat{e}((1 - \tau) y, v(y; \alpha, \beta)) \\ &\equiv \underset{\{e \in [v(y;\alpha,\beta),(1-\tau)y+v(y;\alpha,\beta)]\}}{\arg\max} u((1 - \tau) y + v(y; \alpha, \beta) - e, e). \end{aligned}$$

A household with income y supplements its voucher (i.e., $\widehat{e} > v(y; \alpha, \beta)$) if and only if

$$\left. \frac{\partial u((1 - \tau) y + v(y; \alpha, \beta) - e, e)}{\partial e} \right|_{e = v(y;\alpha,\beta)} > 0$$

or, equivalently,

$$R(y) \equiv \frac{u_1((1 - \tau) y, v(y; \alpha, \beta))}{u_2((1 - \tau) y, v(y; \alpha, \beta))} < 1$$

where the subscripts here denote partial derivatives of u.

To generate an equilibrium wherein the richer households are the ones who supplement their vouchers, we further restrict preferences:

Assumption 2 *For all* $\alpha > 0$, $\beta < \infty$, *and* $\tau \in (0, 1)$,

(i) $R(y)$ *is strictly decreasing in* y,
(ii) $\lim_{y \searrow 0} R(y) > 1$, *and*
(iii) $\lim_{y \nearrow \infty} R(y) < 1$.

Normality of e is a sufficient condition for part (i) of assumption 2. Parts (ii) and (iii) of this assumption ensure that, for income distributions with support on the real line, there exist both low income households who do not supplement their voucher as well a rich households who do supplement their voucher. Then we have the following proposition:

Proposition 1 *For all $\alpha > 0$, $\beta < \infty$, and $\tau \in (0,1)$, there exists a unique level of income $\overline{y} \equiv \overline{y}(\alpha, \beta, \tau) \in (0, \alpha/\beta)$ such that a household y supplements its voucher if and only if $y > \overline{y}$. This $\overline{y}$ is implicitly defined by*

$$u_1\left((1-\tau)\overline{y}, v\left(\overline{y}; \alpha, \beta\right)\right) = u_2\left((1-\tau)\overline{y}, v\left(\overline{y}; \alpha, \beta\right)\right).$$

Remark 1 *In cases where $\alpha = 0$ or $\beta = \infty$, no household y can obtain a nonzero voucher. Assumption 1 then guarantees that all households supplement. When $\tau = 0$, the GBC requires $\alpha = 0$. When $\tau = 1$,* (3) *implies that all households get zero consumption. Assumption 1 will rule this out as a potential equilibrium.*

From proposition 1 it follows that the optimal school quality choice for a household with income y is

$$\widehat{e} = \begin{cases} v\left(y; \alpha, \beta\right) & \text{if} \quad y \leq \overline{y}\left(\alpha, \beta, \tau\right) \\ e^* > v\left(y; \alpha, \beta\right) & \text{if} \quad y > \overline{y}\left(\alpha, \beta, \tau\right) \end{cases}$$

where $e^* \equiv e^*\left((1-\tau)\, y + v\left(y; \alpha, \beta\right)\right)$ is the value of e solving

$$\frac{\partial u\left((1-\tau)\, y + v\left(y; \alpha, \beta\right) - e, e\right)}{\partial e} = 0.$$

2.2 Politico-Economic Equilibrium

The voting problem in this means-tested voucher regime is two dimensional: once τ and β are determined, the value of α is pinned down by (2). We thus think of a public policy as being the pair (τ, β) and we determine the choice of this policy through majority voting. To do this, the voting problem is solved in two stages. In the first stage, individuals vote on the tax rate τ anticipating how the redistribution parameter β will be chosen in the second stage. In the second stage, β is voted on taking τ as given from the first stage.

Definition 1 *A **politico-economic equilibrium** for this economy is an allocation (c, e) across households and a public policy (α, β, τ) satisfying **(i)** Each household's choice of (c, e) is individually rational given public policy (α, β, τ); **(ii)** Given τ, β is a majority winner in the second stage; **(iii)** Anticipating how τ affects voting over β, τ is a majority winner in the first stage; and, **(iv)** The government runs a balanced budget; i.e., $\alpha = \widetilde{\alpha}(\tau, \beta)$.*

We define majority voting in the usual sense of binary comparisons between all candidates. We treat voters as sincere in that they will vote for the candidate that maximizes their utility in any binary comparison between candidates.[5] We say that a candidate is a *majority winner* if and only if no other candidate satisfying the *GBC* is strictly preferred to it by a strict majority of the population.

2.3 Stage 2 Voting

Here we solve the problem of voting over β given τ and (2). A household with income y wants to choose β to maximize (4) subject to (1) and (2). Formally, her optimal β is

$$\widehat{\beta}(\tau, y) \equiv \underset{\{\beta \geq 0\}}{\arg\max} V(\widetilde{\alpha}(\tau, \beta), \beta, \tau, y).$$

Lemma 1 *For a given $\tau \in (0,1)$ and each income y,*

$$\widehat{\beta}(\tau, y) = \begin{cases} 0 & \text{if} \quad y \geq Y \\ \beta^* > 0 & \text{if} \quad y < Y \end{cases}, \tag{5}$$

where $\beta^* \equiv \beta^*(\tau, y)$ is the value of β solving

$$y = \frac{\partial \widetilde{\alpha}(\tau, \beta)}{\partial \beta}$$

and $\widetilde{\alpha}\left(\tau, \widehat{\beta}(\tau, y)\right) / \widehat{\beta}(\tau, y) > y$.

Remark 2 *When $\tau = 0$, $\widetilde{\alpha}$ equals zero for all β and the stage 2 problem is irrelevant. The case $\tau = 1$ can never occur in equilibrium since every household would get zero consumption, and this is ruled out by assumption 1.*

Figure 1 depicts indifference curves and the *GBC* in the (β, α) plane for the stage 2 problem of a voter (i.e., household) with income y. The associated indirect utility function is plotted in Figure 2. From equation (1), we know

[5] In this section, we assume that all households actually vote. In our computational experiments below, we also consider the possibility that the probability of voting is an increasing function of income.

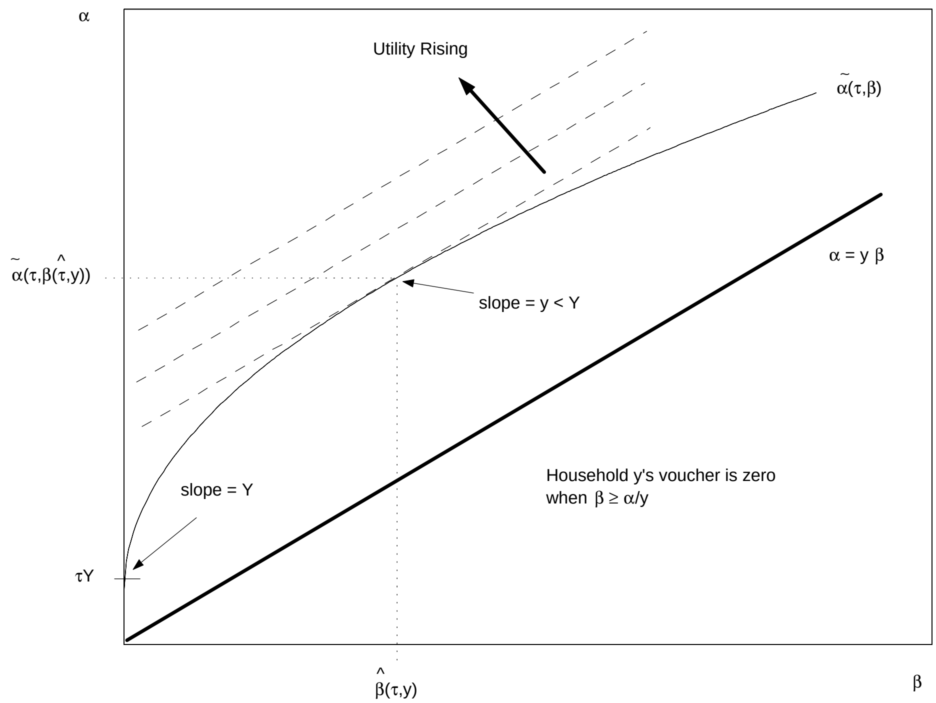

Figure 1: The Stage 2 Voting Problem

that this household gets a nonzero voucher if and only if $\beta < \alpha/y$. Define $\ddot{\beta}(\tau, y)$ such that

$$y = \widetilde{\alpha}\left(\tau, \ddot{\beta}\right)/\ddot{\beta}. \tag{6}$$

Since $\widetilde{\alpha}(\tau, \beta)/\beta$ is strictly decreasing in β, we know that the household gets a nonzero voucher if and only if $\beta < \ddot{\beta}(\tau, y)$. Thus, while $V(\widetilde{\alpha}(\tau, \beta), \beta, \tau, y)$ is strictly concave in β over the region $\beta \in \left[0, \ddot{\beta}(\tau, y)\right]$, it is flat for all $\beta \geq \ddot{\beta}(\tau, y)$.

Proposition 2 $\widehat{\beta}(\tau, y_m)$ *is a majority winner when voting over* β *given* τ*.*

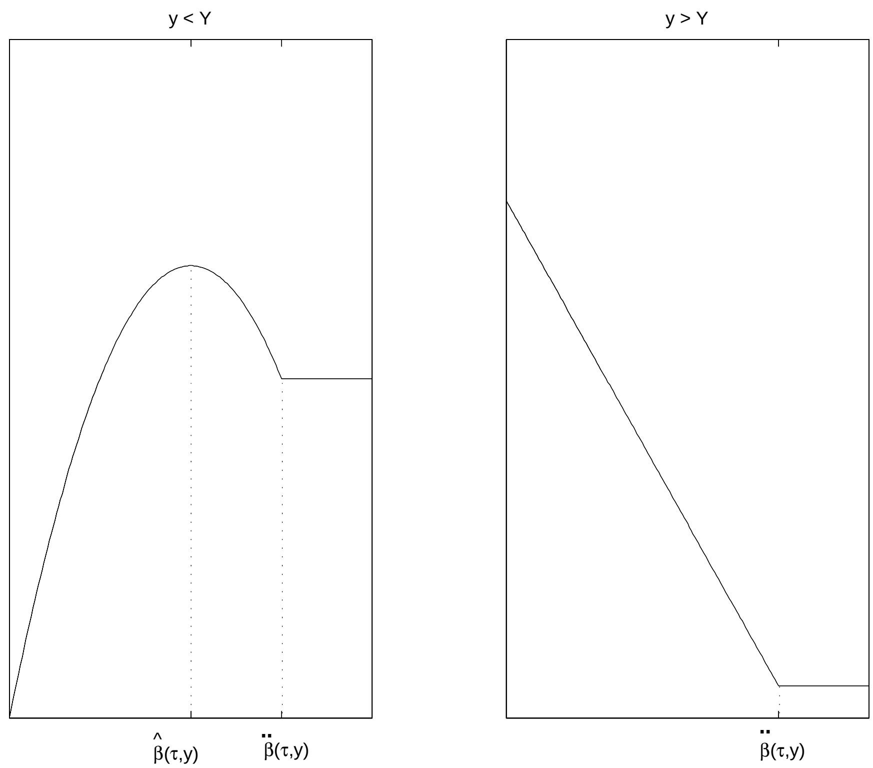

Figure 2: Indirect Utility, $V(\widetilde{\alpha}(\tau, \beta), \beta, \tau, y)$, as a function of β holding τ constant

From Proposition 2 and the assumption that $y_m < Y$, the stage 2 majority winning β is given by

$$\widehat{\widehat{\beta}} \equiv \widehat{\widehat{\beta}}(\tau) \equiv \widehat{\beta}(\tau, y_m) > 0 \tag{7}$$

for all $\tau \in (0, 1)$. The following lemma further characterizes $\widehat{\widehat{\beta}}$:

Lemma 2 $\widehat{\widehat{\beta}}(\tau)$ *is strictly increasing and proportional to the tax rate* τ*.*

As a result of Lemma 2 we can write

$$\widehat{\widehat{\beta}}(\tau) = k_\beta \cdot \tau \; for \; some \; k_\beta > 0. \tag{8}$$

2.4 Stage 1 Voting

Here we determine how our economy chooses τ given $\widehat{\widehat{\beta}}(\tau)$ and the GBC. We begin with the following lemma:

Lemma 3 *$\widetilde{\widetilde{\alpha}}(\tau) \equiv \widetilde{\alpha}\left(\tau, \widehat{\widehat{\beta}}(\tau)\right)$ is strictly increasing and proportional to the tax rate τ.*

As a result of Lemma 3 we can write

$$\widetilde{\widetilde{\alpha}}(\tau) = k_\alpha \cdot \tau \text{ } for \text{ } some \text{ } k_\alpha > 0. \tag{9}$$

From the perspective of a stage 1 voter with income y, indirect utility over funding levels τ is given by

$$V^1(\tau, y) \equiv V\left(\widetilde{\widetilde{\alpha}}(\tau), \widehat{\widehat{\beta}}(\tau), \tau, y\right).$$

Let $\overline{\overline{y}}(\tau) \equiv \overline{y}\left(\widetilde{\widetilde{\alpha}}(\tau), \widehat{\widehat{\beta}}(\tau), \tau\right)$ and let $\overline{\overline{\tau}}(y) \equiv \left\{\tau : y = \overline{\overline{y}}(\tau)\right\}$. Then a household with income y supplements its voucher at τ if and only if $y > \overline{\overline{y}}(\tau)$ or, equivalently, $\tau < \overline{\overline{\tau}}(y)$. For the stage 1 problem, the indirect utility of a household with income y is given by

$$V^1(\tau, y) = \begin{cases} V^{11}(\tau, y) & \text{if} \quad \tau \geq \overline{\overline{\tau}}(y) \\ V^{12}(\tau, y) & \text{if} \quad \tau < \overline{\overline{\tau}}(y) \end{cases},$$

where

$$V^{11}(\tau, y) \equiv u\left((1-\tau)\,y, (k_\alpha - k_\beta y)\,\tau\right)$$

and

$$V^{12}(\tau, y) \equiv u\left((1-\tau)\,y + \tau \cdot \max\{k_\alpha - k_\beta y, 0\} - e^*, e^*\right).$$

The next few lemmata are used to establish that preferences over τ are single-peaked.

Lemma 4 *$V^{11}(\tau, y)$ is strictly concave in τ.*

Lemma 5 *$V^{12}(\tau, y)$ is strictly increasing in τ if and only if $y < k_\alpha / (1 + k_\beta)$.*

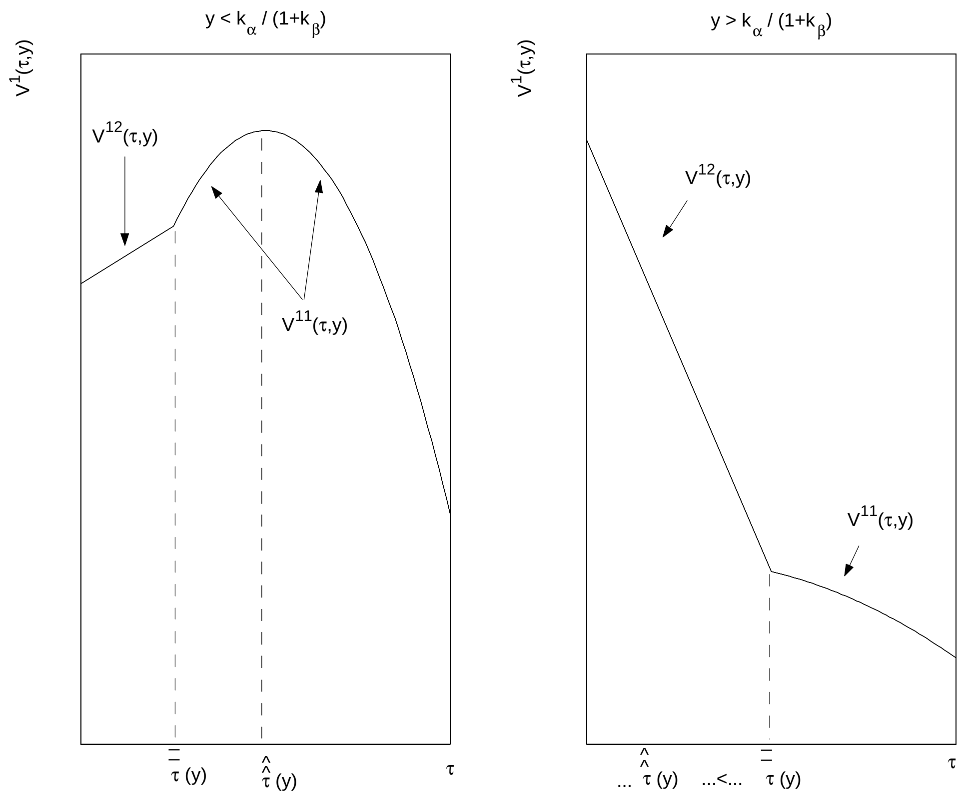

Figure 3: Indirect Utility over Tax Rates in Stage 1 Voting

Let

$$\widehat{\tau}(y) \equiv \underset{\tau\in[0,1]}{\arg\max}\, V^{11}(\tau, y) \equiv \underset{\tau\in[0,1]}{\arg\max}\, u\left((1-\tau)\, y, (k_\alpha - k_\beta y)\, \tau\right). \qquad (10)$$

Lemma 6 $\widehat{\tau}(y) < \overline{\overline{\tau}}(y)$ *if and only if* $y > k_\alpha / (1 + k_\beta)$.

Figure 3 plots indirect utility over tax rates for the stage 1 voting problem. By definition of $\overline{\overline{\tau}}(y)$, we know that $V^{11}\left(\overline{\overline{\tau}}(y), y\right) = V^{12}\left(\overline{\overline{\tau}}(y), y\right)$. Recall that $V^1(\tau, y) = V^{12}(\tau, y)$ if $\tau < \overline{\overline{\tau}}(y)$ and $V^1(\tau, y) = V^{11}(\tau, y)$ otherwise. We can then demonstrate that $V^1(\tau, y)$ is single peaked if $V^{11}(\tau, y)$ peaks at $\tau \geq \overline{\overline{\tau}}(y)$ whenever $y < k_\alpha / (1 + k_\beta)$ and $V^{11}(\tau, y)$ peaks at $\tau \leq \overline{\overline{\tau}}(y)$ whenever $y > k_\alpha / (1 + k_\beta)$. This leads to the following proposition:

Proposition 3 *Each household's preferences over funding levels are single peaked when voting on* τ *given* $\widehat{\widehat{\beta}}(\tau)$*.*

Proposition 3 tells us that a majority voting equilibrium exists for the stage 1 problem (Black, 1958). It remains to identify the decisive (i.e., "median") voter. From Figure 3, we see that households with $y < k_\alpha / (1 + k_\beta)$ most prefer $\widehat{\tau}(y)$ while those with $y > k_\alpha / (1 + k_\beta)$ most prefer $\tau = 0$. If $\widehat{\tau}(y)$ is monotonically decreasing in y, a household's most preferred tax rate is decreasing in income and y_m is the decisive voter. If $\widehat{\tau}(y)$ is monotonically increasing in y, a household's most preferred tax rate is monotonically increasing in $y \in (0, k_\alpha / (1 + k_\beta))$ and zero thereafter. In this case, we can re-number households to obtain an ordering that provides monotonic preferences for tax rates by assigning all households with $y > k_\alpha / (1 + k_\beta)$ the lowest indices. The decisive voter y_d is then implicitly defined by

$$1 - F(k_\alpha / (1 + k_\beta)) + F(y_d) = 0.5. \tag{11}$$

We note that $\widehat{\tau}(y)$ is monotonically increasing in y if and only if

$$\frac{d\left(\left.\frac{d\alpha}{d\tau}\right|_{u\left((1-\tau)y, \alpha - \widehat{\widehat{\beta}}(\tau)y\right) = const.} \right)}{dy} < 0.$$

3 Are Vouchers Electable?

In this section, we examine whether vouchers can garner a majority of the vote in binary comparisons with the mixed public-private regime of Epple and Romano (1996) and Glomm and Ravikumar (1998). We consider two voucher regimes: uniform vouchers and means-tested vouchers. The uniform voucher regime, which corresponds to a special case of the means-tested voucher regime described in section 2 where $\beta = 0$, is identical to that considered in Glomm and Ravikumar (2001).

To implement our quantitative analysis, we assume a *lognormal* (m, s^2) income distribution, and we parameterize utility according to

$$U(c, e) = \frac{1}{1 - \sigma}\left(c^{1-\sigma} + \delta e^{1-\sigma}\right), \quad \sigma > 0, \; \delta > 0. \tag{12}$$

We adopt the calibration strategy of Epple and Romano (1996). In particular, we let $m = 3.36$ and $s = 0.68$ so that mean and median incomes in our model

Incomes in Quintile	Proportion Voting
1	0.4
2	0.48
3	0.56
4	0.64
5	0.72

Table 1: Voting Turnout by Income Quintile

roughly match those for the U.S. household income distribution in 1989. We also choose $\sigma = 1.54$ and $\delta = 0.020408$ to match public funding per public pupil of $\$4,222$ in the 1989 U.S. data (assuming 0.5 pupils per household) and an implied price elasticity of demand for public education equal to -0.67.[6]

We consider the case where all households vote as well as a case where the probability of voting is an increasing function of income. In the latter case, we partitioned the income distribution into quintiles and used data from the *1990 Statistical Abstract of the United States* to assign voting probabilities. Within quintiles, we assume that the probability of voting is constant. Table 1 displays the proportion of voters by income quintile.[7]

Panels A and B of table 2 present the results for pairwise elections across regimes. We see that, for both sets of voting populations, means-tested vouchers are majority preferred to both the mixed public-private regime and to uniform vouchers.[8] Also in every case, the mixed regime is majority preferred to uniform vouchers.

Both empirical evidence (the California 1996 referendum on vouchers and Michigan 2000 referendum) and views commonly expressed in the popular press promote the widespread belief that vouchers are not politically viable. Our results indicate that this claim may be well-grounded with respect to uniform vouchers. On the other hand, our findings suggest that an appro-

[6] Solution techniques for the mixed and uniform voucher regimes are well known. (See Epple and Romano, 1996, and Glomm and Ravikumar, 2001.) Our approach to solving for equilibrium (see definition 1) in the means-tested voucher regime is described in Bearse, Glomm and Ravikumar (2000).

[7] Solving for equilibria in this case is identical to that where all households vote, except that the identity of the decisive voters in stages 1 and 2 must be determined from the income distribution of the voting population instead of that of the full population.

[8] Since uniform vouchers are a special case of the means tested voucher regime, they will never be majority preferred to means-tested vouchers.

A. Case Where All Households Vote	
Regimes	**% Voting for First Regime**
M-T Vouchers vs. Mixed	63.0
M-T Vouchers vs. Uniform Vouchers	56.7
Uniform Vouchers vs. Mixed	31.8
B. Case Where Probability of Voting Increases with Income	
Regimes	**% Voting for First Regime**
M-T Vouchers vs. Mixed	61.8
M-T Vouchers vs. Uniform Vouchers	53.3
Uniform Vouchers vs. Mixed	38.5

Table 2: Binary Voting Comparisons
(Benchmark Case where $m = 3.36$, $s = 0.68$, $\sigma = 1.54$, and $\delta = 0.020408$)

priate means-tested voucher regime could generate a majority backing. As noted earlier, this result is not driven by presumed efficiency gains in the public sector induced by competition from vouchers.

4 Who Wins and Who Loses?

An important issue concerning vouchers involves their welfare implications. Glomm and Ravikumar (2001) have shown in a calibrated general equilibrium model that uniform vouchers generate higher inequality of education spending than a mix of public and private education. Bearse, Glomm, and Ravikumar (2000) showed that, when measured by the Gini coefficient, means-tested vouchers produce less inequality of educational expenditures than do uniform vouchers, but still generate more inequality than a mix of public and private education. Greater inequality, however, does not necessarily indicate inferior outcomes for households. In this section, we examine the welfare implications across the income distribution of adopting a means-tested or uniform voucher regime. This analysis also provides some intuition for the voting results provided in table 2.

To provide a welfare metric that is invariant to monotonic transformations of the utility function, we consider a form of equivalent variation given by the value of d_{ev} solving

$$V^{Mix}(y + d_{ev}) = V^{New}(y) \tag{13}$$

where $V^{Mix}(y + d_{ev})$ denotes the utility that a household with income $y+d_{ev}$ receives in the mixed public-private equilibrium and $V^{New}(y)$ indicates the utility that a household with income y obtains in equilibrium under the proposed voucher regime. The equivalent variation d_{ev} represents the income transfer, measured in dollars (i.e., units of the numeraire), that would make a household with income y indifferent between the mixed public-private regime and the proposed voucher regime. When d_{ev} is positive, the proposed voucher regime represents a welfare improvement from the household's perspective.

Figure 4 depicts the equivalent variations as a percentage of household incomes for both the case where all households vote and the case where the probability of voting is given by table 1. In either case, we see that it is the middle to upper-middle income households who lose under means-testing. For instance, in the case where all households vote, households between the 55^{th}-75^{th} income percentiles would be willing to give up 0.6 percent or more of their income to be allowed to remain in the mixed public-private regime. When voting participation is an increasing function of income, one noteworthy difference to the case of complete voting participation is that the size of the welfare gains from shifting to the means-tested is smaller for the poor, but larger for the rich.

Our computations reveal that shifting from the mixed regime to uniform vouchers imparts welfare losses to the poorest 68 per cent of the population and welfare gains to the richest 32 per cent. The welfare losses to the poor are not higher than 0.9 per cent of income, while the welfare gains to the rich exceed in some cases 2.5 per cent of income.

5 Sensitivity Analysis

In this section, we examine whether our results presented in section 3 are robust to alternative assumptions about preferences and the income distribution.

5.1 Preferences

We begin by examining different values for the preference parameters σ and δ while maintaining the benchmark *lognormal* $(3.36, 0.68^2)$ income distribution. Epple and Romano (1996) considered four sets of values for (σ, δ), each roughly matching public education expenditure per household of $\$2,111$ and

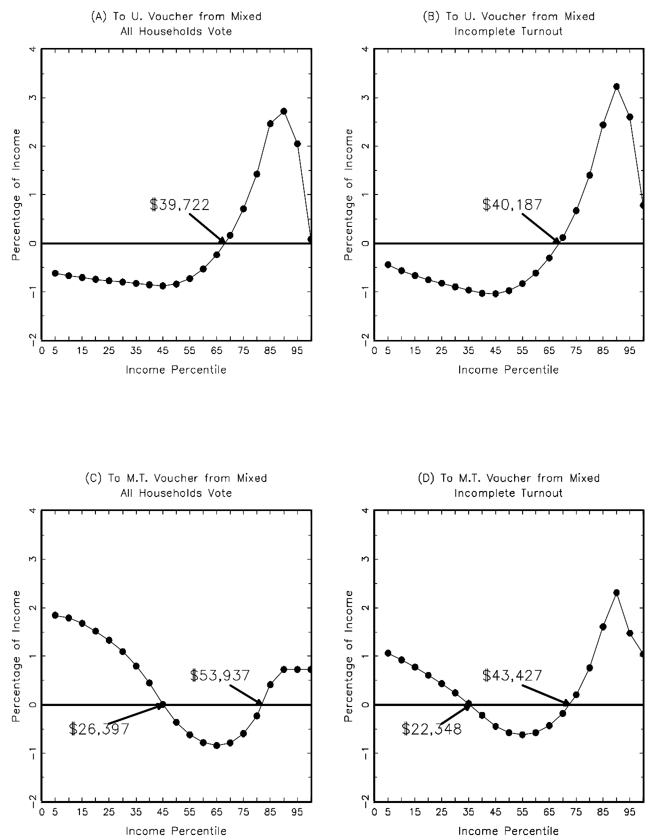

Figure 4: Equivalent Variations (Benchmark is Mixed Public-Private Regime)

σ	δ	Implied Price Elasticity of Education Demand
2.2	0.006036	-0.5
1.54	0.020408	-0.67
0.79	0.111111	-1.25
0.65	0.154734	-1.5

Table 3: Alternative Preference Parameter Values

A. Case Where All Households Vote				
	% Voting for First Regime			
Regimes	$\sigma = 2.2$	$\sigma = 1.54$	$\sigma = 0.79$	$\sigma = 0.65$
M-T Vouchers vs. Mixed	68.8	63.0	56.6	57.0
M-T Vouchers vs. Uniform Vouchers	56.2	56.7	57.9	57.7
Uniform Vouchers vs. Mixed	40.7	31.8	24.3	39.4
B. Case Where Probability of Voting Increases with Income				
	% Voting for First Regime			
Regimes	$\sigma = 2.2$	$\sigma = 1.54$	$\sigma = 0.79$	$\sigma = 0.65$
M-T Vouchers vs. Mixed	56.2	61.8	51.1	52.1
M-T Vouchers vs. Uniform Vouchers	52.8	53.3	54.0	54.0
Uniform Vouchers vs. Mixed	49.8	38.5	32.0	47.6

Table 4: Binary Voting Comparisons
(Income Distribution is $lognormal\,(3.36, 0.68^2)$)

one of four implied price elasticities of education demand when evaluated at the mixed regime equilibrium. These values are displayed in table 3. In the first two rows of this table, $\widehat{\tau}\,(y)$, defined in (10), is increasing in income, while in the last two it is decreasing in income.[9]

In panels A and B of table 4, we again present the results for pairwise elections across regimes. We see that, for both sets of voting populations and each set of preference parameters, means tested vouchers are majority preferred to both the mixed public-private regime and to uniform vouchers. Also in every case, the mixed regime is majority preferred to uniform vouchers.

[9] As in Epple and Romano's (1996) paper, we treated the case where σ = 1.54 and δ = 0.020408 as our benchmark since it delivers a public enrollment level closest to that actually observed in the 1989 U.S. data.

s	m	Median y	Gini
0.43	3.4987	\$33,074	0.2389
0.68	3.36	\$28,789	0.3846
0.93	3.1587	\$23,541	0.4892

Table 5: Mean-Preserving Spreads of Income Distribution
(Preferences fixed at $\sigma = 1.54$ and $\delta = 0.020408$; Mean income fixed at $Ey = \exp(3.36 + 0.68^2/2) \simeq 36.278$)

5.2 Income Distribution

We now examine changing the income distribution while maintaining our benchmark preference parameter values of $\sigma = 1.54$ and $\delta = 0.020408$. Under the lognormal income distribution, mean income is given by $Y = \exp(m + s^2/2)$. We fix mean income at $Y = \exp(3.36 + 0.68^2/2) \simeq 36.278$ and perform mean-preserving spreads of the income distribution using

$$m = 3.36 + 0.68^2/2 - s^2/2$$

for the values of s displayed in table 5. As is well-known for the lognormal distribution, inequality is increasing in s. Table 6 displays the results. We see that our principal findings are robust to variations in the level of income inequality. In particular, while uniform vouchers are unable to defeat the mixed public-private regime at the polls, means-tested vouchers consistently garner a majority of the vote.

6 Conclusion

In this paper we showed that uniform education vouchers do not win sufficient political support to become law. We also showed that means tested vouchers would be supported by a majority of the population. Our model's prediction is consistent with the observed string of political defeats suffered by uniform voucher proposals. The main conclusion of our paper is that vouchers will not be politically viable unless they are means-tested.

In drawing this conclusion, we have abstracted from the decentralized nature of the provision of education as it is found in some states in the US. We do not view this as a serious shortcoming. It seems clear that with decentralized financing the upper middle class would sort themselves into

A. Case Where All Households Vote			
Regimes	**% Voting for First Regime** $s = 0.43$	$s = 0.68$	$s = 0.93$
M-T Vouchers vs. Mixed	58.1	63.0	65.1
M-T Vouchers vs. Uniform Vouchers	55.4	56.7	57.5
Uniform Vouchers vs. Mixed	37.1	31.8	30.2

B. Case Where Probability of Voting Increases with Income			
Regimes	**% Voting for First Regime** $s = 0.43$	$s = 0.68$	$s = 0.93$
M-T Vouchers vs. Mixed	64.9	61.8	61.6
M-T Vouchers vs. Uniform Vouchers	50.3	53.3	54.8
Uniform Vouchers vs. Mixed	47.5	38.5	36.5

Table 6: Binary Voting Comparisons
(Income Distribution is *lognormal* $(\ln(Ey) - s^2/2, s^2)$ where $Ey = \exp(3.36 + 0.68^2/2) \simeq 36.278$)

districts with high expenditure on education and good schools. With such sorting, political support for uniform vouchers will be even smaller than in our set-up. We thus regard our results on the support for uniform vouchers as an upper bound.

As noted earlier, we have also abstracted completely from any efficiency gains associated with the introduction of education vouchers. If the efficiency gains are in fact sizeable, such gains might garner additional political support for uniform vouchers vis-a-vis the status quo, so our result on the lack of support for uniform vouchers could change. How such efficiency gains affect the race between uniform vouchers versus status quo relative to the race between means-tested vouchers versus status quo is an open question. We leave this issue for future work.

Finally, in our model individuals are differentiated only by income. There are no differences in the number of children per family or in preferences. The number of children in a family will most likely influence the family's vote for a voucher regime. Since a large share of the private schools are Catholic, it might be useful also to incorporate in future work differences in preferences that are based on religion. Cohen-Zada and Justman (2001 a, b) study the impact of religious preferences on vouchers, but their vouchers are more limited in scope than ours. We leave for future work the study of the political support for large-scale vouchers when there are several types of heterogeneity.

Appendix

Proof of Proposition 1. For $\alpha > 0$ and $\beta < \infty$, there exists $y > 0$ such that $\alpha - \beta y > 0$. Existence and uniqueness of $\overline{y}$ then follow directly from assumption 2 parts (ii)-(iii) and continuity of $R(y)$. Also by assumption 2, $R(y) < 1$ if and only if $y > \overline{y}$ so y supplements if and only if $y > \overline{y}$. To see that $\overline{y} < \alpha/\beta$, suppose otherwise. Then there exists a household who does not supplement and gets a zero voucher. Assumption 1 rules this out. ■

Proof of Lemma 1. Holding τ fixed, the utility of a household with income y rises to the northwest in the (β, α) plane (see Figure 1). For those points where $y \leq \alpha/\beta$, the slope of y's stage 2 indifference curve in the (β, α) plane is

$$\left.\frac{\partial \alpha}{\partial \beta}\right|_{V(\alpha,\beta,\tau,y)=const.} = -\frac{\partial V(\alpha, \beta, \tau, y)/\partial \beta}{\partial V(\alpha, \beta, \tau, y)/\partial \alpha} = y > 0.$$

Applying the implicit function theorem to (2), the slope and curvature of the GBC are given by

$$\frac{\partial \widetilde{\alpha}(\tau, \beta)}{\partial \beta} = \frac{\int_0^{\widetilde{\alpha}/\beta} y f(y)\, dy}{F(\widetilde{\alpha}/\beta)} > 0, \quad \frac{\partial^2 \widetilde{\alpha}(\tau, \beta)}{\partial \beta^2} = -\frac{\tau^2 Y^2 f(\widetilde{\alpha}/\beta)}{\beta^3 F(\widetilde{\alpha}/\beta)^3} < 0 \qquad (14)$$

so that, holding τ fixed, the GBC is strictly increasing and concave. Since $\lim_{\beta \searrow 0} \frac{\partial \widetilde{\alpha}(\tau,\beta)}{\partial \beta} = Y$, indirect utility $V(\alpha, \beta, \tau, y)$ is maximized at $\beta = 0$ if and only if $y \geq Y$. For $y < Y$, $V(\alpha, \beta, \tau, y)$ is maximized at

$$\left\{\beta > 0 : y = \frac{\partial \widetilde{\alpha}(\tau, \beta)}{\partial \beta}\right\}.$$

We next show that y always chooses β so that $y < \widetilde{\alpha}\left(\tau, \widehat{\beta}(\tau, y)\right)/\widehat{\beta}(\tau, y)$. Given τ, y is indifferent between all points where $\alpha \leq y\beta$. Since $\widetilde{\alpha}(\tau, 0) = \tau Y$ and the indifference curve $\alpha = y\beta$ intersects the origin, this indifference curve must then cut $\widetilde{\alpha}\left(\tau, \widehat{\beta}(\tau, y)\right)$ from below at the point

$$\left(\ddot{\beta}(\tau, y), \widetilde{\alpha}\left(\tau, \ddot{\beta}(\tau, y)\right)\right)$$

for all $\tau > 0$. Thus y can always obtain a point on the $\widetilde{\alpha}\left(\tau, \widehat{\beta}(\tau, y)\right)$ where $\alpha > y\beta$ and utility is larger than at $\left(\ddot{\beta}(\tau, y), \widetilde{\alpha}\left(\tau, \ddot{\beta}(\tau, y)\right)\right)$. ■

Proof of Proposition 2. We know from lemma 1 that $\widehat{\beta}(\tau, y_m)$ is always chosen so that household y_m gets a nonzero voucher. Thus at $\widehat{\beta}(\tau, y_m)$ all $y < y_m$ get nonzero vouchers too. Consider a candidate point $\beta_c < \widehat{\beta}(\tau, y_m)$ on the GBC. Then all households with $y \leq y_m$ strictly prefer $\widehat{\beta}(\tau, y_m)$ to β_c. Consequently, no point β on the GBC less than $\widehat{\beta}(\tau, y_m)$ can garner a majority of households who strictly prefer it to $\widehat{\beta}(\tau, y_m)$. Next consider a candidate point $\beta_c > \widehat{\beta}(\tau, y_m)$ on the GBC. Then all households with income greater than or equal y_m (at least weakly) prefer $\widehat{\beta}(\tau, y_m)$ to β_c. Consequently, no point β on the GBC greater than $\widehat{\beta}(\tau, y_m)$ can garner a majority of households who strictly prefer it to $\widehat{\beta}(\tau, y_m)$. ■

Proof of Lemma 2. From (7) and (14),

$$y_m F\left(\widetilde{\alpha}\left(\tau, \widehat{\widehat{\beta}}(\tau)\right)\right) \equiv \int_0^{\widetilde{\alpha}\left(\tau, \widehat{\widehat{\beta}}(\tau)\right)/\widehat{\widehat{\beta}}(\tau)} y f(y)\, dy.$$

Totally differentiating and using the fact that

$$\frac{d\left(\widetilde{\alpha}\left(\tau, \widehat{\widehat{\beta}}(\tau)\right)/\widehat{\widehat{\beta}}(\tau)\right)}{d\tau} = \frac{d\widetilde{\alpha}\left(\tau, \widehat{\widehat{\beta}}(\tau)\right)/d\tau}{\widehat{\widehat{\beta}}(\tau)} - \frac{\widetilde{\alpha}\left(\tau, \widehat{\widehat{\beta}}(\tau)\right)\widehat{\widehat{\beta}}'(\tau)}{\widehat{\widehat{\beta}}(\tau)^2}$$

yields

$$\left(\frac{\widetilde{\alpha}\left(\tau, \widehat{\widehat{\beta}}(\tau)\right)}{\widehat{\widehat{\beta}}(\tau)} - y_m\right)\left[\frac{d\widetilde{\alpha}\left(\tau, \widehat{\widehat{\beta}}(\tau)\right)/d\tau}{\widehat{\widehat{\beta}}(\tau)} - \frac{\widetilde{\alpha}\left(\tau, \widehat{\widehat{\beta}}(\tau)\right)\widehat{\widehat{\beta}}'(\tau)}{\widehat{\widehat{\beta}}(\tau)^2}\right] = 0.$$

Using (14),

$$\frac{\partial\widetilde{\alpha}(\tau, \beta)}{\partial\tau} = \frac{Y}{F(\widetilde{\alpha}/\beta)} > 0, \tag{15}$$

and

$$\frac{d\widetilde{\alpha}\left(\tau, \widehat{\widehat{\beta}}(\tau)\right)}{d\tau} = \frac{\partial\widetilde{\alpha}\left(\tau, \widehat{\beta}\right)}{\partial\tau} + \frac{\partial\widetilde{\alpha}\left(\tau, \widehat{\beta}\right)}{\partial\beta}\widehat{\widehat{\beta}}'(\tau),$$

we obtain

$$\left[\widetilde{\alpha}F\left(\widetilde{\alpha}/\widehat{\beta}\right) - \widehat{\beta}\int_0^{\widetilde{\alpha}/\beta} y f(y)\, dy\right]\widehat{\widehat{\beta}}'(\tau) = \widehat{\beta}Y.$$

Imposing equation (2) then delivers

$$\widehat{\widehat{\beta}}'(\tau) = \frac{\widehat{\widehat{\beta}}(\tau)}{\tau} > 0$$

and, consequently, $\widehat{\widehat{\beta}}''(\tau) = 0$. ■

Proof of Lemma 3. Differentiation yields

$$\widetilde{\widetilde{\alpha}}'(\tau) \equiv \frac{d\widetilde{\alpha}\left(\tau, \widehat{\widehat{\beta}}(\tau)\right)}{d\tau} = \frac{\partial\widetilde{\alpha}\left(\tau, \widehat{\beta}\right)}{\partial\tau} + \frac{\partial\widetilde{\alpha}\left(\tau, \widehat{\beta}\right)}{\partial\beta}\widehat{\widehat{\beta}}'(\tau).$$

Using (14), (15), and lemma 2,

$$\widetilde{\widetilde{\alpha}}'(\tau) = \frac{Y}{F\left(\widetilde{\alpha}/\beta\right)} + \frac{\int_0^{\widetilde{\alpha}/\beta} yf(y)\,dy}{F\left(\widetilde{\alpha}/\beta\right)}\frac{\widehat{\widehat{\beta}}(\tau)}{\tau}.$$

Rearranging and imposing (2) then yields

$$\widetilde{\widetilde{\alpha}}'(\tau) = \frac{\widetilde{\widetilde{\alpha}}(\tau)}{\tau} > 0$$

and, consequently, $\widetilde{\widetilde{\alpha}}''(\tau) = 0$. ■

Proof of Lemma 4. The slope of an indifference curve of

$$u\left((1-\tau)\,y, \alpha - \widehat{\widehat{\beta}}(\tau)\,y\right)$$

in the (τ, α) plane is given by

$$\begin{aligned} M(\tau, \alpha, y) &\equiv \left.\frac{d\alpha}{d\tau}\right|_{u\left((1-\tau)y, \alpha - \widehat{\widehat{\beta}}(\tau)y\right) = const.} \\ &= y\left[\frac{u_1\left((1-\tau)\,y, \alpha - \widehat{\widehat{\beta}}(\tau)\,y\right)}{u_2\left((1-\tau)\,y, \alpha - \widehat{\widehat{\beta}}(\tau)\,y\right)} + \widehat{\widehat{\beta}}'(\tau)\right] \end{aligned}$$

Suppressing arguments,

$$\begin{aligned}\frac{dM(\tau,\alpha,y)}{d\tau} &= y\left[\frac{-yu_{11}+\left(M(\tau,\alpha,y)-y\widehat{\widehat{\beta}}'(\tau)\right)u_{12}}{u_2}\right. \\ &\quad \left.-\frac{u_1\left(-yu_{12}+\left(M(\tau,\alpha,y)-y\widehat{\widehat{\beta}}'(\tau)\right)u_{22}\right)}{u_2^2}\right] \\ &= -\frac{y^2}{u_2^3}\left[u_2^2u_{11}-2u_1u_2u_{12}+u_1^2u_{22}\right]>0\end{aligned}$$

by strict quasiconcavity of u. From lemma 3, the stage 1 GBC is linear with slope $k_\alpha > 0$. Since

$$\frac{dV^{11}(0,y)}{d\tau} > 0 \;\; and \;\; \frac{dV^{11}(1,y)}{d\tau} < 0$$

$V^{11}(\tau,y)$ achieves an interior maximum in τ at the point where $M(\tau,\alpha,y)$ $= k_\alpha$. Since the indifference curve is strictly convex and the stage 1 GBC, $\widetilde{\widetilde{\alpha}}(\tau)$, is concave, $V^{11}(\tau,y)$ is strictly concave in τ. ■

Proof of Lemma 5. Using the envelope theorem and suppressing arguments,

$$\frac{dV^{12}(\tau,y)}{d\tau} = \begin{cases} u_1\cdot(-y+k_\alpha-k_\beta y) & \text{if} \;\; y<k_\alpha/k_\beta \\ u_1\cdot(-y) & \text{if} \;\; y\geq k_\alpha/k_\beta\end{cases}$$

The result follows immediately. ■

Proof of Lemma 6. Let the slope of the indifference curve in the (τ,α) plane for the utility function $u\left((1-\tau)y,\alpha-\widehat{\widehat{\beta}}(\tau)y\right)$ be given by

$$\begin{aligned}M(\tau,\alpha,y) &\equiv \left.\frac{d\alpha}{d\tau}\right|_{u\left((1-\tau)y,\alpha-\widehat{\widehat{\beta}}(\tau)y\right)=const.} \\ &= y\left[\frac{u_1\left((1-\tau)y,\alpha-\widehat{\widehat{\beta}}(\tau)y\right)}{u_2\left((1-\tau)y,\alpha-\widehat{\widehat{\beta}}(\tau)y\right)}+\widehat{\widehat{\beta}}'(\tau)\right].\end{aligned}$$

Since the indifference curve is strictly convex and utility rises to the northwest in the (τ, α) plane, $\widehat{\tau}(y) < \overline{\overline{\tau}}(y)$ if and only if $M\left(\overline{\overline{\tau}}(y), \widetilde{\widetilde{\alpha}}\left(\overline{\overline{\tau}}(y)\right), y\right) > \widetilde{\widetilde{\alpha}}'\left(\overline{\overline{\tau}}(y)\right)$. But

$$M\left(\overline{\overline{\tau}}(y), \widetilde{\widetilde{\alpha}}\left(\overline{\overline{\tau}}(y)\right), y\right) = y \cdot (1 + k_\beta)$$

since

$$\frac{u_1\left(\left(1 - \overline{\overline{\tau}}(y)\right) y, \widetilde{\widetilde{\alpha}}\left(\overline{\overline{\tau}}(y)\right) - \widehat{\beta}\left(\overline{\overline{\tau}}(y)\right) y\right)}{u_2\left(\left(1 - \overline{\overline{\tau}}(y)\right) y, \widetilde{\widetilde{\alpha}}\left(\overline{\overline{\tau}}(y)\right) - \widehat{\beta}\left(\overline{\overline{\tau}}(y)\right) y\right)} = 1$$

and $\widehat{\widehat{\beta}}'(\tau) = k_\beta$. Thus

$$M\left(\overline{\overline{\tau}}(y), \widetilde{\widetilde{\alpha}}\left(\overline{\overline{\tau}}(y)\right), y\right) > \widetilde{\widetilde{\alpha}}'\left(\overline{\overline{\tau}}(y)\right) \Longleftrightarrow y\left[1 + k_\beta\right] > k_\alpha$$

since $\widetilde{\widetilde{\alpha}}'\left(\overline{\overline{\tau}}(y)\right) = k_\alpha$. Hence,

$$\widehat{\tau}(y) < \overline{\overline{\tau}}(y) \Longleftrightarrow y > \frac{k_\alpha}{1 + k_\beta}.$$

■

Proof of Proposition 3. First consider households with $y < k_\alpha / (1 + k_\beta)$. For $\tau < \overline{\overline{\tau}}(y)$, $V^1(\tau, y) = V^{12}(\tau, y)$ which by lemma 5 is strictly increasing in τ. For $\tau > \overline{\overline{\tau}}(y)$, $V^1(\tau, y) = V^{11}(\tau, y)$ which by lemma 4 is strictly concave in τ. Since $V^{11}\left(\overline{\overline{\tau}}(y), y\right) = V^{12}\left(\overline{\overline{\tau}}(y), y\right)$ by definition of $\overline{\overline{\tau}}(y)$, $V^1(\tau, y)$ is single peaked for $y < k_\alpha / (1 + k_\beta)$ if and only if $\widehat{\tau}(y) \geq \overline{\overline{\tau}}(y)$ which is guaranteed by lemma 6.

Next consider households with $y > k_\alpha / (1 + k_\beta)$. By similar argument, $V^1(\tau, y)$ is strictly decreasing in τ for $\tau < \overline{\overline{\tau}}(y)$ and strictly concave in τ for $\tau > \overline{\overline{\tau}}(y)$. Since $V^{11}\left(\overline{\overline{\tau}}(y), y\right) = V^{12}\left(\overline{\overline{\tau}}(y), y\right)$, $V^1(\tau, y)$ is single peaked for $y > k_\alpha / (1 + k_\beta)$ if and only if $\widehat{\tau}(y) \leq \overline{\overline{\tau}}(y)$. This is guaranteed by lemma 6.
■

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