Vouchers: A Dynamic Analysis

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1. Introduction

Two broad movements can be identi…ed in the public policy debates over …nancing and provision of K-12 education. The …rst movement began in the early 1970's with the landmark ruling by the California Supreme Court that found California's system of …nancing public K-12 education to be unconstitutional. This movement sought to bring about greater equality in educational opportunities by reducing disparities in spending per student across communities. The main route used to accomplish this was by changing the rules used by states to redistribute funding across districts. The second movement began in the 1980's and was largely an outgrowth from a collective sense that the quality of public K-12 education in the US was low. This second movement has advocated increasing the choice of schools available to students with the hope of increasing competition across schools and enhancing e¢ciency.

An important theme in our previous research has been the observation that parents' inability to borrow against the future income of their children (to allow them to, say, move to a neighborhood with better schools) may result in ine¢ciently low investment in the human capital of children from poorer families in a quantitatively signi…cant manner (see for example, Fernandez and Rogerson (1996, 1997, 1998). We will refer to this as the imperfect capital markets perspective on school …nancing. School choice also relates to this market failure since policies that facilitate the access of lower-income students to higher quality schools will help overcome this market failure.

Redistribution and other policies that promote greater access to high-quality schools, therefore, can be seen as operating to overcome similar problems. The school choice movement, though, on the whole tends to stress the potential inefficiencies that arise from the provision of school services in a system with a public monopoly.[1] The capital markets approach stresses the unequal educational opportunities individuals may face as a consequence of parental income and imperfect capital markets.

It is important to note that even if schools functioned efficiently, as long as they responded to parental income either as a result of local funding (with wealthier parents living in wealthier communities able to fund higher quality schools) or as a result of profit maximization on the part of private schools (with higher quality schools charging higher prices), then the inefficiency associated with imperfect markets would remain. The objective of this chapter is to examine the consequences of this source of market failure by abstracting away from inefficient provision per se. We do this by assuming that all schools are private and operate in a competitive market. Consequently, the provision of these services is efficient, in the sense that a dollar of education expenditures can buy the same services regardless of family income, holding other potential inputs constant.

We examine the consequences of several voucher programs that serve to redistribute income in a manner that affects the distribution of the quality of education across students. We consider three voucher programs–a lump-sum voucher program in which all households are given a voucher of equal value, a means-tested voucher program in which all households below some threshold are given a voucher of equal value, and a power-equalizing voucher which gives all households below some income a voucher that depends both on their income and the amount of their funds they devote to education. As the inefficiency associated with imperfect capital markets is dynamic–there exist profitable investments that are not undertaken because of financing constraints–we examine the consequences of these different education finance systems in a dynamic framework. By relating quality of education to future earnings, our framework allows us to analyze the effects of voucher programs on the distribution of income, both in the short and long run. We can also evaluate the dynamic welfare consequences of these programs. Our main finding is that voucher programs can have a large positive impact on income and welfare.

Our analysis concludes with the consideration of endogenously determined parameters in each of the voucher programs. We do this by allowing the specification

[1] See, for example, Hoxby (2000).

of the voucher system to be determined by a process of majority vote. Here we find that the outcomes vary quite widely across systems. In particular, the means tested voucher system leads to very little redistribution relative to the two other systems we analyze.

2. Benchmark Model

The analysis of the effects of different voucher systems is a complex undertaking. Parents can differ in their preferences, education levels, family size, status (divorced, single parent). Children can differ in ability, temperament and family background. Here we choose to abstract away from these elements to concentrate primarily on the dynamic consequences of alternative systems and its interaction with redistribution (i.e., the income distribution). We will also be particularly interested in how the parameters of the voucher system are determined in an endogenous fashion.

In this section we describe the model which will serve as a benchmark in our analysis. In the process of describing the structure of the model we will also describe the choices of functional forms and parameter values to be used in the quantitative analysis in subsequent sections. We note up front that our benchmark model is not meant to describe the current state of the education sector in the US. Nonetheless, we think it is useful when choosing parameter values to choose targets for some of our model's variables, such as fraction of income devoted to education, that are based on data for the US economy over the last 40 or so years. Since we have conducted an extensive sensitivity analysis and find our main findings to be very robust to what would be viewed as large deviations in these targets, the reader should not be overly worried about our exact choices.

Following Fernández and Rogerson (1997a, 1998), we consider a two-period overlapping generations model in which each person belongs to a household consisting of one old individual (the parent) and a young one (the child). Parents make all the decisions and have identical preferences described by

$$u(c) + Ez(y') \tag{2.1}$$

where c is the household's consumption in the current period and y' is next period's income of the household's child. We include the expectations operator E in front of the function $z(y')$ since, as we will see shortly, the child's future income is stochastic viewed from the perspective of the current period. In general, we assume that the two functions u and z are increasing and concave.

In the first period of life, the child attends school and obtains the quality of education q. In the second period, the now old child receives a draw from the income distribution. This income draw depends on the quality of schooling they received when young and an iid shock ξ whose distribution $\Phi(\xi)$ is assumed to be independent of q. Thus, $y' = f(q;\xi)$. Calibrating the model requires choosing an education production function. Unfortunately, there is very little consensus on the form the latter should take, indeed there is a large and controversial literature that surrounds this topic.[2] Guided primarily by simplicity, a convenient specification is

$$y' = Aq^{\theta}\xi$$

which yields an elasticity of future income with respect to education quality that is constant and equal to θ. We assume that ξ is lognormally distributed such that $\log \xi$ has zero mean and standard deviation σ_{ξ}.

An important (and controversial) empirical issue is what determines school quality. There is a substantial amount of work that suggests that many schools do not use resources effectively. Moreover, one of the chief motivations for the school choice proponents is that increased choice will spur competition and hence lead to more efficient use of resources in providing education services. As discussed in the introduction, in order to focus our analysis on the finance side of school choice, we have chosen to examine the role for redistributional finance in a world in which educational resources are used efficiently. In addition to school resources, it is also plausible that peer effects and parental attributes also matter.[3] To focus the analysis on the different incentives associated with alternative voucher schemes, we assume that peer effects and parental attributes do not affect school quality. We also assume that there are no scale effects in providing education. Hence, in the analysis that follows we will assume that spending on education and quality of education are in fact synonymous.

Evidence presented by Card and Krueger (1992), Wachtel (1976), and Johnson and Stafford (1973) suggest an elasticity of earnings with respect to education expenditures close to 0.2. Based on this analysis we set $\theta = .2$ in our benchmark specification.

[2] See Coleman et al (1966), Hanushek (1986), Card and Krueger (1992), and Heckman, Layne-Farrar, and Todd (1996).

[3] Several authors have studied peer effects. See de Bartolome (1990) for a survey of the empirical literature and a theoretical model incorporating peer effects. See also Benabou (1993, 1996), Durlauf (1995), Epple and Romano (1996a, 1998), and Caucutt (1997) for other studies incorporating peer effects.

Given the determination of their income, an adult makes effectively one choice: what fraction of their income to spend on consumption and what fraction to spend on their child's education. In formulating this decision it is convenient to define $w(q) \equiv \int z(f(q;\xi))d\Psi$. The function $w(q)$ represents the expected utility that a parent receives from spending q dollars on their child's education. We can now write the decision problem facing a parent as one of choosing how to allocate income y between c and q so as to maximize:

$$U(c;q) = u(c) + w(q)$$

Not surprisingly, the consequences of various redistributive education finance programs will depend upon the income and substitution effects implicit in the indirect utility function U. It is thus instructive to ask whether there are some reasonable restrictions that can be placed upon preferences in order to discriminate among the many possible formulations. As is true in many other contexts we think that longer run evidence provides some important information to guide choices. Fernandez and Rogerson (2001) show that across US states the share of personal income devoted to public elementary and secondary education has remained roughly constant over the 1970-1990 period at the same time that income per capita almost doubled. This property will be satisfied if the indirect utility function takes the form

$$\frac{c^{\alpha}}{\alpha} + B\frac{q^{\alpha}}{\alpha} \tag{2.2}$$

for some parameters α and B. And this form for the indirect utility function will result if the utility function is of the form

$$\frac{c^{\alpha}}{\alpha} + \frac{b}{\alpha}E(y'^{\gamma}) \tag{2.3}$$

for some parameter values γ and b together with the restriction that $\theta\gamma = \alpha$ and $B = bE(\xi^{\gamma})$. In the analysis that follows we will assume these conditions hold. Additionally, we will assume that α is non-positive.

We assign values for b and α based on the following. Given values for all the other parameters there is a monotone relationship between b and the fraction of income devoted to educational expenditures. In our benchmark model we choose the value of b so that this ratio equals $.041$; which is roughly the fraction of income devoted to K-12 education in the US over the last forty years. Specifically, the value of b is given by $b = \frac{[(1-t^*)/t^*]^{\alpha-1}}{A^{\gamma}E(\xi^{\gamma})}$, where $t^* = .041$ is the fraction of income devoted to education. Choosing a value of α is somewhat more difficult. Fernandez and Rogerson (1999) survey several different approaches to picking this value and conclude that values in the range of $[-2; 0]$ are most reasonable. Following this we choose $\alpha = -1$ for our benchmark model.

In order to analyze the model described above we need to specify an initial distribution of income. We denote the initial period by period 0 and let the initial income distribution be described by a density function denoted by $g_0(y)$: Letting $g_t(y)$ be the income distribution of old individuals at the beginning of period t, an equilibrium generates a beginning-of-period income distribution for period $t + 1$, g_{t+1}. Let $F(g(y))$ be the income distribution that results in the following period given this period's distribution of $g(y)$. A steady state in this model then consists of an income distribution g^* such that $g^*(y) = F(g^*(y))$. In the analysis of alternative voucher systems that follows, we will take the starting position of the economy to be the steady-state for the model just described. We will be interested in solving both for the steady states of the model with different voucher schemes as well as examining the transition path to these steady states.

The final element of the calibration exercise that remains concerns two parameters of the educational production function: A; the constant term in front of the production function and σ_ξ, the standard deviation of the idiosyncratic income shock. Given the functional forms described above, the steady-state distribution of income in the benchmark model is also lognormally distributed, with mean and standard deviation determined by the values of A and σ_ξ. To see this consider the decision problem solved by a particular individual with income y_i. Let t_i be the fraction of their income that they devote to education. Then, they solve the following problem:

$$\max_{t_i} u((1 - t_i)y_i) + w(t_i y_i) \tag{2.4}$$

Thus, each individual's value for t_i is given by the first-order condition:

$$-u'(y_i(1 - t_i)) + w'(t_i y_i) = 0 \tag{2.5}$$

Note that (??) has individuals set spending on education to equate the marginal utility of consumption with the marginal utility of education quality (i.e., $u'(c) = w'(q)$).

It is then easy to solve for the dynamic evolution of the economy. Note that the preferences specified in (2.2) above imply a constant and identical value of t_i across individuals, $t^* = \frac{1}{1+\kappa}$, where $\kappa = (bA^\gamma E(\xi^\gamma))^{\frac{1}{\alpha - 1}}$, i.e., all individuals spend the same fraction of their income on education. To solve for the dynamics of the system, note that if a parent's income in period 0 is y_0, the child's income, y_1, is given by $\log y_1 = \log A + \theta \log t^* + \theta \log y_0 + \log \varepsilon_1$. Given $\theta < 1$, it follows that $\log y_t$ has a limiting distribution that is normal with mean and standard deviation:

$$\mu_1 = \frac{\log A + \theta \log t^*}{1 - \theta} \quad \sigma_1 = \frac{\sigma_\varepsilon}{(1 - \theta^2)^{1/2}} \tag{2.6}$$

We choose A and σ_ε such that μ_1 and σ_1 are reasonable in view of US data over the last forty years. Specifically, we match the mean and median of the US family income distribution as measured in the 1980 Census, respectively 23.1 and 19.9 measured in thousands of dollars.

We next turn to the determination of the distribution of q across individuals under different voucher systems.

3. Voucher Programs

In this section we describe three different types of voucher programs. We focus on the outcomes for the distribution of education expenditures achieved in a given period under each of the voucher systems taking the income distribution as given. Of course, as was the case with our benchmark model, this determination of education expenditures will also yield a mapping from this period's income distribution across households to next period's income distribution across households. It follows that we can again trace out the dynamics of the evolution of the income distribution as well as the limiting or steady-state income distribution that will result.

3.1. A Lump-sum Voucher System

In this section we consider a voucher system which we refer to as a lump-sum voucher system. Under this system all households receive a voucher of size v_l, which they can use only to fund expenditures on education. However, if they wish to spend more than this amount then they are free to supplement it out of their own funds. This voucher is assumed to be financed by proportional (income) taxation at rate τ_l and we require that the budget is balanced in every period:

$$v_l = \tau_l \mu_y \tag{3.1}$$

where μ_y is mean income in the economy. We refer to this as a lump-sum voucher system. In this section we assume that the size of the voucher is fixed over time, and hence omit time subscripts to simplify notation.

Consider the choices facing an individual in an economy which offers this type of voucher program. Letting t_i denote the fraction of their income that individual i devotes to education over and above the voucher level, we have:[4]

$$
\begin{aligned}
c_i &= (1 - t_i - \tau_l)y_i \\
q_i &= v_l + t_i y_i
\end{aligned}
\qquad (3.2)
$$

Note that because of the balanced budget requirement the voucher program in a given period is effectively summarized by one parameter, either τ_l or v_l. Given a tax rate outcome, τ_v, an individual's preferred choice of t_i is the solution to:

$$\max_{t_i} \; u((1 - t_i - \tau_l)y_i) + w(v_l + t_i y_i); \qquad t_i \geq 0 \qquad (3.3)$$

yielding the first-order condition

$$-u'((1 - t_i - \tau_l)y_i) + w'(v_l + t_i y_i) \leq 0 \qquad (3.4)$$

with strict equality for $t_i > 0$.

With the restriction on preferences described earlier, one can show that the values of the t_i are increasing in y_i. Moreover, there will typically be some cutoff value of y which we call $\hat{y}_l$ such that all individuals with $y \leq \hat{y}_l$ choose $t_i = 0$, i.e., all households with income below $\hat{y}_l$ have spending on education that is exactly equal to the size of the voucher. Moreover, the level of this cutoff value is increasing in the size of the voucher.

We can also say something about how this program affects the distribution of education expenditures across the income distribution. For example, it is easy to show that anyone who chooses $t_i = 0$ will have a larger expenditure on education under this lump-sum voucher system than in the benchmark model. More generally, one can show that there exists some level of income $\tilde{y} > \hat{y}_l$ such that everyone below this value spends more than in the benchmark model while everyone above this level will end up spending less than in the benchmark model.

The properties of this system come from noting that with a system of proportional taxation, all households with income less than mean income receive pay less in taxes than the value of the voucher they receive. This induces households with income less than mean income to increase their spending on education relative to the benchmark model. The same reasoning does not hold for individuals

[4] See de Bartolome (1997) for an alternative formulation of a foundation system.

with income above the mean, as the voucher is effectively redistributing income from these to those with lower income. Of course, if the voucher level is set sufficiently high, say higher than the maximum amount being spent by anyone in the benchmark model, then spending on education by everyone would increase.

It follows that a lump-sum voucher system tends to compress the distribution of educational expenditures, and (for any voucher amount below the maximum spending on education observed in the benchmark system) this compression will come about both by raising the bottom and lowering the top. We will see later that the extent of compression from above turns out to be quite small quantitatively, so that the primary effect is to generate compression from below.

3.2. A Means-Tested Voucher

In this subsection we describe a second voucher system, which we refer to as a means-tested voucher. This system is similar to the lump-sum voucher but differs in one feature. Rather than all families receiving a voucher of value v_m, we now assume that the voucher is received only by those households that have income below some cut-off level denoted by y_m. As before, households are free to supplement the voucher if they wish to spend more on education, but the voucher must be used only for spending on education. As above, the voucher program is financed by a proportional tax on income and the budget is assumed to balance in each period.

The mechanics of this voucher system are quite similar to that described above. The problem faced by a household with income less than the means-tested cutoff y_m will solve

$$\max_{t_i} \; u((1 - t_i - \tau_m)y_i) + w(v_m + t_i y_i); \qquad t_i \geq 0 \tag{3.5}$$

yielding the first order condition:

$$-u'((1 - t_i - \tau_m)y_i)y_i + w'(v_l + t_i y_i)y_i \leq 0 \tag{3.6}$$

with strict equality for $t_i > 0$.

On the other hand an individual with income that lies above the means-tested cut-off y_m faces the problem of:

$$\max_{t_i} \; u((1 - t_i - \tau_m)y_i) + w(t_i y_i); \qquad t_i \geq 0 \tag{3.7}$$

yielding the first-order condition

$$-u'((1 - t_i - \tau_m)y_i)y_i + w'(t_i y_i)y_i \le 0 \tag{3.8}$$

with strict equality for $t_i > 0$.

Assuming that assuming y_m is binding (i.e., some households are not eligible), a voucher of the same size as in the lump-sum system (i.e., $v_l = v_m$) will require a smaller tax to finance it since not all households are receiving the voucher.

Several basic results follow easily. Relative to the benchmark model, all households that have income above the means-tested cutoff will now spend less on education. For those households that receive the voucher, spending on education may actually increase or decrease relative to the benchmark model. As was the case in the lump-sum voucher system, the voucher may lead to an increase or decrease in a given household's spending on education. However, any household who receives the voucher and has income below mean income will necessarily spend more on education.

As above, we conclude that this type of voucher system will also tend to compress the distribution of educational spending. Once again, however, we will see in the quantitative work that the compression from above tends to quite small.

3.3. A Power-Equalizing Voucher

Lastly, we turn to an analysis of another means-tested voucher that we refer to as a power-equalizing voucher system. Like the previous case, this system excludes individuals with income greater than some pre-specified level. However, rather than providing all recipients with a voucher of fixed value, this system presents individuals with a voucher payment that responds to both their income and the fraction of their income devoted to education. While we are not aware of any implementation of this type of voucher program, this alternative has important parallels in the redistributive schemes that are used in other contexts.

Let y_p be the means-tested cutoff level of income in this system. Consider a household with income y_i and suppose this household chooses to devote a fraction t_i of its income to education. The voucher system is set up to guarantee all households a minimum base from which to obtain its total expenditures on education that is given by:

$$q_i = t_i \max\{y_i; y_p\}$$

It follows that the actual voucher received by a household with income y_i that allocates a fraction t_i of its income to education is given by:

$$v_p = \max\{t_i(y_p - y_i); 0\}$$

Obviously anyone with income greater than the cutoff level y_p will not receive any voucher. Thus while not guaranteeing any particular level of education spending, the system does guarantee the base which individuals can use to generate education spending.

We assume, as in the previous case, that the required education funds are generated by a state income tax, τ_p, so that private consumption is given by:

$$c_i = (1 - t_i - \tau_p) y_i \tag{3.9}$$

and the tax rate must satisfy the budget constraint:

$$\tau_p \mu_y = \int_{y<y_p} t_i (y_p - y) g(y) dy \tag{3.10}$$

Once again we can characterize how this type of a voucher system will impact on the distribution of educational expenditures relative to the benchmark model. It is straightforward to show that any household with income greater than the means-tested cutoff y_p will have lower spending on education than in the benchmark model. And, similar to the situations considered above, any individual with income below the $\min\{y_p; \mu_y\}$ will necessarily increase their spending on education. Once again, this type of voucher program serves to compress the distribution of educational expenditures.

We mentioned above that this voucher scheme has parallels in other redistributive programs. One such parallel is a negative income tax program which seeks to guarantee a "reasonable" level of income for someone who satisfies a work requirement. By way of comparison, the voucher program just described attempts to provide everyone who devotes a specified fraction of their income to education a "reasonable" level of educational expenditures.

3.4. Parallels with the School Finance Literature

Before turning to an analysis of the quantitative impact of the various voucher programs just described, we think it is useful to note some parallels between these and several programs that are commonly studied in the literature on school finance. As noted in the introduction, the issue of redistributing resources across school districts has been prominent in public policy discussions of education at least since the landmark Serrano decision in California in 1971. Many states have been forced to restructure their systems of school finance as a result of court orders. The common issue raised in all of these court cases is that children who grow up in poor school districts (where poor is de…ned as low property value per person) do not receive an adequate education because of the shortage of funding. In an attempt to deal with this situation various types of programs have been used to redistribute resources from property rich districts to property poor districts.

In addressing this issue, a common benchmark is a system of pure local …nance in which all school districts are solely responsible for …nancing their own schools, i.e., there is no redistribution across districts. This system has its parallel with our benchmark model, except that in our model there is no longer an entity known as a school district. Instead, each individual is solely responsible for …nancing their educational expenditures, i.e., there is no redistribution across individuals Just as property-poor districts are at a signi…cant disadvantage in terms of …nancing an adequate education in the district system, in our benchmark model it is the income-poor individuals that are at a disadvantage in terms of …nancing an adequate education.

One popular redistributive school …nance system is what is known as a foundation system. In this system, each district is given a …xed amount of money per student in order to help all districts ensure a minimum level of quality. This type of system closely parallels our lump-sum voucher system in which all households are given a …xed amount of money per child in order to help all households a¤ord an education of some minimum level of quality.

Another popular redistributive measure is means-tested transfers to school districts, i.e., all districts whose property base per student lie beneath some cuto¤ value receive a given grant per student. Our means-tested voucher is obviously the analogous program in our context.

Lastly, the nature of the Serrano ruling in California in the early 1970's prompted Coons (1974) to devise a school …nance system known as a power equalizing system. The basic idea underlying this system was targeted speci…cally to the nature of the problem identi…ed by the California Supreme Court. Namely, that even if families in districts with di¤erent property value per student chose to tax themselves at the same rate, the children would end up with very di¤erent qualities of education because a given tax e¤ort yielded such di¤erent revenues in di¤erent districts. To remedy this Coons suggested a scheme where districts would be guaranteed a given revenue per unit of tax e¤ort. While such a system does not guarantee a given level of spending in a particular district, it does o¤er that district a guaranteed yield for its tax e¤ort. Obviously, our power equalizing voucher system is the analogue of this system.

To summarize, the issue of redistribution in the context of education appears both in a world in which education is publicly provided and children attend district level schools as well as in a world in which education is privately provided and children can attend any school subject to paying the tuition. Many of the schemes used to redistribute in one context are likely to have interesting counterparts in other contexts as well.

4. Results with Exogenous Policy

In this section we examine the quantitate impact of introducing vouchers of the types discussed previously. We assume that the parameters of these voucher systems are set exogenously and contrast how various parameter values affect the outcomes. Specifically, in the lump-sum voucher plan we consider different settings for the size of the voucher. In the case of the power equalizing voucher program, we consider different levels for the guaranteed tax base, which is also the cut-off level of income at which households qualify for some voucher. In the case of the means-tested voucher, the program is characterized by two values-the cut-off level of income that determines who receives the voucher, plus the value of the voucher. Because this system is characterized by two parameters there are obviously many more possibilities to consider when setting parameters exogenously. To simplify matters, in what follows we will report results for a particular one-dimensional family of specifications. We will look at means-tested vouchers that are introduced into the benchmark model with the following characteristic: Let v_m be the size of voucher. Then, we assume that the income threshold is set such that all households who in the steady state of the benchmark model spent less than v_m will be eligible for the voucher.[5]

Before proceeding with the results, it is of interest to first consider some aspects of the benchmark steady-state equilibrium, in particular, the distribution of educational expenditures across families. In considering the impact of various voucher systems it is instructive to see the original distribution of expenditures in order to gauge the number of families that will be directly affected by a given size of voucher system. Recall that in the benchmark steady state all families are spending the same fraction (:041) of their income on education. Hence, the steady-state distribution of education spending mimics the properties of the steady state income distribution. Table One provides a breakdown of the income distribu-

[5] This formulation obviously introduces a discrete jump in spending as a function of income, as those who spent $v_m + \epsilon$, $\epsilon > 0$, get zero and hence in aggregate will end up having lower education spending (despite having higher income).

tion of families by reporting the fraction that fall below certain threshold values relative to mean income.

Table One

income threshold	% below threshold
$.25\mu_y$	1.6
$.4\mu_y$	9.72
$.5\mu_y$	18.9
$.75\mu_y$	44.2
μ_y	64.4

So, for example, if we consider a lump-sum voucher of size equal to 25% of average educational expenditures in the original steady state, fewer than 2% of families will be directly affected in the sense that the voucher exceeds their spending in the original steady state. This is significant because, as we shall see that in the case of a lump-sum voucher program, the impact of the voucher on families whose original spending exceeded the size of the voucher is minimal. A similar point also applies to the case of the means tested voucher.

In what follows we will report results about both allocations and welfare, looking at static (initial period) effects, steady state effects and the transition. We begin by analyzing the effects on allocations.

4.1. Allocations

4.1.1. Static Effects

We begin our analysis by examining the static or first period affects of the voucher programs on education spending. Specifically, we take the income distribution corresponding to the steady state of the benchmark model and ask what will happen to the distribution of education expenditures in that period if various voucher programs are introduced. In the case of the lump-sum and the means-tested voucher systems it is useful to measure the size of the voucher relative to mean spending on education in the benchmark steady state. In the case of the power-equalizing voucher it is useful to measure the value of the cutoff relative to mean income in the benchmark steady state. We let μ_e represent mean spending on education in the benchmark steady state and let μ_y represent mean income in the benchmark steady state. Recall that these values are $(.0410)(23.08)$ and 23.08 measured in thousands of dollars. Table Two reports results for each of the three voucher systems for several cases distinguished by the magnitudes of the program.

Table Two

First Period E¤ects on Education Spending

A. Lump-Sum Voucher System

v_l=¹$_e$	E=y	cv_e	¿$_l$ £ 100
0	.0410	.594	.00
.10	.0410	.592	0.4
.25	.0410	.588	1.0
.40	.0412	.577	1.6
.50	.0416	.562	2.1
.60	.0423	.541	2.5
.75	.0437	.501	3.1
1.00	.0474	.421	4.1

B. Means-tested Voucher System

v_m=¹$_e$	E=y	cv_e	¿$_m$x100
0	.0410	.594	.00
.10	.0410	.592	.00
.25	.0410	.588	.01
.40	.0412	.577	.13
.50	.0416	.562	.33
.60	.0422	.541	.63
.75	.0436	.501	1.24
1.00	.0471	.421	2.50

C. Power-equalizing Voucher System

y_p=¹$_y$	E=y	cv_e	¿$_p$ £ 100
0	.0410	.594	.00
.10	.0410	.594	.00
.25	.0410	.593	.00
.40	.0411	.590	.02
.50	.0413	.582	.06
.60	.0416	.572	.13
.75	.0424	.548	.28
1.00	.0441	.504	.64
1.25	.0463	.456	1.09

The …rst column in each table reports the size of the voucher system. The second column reports the fraction of income devoted to education (E=y). The third column reports the coefficient of variation (cv_e) for the distribution of education spending, i.e., the ratio of the standard deviation of education spending to the mean of education spending. In what follows we will use this as our measure of inequality. The final column in each case reports the tax rate that is required to finance the specified voucher system. Note that the first row in each panel of the table corresponds to the case where there is no voucher system and hence simply reproduces the distribution of education spending in the original steady state.

A few basic patterns emerge. In each case as the magnitude of the voucher system is increased we experience an increase in the fraction of income devoted to education and a decrease in the inequality of education expenditures. These qualitative results are really not that surprising. One of the key impacts of both voucher systems is to raise expenditures on education at the bottom of the distribution. Not surprisingly, this raises overall spending on education and decreases inequality in education spending. However, the quantitative results also produce some findings that are of interest and which are not necessarily expected. For example, in the case of the lump-sum voucher, the above results indicate that unless the size of the voucher exceeds the initial spending for a substantial fraction of the population it has very small effects on total spending on education. To see this, consider the second row of the first panel, which corresponds to a voucher that is equal to 10% of average spending. This is seen not to have an effect on education expenditures, either by way of changing total expenditure or by changing inequality. However, from Table One we know that this voucher exceeds initial spending for less than 2% of the households, and even for them raises their spending by relatively little on average. The basic message is that in order for a lump-sum voucher (or a means-tested voucher) to have any sizeable impact, it must be of a magnitude that exceeds education spending for a significant fraction of the population. Otherwise it simply amounts to a small program of income redistribution. A similar point is holds in the case of the power-equalizing voucher.

Lastly, it is also of interest to draw a few comparisons across the three systems. One point which the table makes quite clear is that the consequences of the lump-sum voucher and the means-tested voucher are virtually identical for education spending . The one difference between the two, not surprisingly, is that the means-tested voucher requires a smaller tax to finance the system. This is a pattern that will be repeated in the remainder of the results as well. There are two noticeable differences that appear in the table. One is that offering a voucher equal to the expenditure of say the mean income household will reduce inequality in spending by a much greater amount than will guaranteeing everyone a tax base equal to mean income. The other is that the power equalizing system seems to provide a steeper drop in inequality per dollar of tax revenue raised than do either of the other two systems.

In order to more fully appreciate the di¤erent consequences of the three systems for the distribution of educational expenditures it is of interest to look at these distributions in more detail. In Table Three we report average spending on education by deciles of the income distribution for each of the three systems.

Table Three

First Period E¤ects on the Distribution of Education Spending

A. Lump-Sum Vouchers

Decile		v_l						
	0	$:1^{1}_{e}$	$:25^{1}_{e}$	$:4^{1}_{e}$	$:5^{1}_{e}$	$:6^{1}_{e}$	$:75^{1}_{e}$	1^{1}_{e}
1st	.315	.317	.323	.382	.473	.568	.710	.946
2nd	.456	.458	.461	.464	.483	.568	.710	.946
3rd	.559	.560	.563	.565	.567	.580	.710	.946
4th	.656	.658	.659	.661	.662	.664	.710	.946
5th	.758	.759	.760	.761	.762	.763	.764	.946
6th	.870	.871	.871	.872	.872	.872	.873	.946
7th	1.004	1.004	1.004	1.003	1.002	1.003	1.002	1.002
8th	1.181	1.180	1.178	1.177	1.176	1.175	1.174	1.171
9th	1.448	1.446	1.443	1.440	1.438	1.436	1.433	1.427
10th	2.196	2.191	2.183	2.176	2.171	2.165	2.158	2.145

B. Means-Tested Vouchers

Decile		v_m						
	0	$:1^{1}_{e}$	$:25^{1}_{e}$	$:4^{1}_{e}$	$:5^{1}_{e}$	$:6^{1}_{e}$	$:75^{1}_{e}$	1^{1}_{e}
1st	.315	.315	.320	.381	.473	.568	.710	.946
2nd	.456	.456	.456	.455	.480	.568	.710	.946
3rd	.559	.559	.559	.558	.557	.576	.710	.946
4th	.656	.656	.656	.656	.654	.652	.710	.946
5th	.758	.758	.758	.757	.756	.754	.750	.946
6th	.870	.870	.870	.869	.868	.865	.860	.946
7th	1.004	1.004	1.004	1.003	1.001	1.000	.992	.9832
8th	1.181	1.181	1.180	1.179	1.177	1.173	1.166	1.151
9th	1.447	1.447	1.448	1.446	1.443	1.439	1.430	1.412
10th	2.196	2.196	2.196	2.193	2.189	2.182	2.169	2.141

C. Power-Equalizing Vouchers

Decile		y_p							
	0	$:1^1_y$	$:25^1_y$	$:4^1_y$	$:5^1_y$	$:6^1_y$	$:75^1_y$	^1_y	$1:25^1_y$
1st	.315	.315	.317	.345	.386	.424	.475	.549	.612
2nd	.456	.456	.456	.456	.468	.510	.572	.661	.737
3rd	.559	.559	.559	.559	.558	.567	.631	.729	.814
4th	.656	.656	.656	.656	.656	.656	.682	.788	.881
5th	.758	.758	.758	.758	.758	.757	.756	.845	.944
6th	.870	.870	.870	.870	.870	.869	.868	.903	1.009
7th	1.004	1.004	1.004	1.004	1.003	1.003	1.001	.998	1.081
8th	1.181	1.181	1.181	1.181	1.180	1.179	1.178	1.173	1.182
9th	1.447	1.447	1.447	1.447	1.447	1.446	1.444	1.439	1.432
10th	2.196	2.196	2.196	2.196	2.195	2.193	2.190	2.182	2.172

In each panel the …rst column repeats the results without a voucher program; thus, it simply describes the distribution of spending in the steady state of the benchmark model. Reading across each panel allows one to examine how increasing the magnitude of a given voucher program a¤ects spending at various deciles of the income distribution. A general pattern is that as each voucher program becomes more generous, spending at the bottom part of the income distribution increases whereas spending at the higher end of the distribution tends to decrease. However, the relative order of magnitudes of these two changes is noteworthy. Whereas spending at the bottom of the distribution may double or even triple as we move to the columns at the far right of each panel, the spending at the top of the distribution is decreasing on the order of one percent. Hence, while each of the voucher programs is decreasing inequality in spending by compressing the distribution of spending, this compression is almost entirely acting from below.

Next we compare the lump-sum voucher and the means-tested voucher. We noted previously that both vouchers had virtually identical aggregate e¤ects. If we look at the distributions more carefully, we see that the two vouchers do produce some di¤erences across the distribution, but that these e¤ects tend to roughly cancel in aggregate. For example, consider the case of a voucher of size $:75^1_e$. This voucher is available to the bottom forty-four percent of households. In both cases the bottom forty percent of the population spends only the amount of the voucher. However, note that the next decile spends more under the lump-sum voucher than they do under the means-tested voucher. This re‡ects the fact that in the means-tested case everyone with income above $:75^1_y$ is receiving no voucher and hence the only e¤ect on their education spending is due to the imposition of the income tax needed to finance the voucher. In contrast, in the case of the lump-sum voucher, those households with income slightly higher than $.75\mu_y$ do receive a voucher that is large relative to their spending in the benchmark model. This of course must all be allocated to education. However, they also choose to supplement this with a small amount of their own funds. They also face a larger income tax, but for these families the effect of the subsidy to education exceeds the effect associated with the tax rate. However, as we move to higher deciles in the income distribution we see that the relative spending levels are reversed. For the highest decile, spending is greater under the means-tested voucher than under the lump-sum voucher. The reason for this is that for this group the voucher is relatively small compared to education spending in the benchmark model. And, the loss in income due to taxation is much larger. So, the net effect of the tax is much greater for this group. Since the tax is much smaller under the means-tested program, they spend more under this program.

Next we compare the means-tested voucher with the power-equalizing voucher. The differences are more apparent for larger values of the voucher programs, so once again we focus on the cases where $v_l = .75\mu_e$ and $y_m = .75\mu_y$. What is particularly striking is how different the spending is in the lower part of the distribution. For the lowest decile the means-tested voucher yields spending on education that is more than one-third larger than that under the power equalizing voucher. The reason for this difference is that under the means-tested voucher these households are receiving a voucher in the amount of .071 that must be used for education. In contrast, under the power equalizing system these households are told that they can raise money for education as if they had a tax base of $.75\mu_y$, but every dollar they devote to education reduces their consumption. However, all families that have income above the fiftieth percentile have greater spending under the power equalizing system than under the means-tested system. None of these household is eligible for a voucher, so the differences are due entirely to the fact that the tax rate is lower under the power-equalizing system. These two observations go hand-in-hand: the reason that taxes are lower in the power-equalizing system is that less money is being redistributed to low income households to be used for education. The key point that this table illustrates, however, is that the largest difference between the two systems has to do with the differential extent to which the means-tested program will lift up the spending of the lowest income households. The different levels of spending among the richer households is in fact less than one-percent.

4.1.2. Steady State Effects

The results in the last section focused on what would happen to current education spending as a result of introducing various voucher systems. However, changes in the level or distribution of current education expenditures will also have impacts on the future level and distribution of income. In fact, one of the main motivations for public concern over the distribution of education spending is that this spending plays a key role in the human capital accumulation of children and thus the future productive capacity of the economy. In this section we focus on the long-run implications for the distribution of income associated with the various voucher programs analyzed previously, i.e., we look at the resulting steady state distributions. Table Four provides the information.

Table Four

Steady State Implications of Vouchers

A. Lump-Sum Voucher

v_l/μ_e	mean(y)	sd(y)	cv_y	E/y	cv_e	$\tau_l \times 100$
0	23.08	13.72	.594	.0410	.594	0.0
.10	23.09	13.72	.594	.0410	.592	0.4
.25	23.13	13.73	.594	.0410	.587	1.0
.40	23.32	13.78	.591	.0412	.572	1.6
.50	23.55	13.87	.589	.0416	.554	2.0
.60	23.84	14.00	.587	.0423	.527	2.4
.75	24.36	14.25	.585	.0437	.480	2.9
1.00	25.29	14.74	.583	.0474	.390	3.7

B. Means-Tested Voucher

v_m/μ_e	mean(y)	sd(y)	cv_y	E/y	cv_e	$\tau_m \times 100$
0	23.08	13.72	.594	.0410	.594	0.00
.10	23.08	13.72	.594	.0410	.594	0.00
.25	23.11	13.72	.594	.0410	.592	0.01
.40	23.29	13.77	.591	.0412	.580	0.13
.50	23.52	13.86	.589	.0416	.562	0.30
.60	23.82	13.99	.587	.0422	.534	0.56
.75	24.34	14.23	.585	.0437	.486	1.05
1.00	25.27	14.73	.583	.0471	.393	2.03

C. Power-Equalizing Voucher

$y_p={}^1{}_y$	mean(y)	sd(y)	cv_y	E=y	cv_e	¿$_p$ £ 100
0	23.08	13.72	.594	.0410	.594	0.00
.10	23.08	13.72	.594	.0410	.594	0.00
.25	23.09	13.72	.594	.0410	.593	0.00
.40	23.18	13.74	.593	.0411	.588	0.02
.50	23.30	13.78	.591	.0413	.578	0.06
.60	23.46	13.84	.590	.0416	.564	0.12
.70	23.64	13.92	.589	.0421	.547	0.20
.75	23.73	13.96	.588	.0424	.537	0.25
1.00	24.21	14.20	.587	.0441	.486	0.56
1.25	24.68	14.44	.585	.0462	.437	0.93

As before, the …rst column reports the size of the voucher system. The next three columns report some properties of the steady state income distribution. The second column reports mean income, the third column reports the standard deviation of income and the fourth column reports the coe¢cient of variation, which we will again use as our measure of income inequality. The …nal three columns present the same information that was presented in the previous subsection where we focused on the static e¤ects on education spending. Once again the …rst row of each panel considers the case of no voucher, and hence simply reproduces the benchmark steady state.

Perhaps the most striking result to note here is the size of the potential increases in income that are associated with some of the programs considered above. A lump-sum voucher that was equal to average expenditures in the benchmark steady state leads to an increase in income of roughly 10%! A power equalizing voucher that assisted everyone with income below the mean would raise income by more than 6%. And note that the tax rate needed to support this voucher system is just slightly more than one half of one percent. These gains in income are large and point to the potential gains to be obtained by a redistributive education …nance system even in a world where all individuals have access to schools that use resources e¢ciently. We will show later that these large gains in income also represent large gains in average welfare.

Considering the results in more detail, if education expenditures increase and the inequality of those expenditures decreases, we would expect to see these two properties to show up in the distribution of income as well. The above table reveals this to be the case. It is interesting to note, however that the magnitudes of these two e¤ects are quite di¤erent. Consider for example the two extreme cases represented in panel A of Table Three, those of v_l = 0 and v_l = ¹$_e$. Looking at the expenditure on education there is an increase of roughly 15%, and looking at the decrease in inequality in the distribution of educational spending there is a decrease of roughly 33%. However, whereas the increase in mean income is roughly 10%, the decrease in inequality in the income distribution is only about 1:5%. The reason that inequality in the income distribution decreases by so little relative to the decrease in inequality in the education spending distribution is that di¤erences in education spending account for very little of the variance in the income distribution. Most of the variance is accounted for by the stochastic earnings term ". In fact, one can ask what would happen to inequality in the income distribution even if inequality were completely removed from the education spending distribution. Holding mean spending constant, the resulting steady-state income distribution would have a coe¢cient of variation of .58.

4.1.3. Transition E¤ects

What is the nature of the transition from the initial steady state to the …nal steady state? The transition is very fast–the economy moves most of the way to the new steady-state income distribution one period after the introduction of the voucher programs. Rather than present a long list of results for all of the various cases we simply present one case for each of the lump-sum and power equalizing voucher systems (the results for the means-tested voucher are similar to those for the lump-sum voucher). For the lump-sum voucher we consider the case of v_l = ¹$_e$, and for the power-equalizing voucher we consider the case of y_p = ¹$_y$. Period 0 indicates the period in which the voucher is introduced, so that in period 0 the income distribution corresponds to that of the benchmark steady state. Table Five reports the results for several of the variables considered above.

Table Five
Transition Paths
A. Lump-sum Voucher, v_l = ¹$_e$

Period	mean(y)	sd(y)	cv_y	E=y	cv_e	¿$_l$ £ 100
0	23.081	13.718	.594	.0474	.421	4.10
1	25.166	14.649	.582	.0474	.391	3.76
2	25.286	14.732	.583	.0474	.390	3.74
3	25.294	14.737	.583	.0474	.390	3.74
4	25.294	13.738	.583	.0474	.390	3.74
5	25.294	13.738	.583	.0474	.390	3.74

B. Power-Equalizing Voucher $y_p = \mu_y$

Period	mean(y)	sd(y)	cv_y	E/y	cv_e	$\tau_m \times 100$
0	23.081	13.718	.594	.0441	.504	0.64
1	24.039	14.091	.586	.0441	.489	0.57
2	24.190	14.183	.586	.0441	.486	0.56
3	24.210	14.195	.586	.0441	.486	0.56
4	24.212	14.197	.586	.0441	.486	0.56
5	24.213	14.197	.586	.0441	.486	0.56

As already indicated, it is clear that most of the change in the income distribution actually occurs by period one. Subsequently there are relatively minor increases in both mean income and mean educational expenditures (note that even if E/y stays constant that mean income continues to increase), and minor decreases in inequality in both distributions. Given that mean income is increasing it turns out that required tax rates are decreasing over time.

4.2. Welfare

Having analyzed the effects on allocations, we now turn to analyze the welfare effects associated with these changes. In a model such as this in which families are heterogeneous with regard to income and policies have differential effect on households there is no definitive choice for a measure of welfare. We adopt a measure of welfare which is in the spirit of a behind-the-veil measure in which we compute the expected utility for a family that results from taking a random draw from the actual distribution of utility across families. This is equivalent to a utilitarian welfare criterion. We then compute the extent to which the income distribution in the benchmark model would have to be scaled in order to equalize welfare across the comparisons. We make this comparison for each of several periods following the adoption of the various voucher programs.

We should expect that welfare comparisons at different dates will look quite different since income is changing over time. In particular, given that steady state income is sometimes significantly higher in the economy with vouchers, we would expect welfare to also be substantially higher. Such a comparison of course ignores the fact that in order to get the higher income redistribution was required (with a welfare cost for some). This element is particularly significant in the first period (period 0) since at that point in time there has not been any increase in mean income and more resources are being devoted to education. Of course, families do take into account the fact that their children will end up with higher incomes when they assess the utility that they receive from a given voucher program.

Table Six presents the welfare results.

Table Six
Welfare Effects

A. Lump-Sum Voucher

period	v_l						
	$.1\mu_e$	$.25\mu_e$	$.4\mu_e$	$.5\mu_e$	$.6\mu_e$	$.75\mu_e$	$1\mu_e$
0	1.006	1.014	1.020	1.023	1.024	1.023	1.019
1	1.007	1.018	1.036	1.051	1.067	1.094	1.137
2	1.007	1.019	1.037	1.053	1.071	1.098	1.142
3	1.007	1.019	1.038	1.054	1.072	1.099	1.142
4	1.007	1.019	1.038	1.054	1.072	1.099	1.142
5	1.007	1.019	1.038	1.054	1.072	1.099	1.142

B. Means-Tested Voucher

Period	v_m						
	$.1\mu_e$	$.25\mu_e$	$.4\mu_e$	$.5\mu_e$	$.6\mu_e$	$.75\mu_e$	$1\mu_e$
0	1.000	1.006	1.019	1.027	1.032	1.034	1.0330
1	1.000	1.008	1.033	1.053	1.074	1.105	1.152
2	1.000	1.009	1.034	1.056	1.078	1.110	1.156
3	1.000	1.009	1.035	1.056	1.078	1.110	1.157
4	1.000	1.009	1.035	1.056	1.078	1.110	1.157
5	1.000	1.009	1.035	1.056	1.078	1.110	1.157

C. Power-Equalizing Voucher

Period	y_p						
	$.25\mu_y$	$.4\mu_y$	$.5\mu_y$	$.6\mu_y$	$.75\mu_y$	μ_y	$1.25\mu_y$
0	1.001	1.005	1.008	1.011	1.015	1.019	1.020
1	1.002	1.012	1.022	1.033	1.050	1.076	1.098
2	1.003	1.013	1.024	1.036	1.054	1.083	1.107
3	1.003	1.014	1.024	1.036	1.055	1.083	1.108
4	1.003	1.014	1.024	1.036	1.055	1.084	1.108
5	1.003	1.014	1.024	1.036	1.055	1.084	1.108

In interpreting these numbers note that a value of 1.020 for a particular period, for example, indicates that income in the benchmark economy would have to be scaled upward by 2% in order to make individuals indi¤erent between the steady state in the no voucher world versus having the allocation of resources be given to that in the world with a voucher in the particular time period considered.

A striking …nding is that welfare gains are positive in all periods for all voucher plans considered (as indicated by the fact that all numbers are equal to or greater than one). Moreover, the e¤ects are large; in several cases the steady-state welfare gain exceeds ten percent. As suggested above, it is in fact the case that welfare gains in the initial period are quite a bit less than the welfare gains associated with later periods. However, the size of the welfare gain in the period following the introduction of the voucher is already close to the steady state welfare gain. Another …nding of some interest is that for the lump-sum voucher the size of the …rst period gain is not monotone in the size of the voucher. For the values considered in the table it reaches its maximum value for a lump-sum voucher equal to :6$^{\mathbf{1}}_{e}$ However, for the case of steady state welfare gains the increase is in fact monotone over the range of voucher programs considered here.

5. Endogenous Choice of Vouchers

In the previous section we traced out the consequences of various voucher programs for allocations and welfare both in the short and long run. In tracing out these consequences, however, we have simply taken the parameters of a given voucher system as exogenous. In reality, once a voucher program is put in place, its parameters are likely to ultimately be chosen through the political process. In view of this it is also important to try and assess the likely outcome of the political process for the magnitude of various voucher programs. This is the issue that we address in this section.

Modelling the political process is of course a challenging endeavor. As is common in the political economy literature, the benchmark that we adopt for our study is that of majority voting. Hence, we will assume that all households participate and are given equal weight in the process. In each period, agents are assumed to choose the parameter that governs the size of the voucher. The analytics of this problem for the lump-sum voucher and the power equalizing voucher have been studied previously by Fernandez and Rogerson (1999).[6] We refer the reader to that reference for analytical details on the voting problem.

[6] That paper considers several school …nance systems rather than voucher systems, but as discussed previously therre is a mapping between the two.

Here we focus on the outcomes that result from majority voting. In our previous analysis we considered vouchers that were of constant value over time. Once we endogenize the determination of the voucher this will in general not be the case since changes in the income distribution over time may lead to changes in the political outcome over time as well.

We begin with the case of the lump-sum voucher. Results are presented in Table Seven.

Table Seven
Endogenous Choice of Vouchers
Lump-Sum Vouchers

Period	mean(y)	sd(y)	cv_y	$\tau_l \times 100$	v_l/μ_e	cv_e	E/y	Δ
0	23.081	13.718	.594	2.75	.671	.523	.0429	1.024
1	23.950	14.024	.582	2.75	.696	.502	.0431	1.080
2	24.142	14.159	.583	2.75	.702	.496	.0432	1.088
3	24.183	14.168	.583	2.76	.705	.495	.0432	1.090
4	24.202	14.170	.583	2.76	.706	.495	.0432	1.091
5	24.202	14.170	.583	2.76	.706	.495	.0432	1.091

The table shows that in the initial period, majority vote leads to a voucher whose value is a fraction .671 of average household education expenditure in the benchmark steady state. The consequences of this for education expenditures can be inferred from the earlier tables which indicate the consequences of a given voucher. Hence, the results here lie somewhere between those reported in Table Two for $v_l = .6\mu_e$ and $v_l = .75\mu_e$. As before, we still find that the transition to a steady state is quite rapid. The one feature that could potentially be different in this case is that it could be that there are more dynamics introduced by the endogenous choice of the voucher each period. In particular, the size of the voucher increases over time, but otherwise these additional dynamics are not too significant quantitatively. Hence, the economy is most of the way to the new steady state income distribution one period after the introduction of the voucher. As the final column indicates, there are substantial welfare gains associated with the introduction of the voucher plan, both in the short run and the long run. The long run gain exceeds nine percent when expressed relative to steady state income in the benchmark economy.

Next consider the case of the means tested voucher. The political economy of this system is more complicated than the other two systems. The reason for this is that whereas the other two systems were completely summarized by a single parameter, this system is summarized by two parameters. As is well known in the social choice literature, two dimensional problems are much more di¢cult. In considering the political economy of this system we assume a two stage process. In the …rst stage the cuto¤ level y_m is chosen, and in the second stage the size of the voucher is chosen given the value of y_m chosen in the …rst stage. We …nd that a majority voting equilibrium exists, and takes the form of having the cut-o¤ level y_m being equal to median income, so that half of the population receives the voucher. The size of the voucher is then decided as the preferred choice of the lowest income individual. We take this individual to be someone with income of $1;000$ dollars. This turns out to generate a relatively small amount of redistribution. Results are reported in Table Eight.

Table Eight
Endogenous Choice of Vouchers
Means Tested Voucher

Period	mean(y)	sd(y)	cv_y	¿$_m$ £ 100	y_m=¹$_y$	v_m=¹$_e$	cv_e	E=y	¢
0	23.081	13.718	.594	0.62	0.86	.299	.593	.0410	1.021
1	23.156	13.737	.593	0.62	0.86	.300	.593	.0410	1.028
2	23.179	13.740	.593	0.62	0.86	.300	.593	.0410	1.029
3	23.184	13.741	.593	0.62	0.86	.300	.593	.0410	1.030
4	23.185	13.741	.593	0.62	0.86	.300	.593	.0410	1.030
5	23.185	13.741	.593	0.62	0.86	.300	.593	.0410	1.030

As the table indicates the size of the voucher is relatively small–only thirty percent of average educational spending in the original steady state. As we know from Table One, this voucher exceeds spending for only about two percent of all households, and not surprisingly has a fairly negligible e¤ect on the economy.

Lastly consider the case of the power equalizing voucher. Table Nine presents the results.

Table Nine
Endogenous Choice of Vouchers
Power-Equalizing Voucher

Period	mean(y)	sd(y)	cv_y	¿$_p$ £ 100	y_p=¹$_e$	cv_e	E=y	¢
0	23.081	13.718	.594	1.45	1.44	.432	.0481	1.019
1	24.755	14.471	.585	1.45	1.55	.394	.0490	1.112
2	25.132	14.689	.585	1.45	1.57	.387	.0492	1.129
3	25.208	14.733	.585	1.45	1.57	.385	.0493	1.133
4	25.223	14.742	.585	1.45	1.57	.385	.0493	1.133
5	25.226	14.744	.585	1.45	1.57	.384	.0493	1.133

An interesting …nding here is that majority vote leads to a very high value of y_p: as can be seen this level is 1.44 times mean income. As a result this system brings about considerably more compression in the distribution of education spending than does the lump-sum voucher system. The increase in steady state income is now almost ten percent and the increase in steady state welfare exceeds thirteen percent. Note that although y_p increases over time in absolute terms, in fact it is quite stable relative to mean income over time. As a result of the increase in y_p the convergence to the new steady state is somewhat slower here than in the case of exogenous policy considered earlier.

It is interesting to note that the political economy of these three systems are quite di¤erent. We saw earlier that a means tested voucher is able to increase education spending among poorer households equally well as the other two systems, given appropriate choice of program parameters. However, the striking …nding in the above analysis is that when choices are made by a process of majority vote, poorer households end up with very little increase in their spending on education relative to the other two systems.

While this …nding is signi…cant, it is important to note some quali…cations. Majority vote is one mechanism that can be used to generate a solution to a social choice problem. Also, we have abstracted from some features that may generate additional support for redistribution. For example, we have assumed that greater education for poorer households has no bene…ts for other households. In reality the additional skills accumulated by these households may bene…t others as well. (See Benabou (1996) for a model in which possibility is allowed.) With this in mind it is probably best to interpret our results as showing that political economy considerations may imply that the three systems generate quite di¤erent outcomes.

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