How to Subsidize Education and Achieve Voluntary Integration: An Analysis of Voucher Systems

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HOW TO SUBSIDIZE EDUCATION AND ACHIEVE VOLUNTARY INTEGRATION: AN ANALYSIS OF VOUCHER SYSTEMS

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ABSTRACT

Reforms in education is currently a hot topic. Many suggestions for reform use elements of Friedman's voucher scheme. According to this scheme parents get a transfer of money (vouchers) from the government, which they must spend on education. But they are free to choose the type of education they want for their children. In particular, they can choose among alternative schools.

Surprisingly, the ideas sketched by Friedman about thirty years ago were not examined in the rigorous general equilibrium tools which are now available. Here I attempt to fill this gap. It is argued that vouchers are not sufficient for successful decentralization: To achieve the socially optimal amounts of educational outputs the government must pay schools for the educational outputs in addition to payments for the employment of students. Once this achievement based system (ABS) is in place, there is no need to worry about school integration: the optimal amount of integration will arise voluntarily, because in the ABS schools face the correct shadow wages for the employment of students.

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1. INTRODUCTION

Chubb and Moe open their book by the following statement: "For America's public schools, the last decade has been the worst of times and the best of times. Never before in recent history have the public schools been subjected to such savage criticism for failing to meet the nation's educational needs-yet never before have governments been so aggressively dedicated to studying the schools' problems and finding the resources for solving them." Elsewhere, they argue: "Of all the reforms that attract attention, only choice can address the basic institutional problems plaguing America's schools". (Chubb and Moe, 1990a, pp.1 and 1990b, pp.7.) President Bush, in his April 1991 speech unveiling the new America 2000 education strategy stated: "The concept of choice draws its fundamental strength from the principle at the very heart of the democratic idea. Every adult in America has the right to vote, the right to decide where to work, where to live. It's time parents were free to choose the schools that their children attend". Manski (1992) states the need for economic analysis instead of rethoric partly because "during the past thirty years, the basic intellectual argument for systematic choice has not notably advanced beyond the classical economic ideas sketched by Friedman (1955, 1962)."[1] Here I attempt to advance the understanding of vouchers systems.

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[1] For a recent statement see Milton and Rose Friedman (1981, pp.140-78). For some discussion see Cohen and Farrar (1977), Coons and Sugarman

Economists focus on two main reasons for government intervention in education: Imperfections in the capital markets and external effects. The first arises because human capital is a poor collateral. It can be solved by providing government backed loans to finance the investment in education. The second may arise because democracy seems to work better when the population is educated and because some parents fail to represent the interest of their children.[2] The availability of government backed credit will not solve the externality problem: in the absence of further government intervention there will be under investment in education.

A distinction should be made between two types of proponents of choice: Those who think that the external effects are important and those who think that they are relatively unimportant. The latter base their argument for vouchers on incentives. Levin (1991) notes that this incentive argument can be found as early as 1776, in Adam Smith's *The Wealth of Nations*. Smith (1937, p.737) argued that if the government pays all the cost of education the teacher "... would soon learn to neglect his business". Manski (1992) summarizes the incentives argument, which he attributes to Friedman (1955, 1962), in the following way.

(1978) and Lieberman (1989). An early voucher proposal, by Tom Paine is discussed in West (1967).

[2] In this latter case, society rather than parents represents the children interest. These externalities seem to be important in elementry and high-school, where socialization takes place. It is often argued that external effects in higher education are less important. See Arrow (1973), for example.

"... public schools distorts the incentives faced by both the consumers and producers of schooling. Consumer incentives are distorted because the residents of a given school district are encouraged to enroll their children in that district's public schools rather than in private schools or out-of-district public schools, where they may have to pay fees of several thousands dollars per year." Producers incentives are distorted because government funding gives schools local monopoly power and therefore "the public schools can attract students even if they do not provide the type and quality of education that families want."

This is an argument for letting the free market produce education. If student interactions (Friedman's "neighborhood effects") are important, a simple voucher system will actually be different from the free market system. The effect of the mix of students in the classroom has been recently studied by Gamoran (forthcoming) and Reuman (1989). Manski argues that "student interactions generate 'external' effects". It is argued here and in the accompanying paper Eden and Klinov (1992), that in a free market environment, this external effect will be internalized by differential tuitions: High ability students will pay relatively low tuitions or may even get stipends. In detail, I treat students as factors of production rather than consumers and argue that student interactions is not different from the interaction of workers in the adult world: If schools (firms) face the correct wages for the employment of different types of students (workers), the interaction of students (workers) does not lead to an external effects problem: it is internalized by the price system.

To mimic the free market system we need a differential voucher system (DVS), in which high ability students get a relatively low or even negative vouchers.

The argument for government intervention is the external effects: Society wants something different from what parents do. For example, society may want more knowledge of history because it provides roots and a sense of community. The proponents of choice who think that the external effects are important, argue for increasing the amount of vouchers beyond what students will spend in a free market solution which is supplemented by government backed credit. Manski argues that in the absence of monitoring "students and schools can subvert social objectives by using the subsidies to further their own private interests." To appreciate the enforcement problem, consider first the case in which there are no restrictions on the amount of stipends. If students want to spend only $y on education out of a voucher of $x, then in equilibrium schools will offer $y worth of education + a stipend of x - y dollars. Schools that offer $y worth of education will not be able to compete because students prefer the additional x - y dollars as cash. If monetary stipends are not allowed, schools will pay stipends in kind by providing, for example, cheap lunches and clothing.[3] In what follows,

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[3] Food stamps is another example of transfer payments with an added restriction on spending. We expect a market for food stamps to develop whenever the amount of food stamps is larger than what the receipients want to spend on food: The receipients will use this market to sell any amount of food stamps which is above what they really want to consume. There are however, two important differences between food

I refer to everything that society does not wish to subsidize as stipend in kind or consumption.[4]

Since some of the voucher money will be spent on consumption a voucher system is an expensive way to increase the level of education. I now turn to discuss a version of the voucher system that pays explicit attention to the enforcement problem.

In a simple voucher system, schools get funds from the government on the basis of the number of students. In a differential voucher system (DVS), schools get funds also on the basis of the mix of students. The achievement based system (ABS) adds measures of schools' achievements to the above criteria for government funding.

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stamps and vouchers. Food stamps represent a transfer from the entire population to a small group of poor people and therefore the receipients get a significant increase in their wealth. In the case of vouchers, the transfer is from families with small number of children to families with large number of children and the wealth effect is much smaller. In addition the elasticity of food consumption with respect to wealth for poor people must be relatively large but the wealth elasticity of education may be small because the consumption element in education may be small. These differences suggest that in spite of the enforcement problem food stamps will increase the demand of poor people for food, but vouchers may fail to have a significant effect on the demand for education.

[4] For example, some parents may value the knowledge of the bible more than society does. In this case spending the additional x - y dollars on bible studies, is equivalent from the social point of view to spending it on consumption because it does not generate external effects.

Ideally, we should measure schools' achievements by the average achievements of the graduating students in: math, the ability to learn think and create, sports, social skills, the ability to carry on a democratic debate, etc. The ABS requires the measurement of gross educational final outputs: not the value added. This makes the measurement problem less severe. But still, measurement is costly. One view is that we can measure the inputs but not the outputs, because measuring the outputs by a government agency will create a serious disturbance to the production process itself. If we have some knowledge of the production function, we can measure outputs indirectly, by measuring inputs. We may know for example, that if we put together a qualified history teacher, 10 low ability (L) students and 30 high ability (H) students, for one hour in a class room that meet a certain critiria, we will get on average 2 units of history knowledge per H student and 1 unit per L student. If the ABS calls for 1 dollar per unit of history knowledge achieved by H and 2 dollars per unit achieved by L, we pay the school 60 dollars for this history class. Thus the ABS can work even when only inputs are measured.

In an ABS both the government and the parents monitor schools performance. The need for this joint monitoring arises because of the difference between the social and private value of education: Typically, parents want to receive some of the education budget as consumption, while society wants to spend the entire budget on educational inputs.[5][6]

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[5] An analogy with subsidizing clean air may be useful. Assume, for example, that a factory and a school get money from the government.

The ABS has a clear advantage over direct government production, even when only inputs are measured. This is because parents choice acts as a monitoring device: A school that does not use inputs efficiently will eventually go bankcrupt.

I treat zero tuition as an independent objective. To meet this objective, the government pays schools for the employment of students who will otherwise have to pay tuition and taxes schools for the employment of students who will otherwise receive stipends.[7] Since students do not have out of pocket expenses, universal school attendance can be achieved.

The factory is run and owned by the workers and the school is run and owned by the parents. In the absence of government monitoring, there are two options for spending the money. For the workers these are: pollution controls and subsidized lunches. For the parents these are: a library and subsidized lunches. In the absence of monitoring, both groups may go for subsidized lunches even when society favors the alternative.

[6] Asymmetric information is another argument for joint monitoring. But this is a more general problem: Car manufacturers are better informed then consumers about the quality of their products. The government intervention in this case is to impose certain safety standards for cars and, using analogy, minimum requirements for schools. The ABS requires the measurements of achievements, which is more than just monitoring minimum requirements. This additional monitoring is required because society and parents want different things.

[7] This requires the classification of students to many types. Indeed if we insist on no out of pocket expenses we may have to auction individual students among all potential schools. More realistically, we should expect that students will have small out of pocket expenses.

The second section is an example and the third is a general equilibrium type analysis.

2. AN EXAMPLE

This example is aimed at readers with different backgrounds. I consider the following environment. Everyone can plant an orchard and for simplicity I assume that it is costless to do so. The owner of an orchard charge students for the privilege to enter the orchard and pick apples. The capacity of each orchard is limited to 40 students. There are two types of students: high (H) and low (L) ability. Let R denotes the fraction of H students in the orchard. The apple picking technology is:

(a) $R = 0$: each student picks \$50 worth of apples;

(b) $R = 1$: each student picks \$100 worth of apples;

(c) $R \geq .75$: each L student picks \$70 worth of apples and each H student picks \$99 worth of apples ;

(d) $R < .75$: each L student picks \$55 worth of apples and each H student picks \$70 worth of apples.

In the population there are 80 L students and 240 H students. If they are all segregated we will get 2 orchards of L students which produce 2000 per orchard and 6 orchards of H students which produce 4000 per orchard. The total production is 28000 dollars. If they are integrated we will have 8 orchards with 30 H students and 10 L students in each orchard. The production in each orchard is (10)(70) + (30)(99) = 3670 and the total production is 29,360. The gain from integration is 1360 dollars.

I now turn to discuss how the free market mechanism chooses the mix of students in the orchard. I assume that the economy will reach equilibrium, in which entrepreneurs exhaust all the money making opportunities. Since there is no cost of production, this implies that in equilibrium average tuition is zero.

<u>Claim: Free competition will lead to integration</u>

<u>Proof:</u> We need to show that there is a money making opportunity in a complete segregation zero tuition environment. To show that note that an entrepreneur can plant an orchard and offer to admit 10 L students for 20 dollars tuition and 30 H students with a one dollar stipend. He will be able to attract students because (a) the net income for L students in the new orchard = 70 - 20 = net income for L students in an alternative orchard = 50 and (b) the net income for H students in the new orchard = 99 + 1 = net income for H students in an alternative orchard = 100.

Now,

profits = total tuition fees - total stipends = 200 - 30 = 170 .

Thus in a segregated environment, an entrepreneur can make money and therefore complete segregation is not consistent with equilibrium. □

In the same way it can be shown that any solution which does not maximize total output is not consistent with equilibrium. I now solve for the equilibrium levels of tuitions (T) and stipends (S). Since there are 3 H students on each L student, zero profit requires:

(1) $$T = 3S$$

Equilibrium also requires that an entrepreneur cannot make money by planting an orchard and admitting one type of students only or changing the mix of students. This leads to:

(2) $$99 + S \geq 100 ;$$

(3) $$70 - T \geq 50 ;$$

(4) $$99 + S \geq 70;$$

(5) $$70 - T \geq 55.$$

There are many pairs (S , T) that satisfy (1) - (5). For example, $T = 3$ and $S = 1$.

Free tuition can lead to segregation: It is often argued that if we allow add-ons of private tuition, we will get segregation because rich students will be willing to pay higher tuitions for segregated schools (see, Levin 1991, for example). The opposite is true: Segregation is caused by government restrictions on tuitions and allowing private tuition will lead to integration.

To get the optimal mix of students in the class, the free market uses tuitions and stipends which play the same role as wages in the adult world. Indeed it may help to think of an adult economy in which there are two types of workers: skilled and unskilled. Factories employ both types because in general, segregation lowers total output. The mechanism used in the adult world, to achieve the desired mix of workers, is to pay a higher wage to the skilled workers. In the kids world the mechanism requires a higher stipend (or a lower tuition) to the H student.

To see that wage control of the form $T = S = 0$, can lead to segregation, assume in our example, that orchard owners have a non pecuniary pleasure from interacting with H students and try to attract them by promising exclusivity. The H students pick more apples in exclusive orchards, so some of the orchards will indeed be successful in becoming exclusive. The other orchards will have to accept the L students.

An ABS is necessary to solve the externality problem: Assume that if the orchard owner invests $\$x > 0$ per student production per student goes up by $\log(x)$. Production is the same as before if $x = 0$. Assume further that without government intervention the students choose $x = 0$ but the socially desired level is $x = 10$ or $\log(x) = 1$. When $R \geq .75$, an ABS will pay orchard owners according to the following formula:

$10 \times$ (total production - 3670) + 3L - H and the owner will therefore maximize:

$$(6) \qquad 10 \times (\text{total production} - 3670) + 3L - H - 40x .$$

Substituting $3670 + 40 \times \log(x)$ for total production in (8) yields:

$$(7) \qquad 10 \times 40 \times \log(x) + 3L - H - 40x .$$

Maximizing (7) with respect to x yields x = 10.[8]

<u>Coexistence of different orchard types:</u> The efficient degree of integration depends in general on the fraction of H in the population and need not be 0 or 1.[9] When there are 80 H students and 240 L students

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[8] Assuming that the owner choose the integrated option in which there are 3H on each L, he will make zero profits. At this solution L gets 71 units of education, H gets 100 units and no one pays tuition or get a stipend. A segregated H orchard will not be able to make money because if it stays in the system it must pay 40 for the privilege to employ H and if it gets out it cannot offer H more than they are already getting. Also a segregated L orchard cannot make money.

[9] Arnott and Rowse (1987) analyse the implications of different specifications of a Cobb-Douglas educational production function on the efficient degree of integration. Benabou (1991) study a similar problem with a CES production function.

in the population, total output is maximized by having some integrated orchards and some segregated ones. All the H students are however in integrated orchards.[10][11]

3. THE MODEL

Here I show that whatever the government can do by directly producing education and by bussing students, an ABS can achieve without coercion and without requiring a higher budget. Decentralization requires that schools face the socially correct prices for all outputs and inputs. It will be shown that in a DVS the prices of outputs may be

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[10] The total output maximizing solution is: 2 orchards with 30 H students and 10 L students; one orchard with 20 H students and 5 L students; one orchard with 15 L students; 5 orchards with 40 L students. Total production = (3670)(2) + 2330 + 750 + (5)(2000) = 20,420. It can be shown that the alternative of complete segregation yields a total output of 20,000 and the alternative of complete integration yields total output of 18,800. To solve for the equilibrium levels of T and S, note that zero profits require zero tuition in the segregated orchards. The net income of the segregated L students is therefore 50. The net income of L students in the integrated orchard must be the same: (*) 70 - T = 50 . Zero profits in the integrated orchards implies: (**) 3S = T . In equilibrium, the pair (S , T) must satisfy (*), (**) and (2)-(5). Here we have a unique solution: T = 20 and S = 20/3.

[11] This example suggests that in an economy with a large fraction of low ability students we should have two types of schools: an integrated school with poor facilities and a segregated school with good facilities.

too low: the ABS corrects this problem by paying for the educational outputs as well.

There are only two types of students: low and high ability. There are L low ability students and H high ability students in the economy. The capital letters L and H will also be used as indexes. Let E_L (E_H) stands for the quantity of education received by low (high) ability students in the economy and let m denotes the amount of money spent on education.[12] The production possibility set for the economy is denoted by Y. Thus $y = (E_H , E_L , l , h , m) \in Y$, if it is possible to produce E_H units of type H education and E_L units of type L education with the inputs of l low ability students, h high ability students and m dollars.

Factors of production are perfectly mobile. Thus as in Friedman (1962), I limit the analysis to large urban areas. It is assumed that the level of education per student depends on his class but not on his school. Adding a "school effect" will not change the main results.

I now introduce rather standard assumptions regarding the production possibility set.[13] Suppose that y can be achieved by a school system that uses l low ability students, h high ability students and m dollars as inputs, and y' can be achieved by a school system that uses

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[12] The model can be easily extended to the case in which there are many types of students, many educational outputs and many other inputs. In such a general model, E_j is a vector that may include knowledge of math, the ability to think and to create, achievements in sports and social skills. The "other" inputs may include teachers and facilities.

[13] See, for example, Arrow and Hahn (1971. ch.3).

l' low ability students, h' high ability students and m' dollars as inputs. Then we assume that it is possible to build both kinds of school systems. Thus,

Additivity (A1): $y \in Y$ and $y' \in Y$ implies $y + y' \in Y$.

I also assume that it is possible to reduce all inputs by the same percentage without affecting the level of education per student. This seems a reasonable approximation when the relevant scale of operation is large.[14] Thus,

Divisibility (A2): $y \in Y$ implies $\lambda y \in Y$ for all $0 \le \lambda \le 1$.

<u>The planner's problem:</u> There are infinitely many potential classes. The maximum amount of education that a type t student can get in class i with the inputs $x_i = (m_i , h_i , l_i)$ is denoted by $G_t(x_i)$. It is assumed

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[14] To illustrate, suppose that initially we have 31 classes with 30 students per class. We are now asked to cut all inputs to a third of their initial level. In this case, we will have 10 classes with 31 students per class. We do not expect that changing the number of students per class from 30 to 31, while holding the amount of money spent per student constant, will have much effect on the level of education per student. To see that large scale operation is required, consider the case in which in the context of the above example, initially we have 4 classes rather than 31. In this case, if we cut the level of all inputs to a third of their initial level, we will end up with a class of 40 students. This is more likely to alter the level of education achieved by each student.

that $G_t(0) = 0$, G_t is an increasing function of m and a decreasing function of l. It may be either increasing or decreasing in h.

Let $\alpha_t > 0$ denotes the weight assigned by a social planner to type t education and let $x = [x_1, x_2, x_3 \ldots]$ denotes an allocation of inputs among all potential classes. The planner values the outputs associated with the vector of inputs x, by:

$$(8) \qquad F(x) = \Sigma_i \; \alpha_H h_i G_H(x_i) + \alpha_L l_i G_L(x_i) \; .$$

The assumptions (A1) and (A2), imply that F( ) is concave.[15] Let, $X = (M, H, L)$ denote the total quantities of available inputs. The planner solves:

$$(9) \qquad \max F(x) \quad \text{s.t.} \quad \Sigma_i \, x_i \le X \; , \quad x_i \ge 0.$$

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[15] To show this claim we need to show that:

$F(\delta x' + [1-\delta]x) \geq \delta F(x') + (1 - \delta)F(x)$; for $0 < \delta < 1$.

From the definition of $G_t(\;)$ as the maximum amount of type t education possible given the input vector, it follows that

$y = [\; \Sigma_i \; h_i G_H(x_i) \;, \Sigma_i \; l_i G_L(x_i), \Sigma_i \; x_i] \in Y$ and

$y' = [\; \Sigma_i \; h'_i G_H(x'_i) \;, \Sigma_i \; l'_i G_L(x'_i), \Sigma_i \; x'_i] \in Y$. It therefore follows from (A2) that $(1-\delta)y \in Y$ and $\delta y' \in Y$. From (A1) it follows that $(1-\delta)y + \delta y' \in Y$. Thus the firm can produce the output $\delta F(x') + (1 - \delta)F(x)$, with the vector of inputs $\delta x' + (1 - \delta)x$. This completes the proof.

Assuming the constraint qualifications[16], there exist shadow prices (lagrangian multipliers) λ_j such that the solution to (9) is also the solution to:

(10) $$\max F(x) - \lambda_1 \Sigma_i l_i - \lambda_2 \Sigma_i h_i - \lambda_3 \Sigma_i m_i \ ; \quad \text{s.t. } x \geq 0.$$

We can therefore choose units in a way that will make $\lambda_3 = 1$.[17] Under this choice, α_t can be interpreted as the price in terms of tax dollars that the planner is willing to pay for a unit of type t education.

Students objective function: Let $U_t(E , w)$ denote the level of utility of a type t student who gets E units of education and is paid a current wage of w dollars. The current wage can be positive (a stipend) or negative (tuition). I assume[18]:

(11) $$U_t(E , w) = E + w .$$

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[16] I.e., the inputs vector which is available for the economy, X, is strictly positive and it is possible to produce some education with $X_0 << X$.

[17] The solution to (9) is invariant to an equiproportional change in α_L and α_H . Since (10) and (9) have the same solution, it follows that if we increase α_L and α_H by x%, the shadow prices will also increase by x% .

[18] Assuming $U = \beta E + w$, with $\beta > 0$, will not change the main results.

In the presence of perfect capital markets, we may think of E as the contribution of education to human capital. Following the labor contracts literature I assume that an individual school must promise a type t student W_t utils to attract him or her, where W_t is the level of utility that can be achieved by a type t student elsewhere. Thus,

$$(12) \qquad U_t(E_{ti}\ ,\ w_{ti}) = G_t(x_i) + w_{ti} \geq W_t\ .$$

<u>The achievement based system (ABS):</u> I start with a system in which tuitions and stipends are allowed: $w_t \gtrless 0$. The government pays P_t dollars per unit of type t education and does nothing else. Each firm owns one class and chooses the current wages, w_{ti} , and the number of students from each type to maximize:

$$(13) \qquad \max\ P_H h_i G_H(x_i) + P_L l_i G_L(x_i) - w_{Hi} h_i - w_{Li} l_i - m_i$$
$$\text{s.t. (12) and } x_i \geq 0.$$

Since I allow negative current wages, at the optimum (12) must hold with strict equality. Substituting $w_{ti} = W_t - G_t(x_i)$ the problem (13) becomes choosing $x_i \geq 0$, to:

$$(14) \qquad \max\ (P_H + 1)\ h_i G_H(x_i) + (P_L + 1) l_i G_L(x_i) - W_H h_i - W_L l_i - m_i.$$

The problem (14) uses full prices. The full price of education is $P_t + 1$. This is intuitive: For a unit of output the school gets P_t dollars from the government and a dollar increase in tuition.

Using $x = (x_1, x_2, \ldots)$, $P = (P_L , P_H)$ and $W = (W_H , W_L)$, I define equilibrium as follows.

Equilibrium for an output price vector P is a non-negative vector $[x(P) ; W(P)]$ that satisfies:

(a) given $[P, W(P)]$ the vector $x_i(P)$ solves (14) for all i ;

(b) market clearing:

$\Sigma_i h_i(P) \leq H$ with equality if $W_H(P) > 0$;

$\Sigma_i l_i(P) \leq L$ with equality if $W_L(P) > 0$.

Note that in the case of unemployment, the full wage must be zero.

A solution to the planner's problem (10) can be implemented by an ABS if we can find P such that the resulting equilibrium allocation coincide with the solution to (10).

Proposition 1: (a) Any solution to the planner's problem (10) can be implemented by an ABS by setting: $P_t = \alpha_t - 1$; (b) The resulting equilibrium full wages are given by: $W_H = \lambda_2$ and $W_L = \lambda_1$.

Note that when $\alpha_t = 1$, $P_t = 0$. In this case the private and social value of education are the same and there is no need to subsidize education.

Proof: Substituting $P_t = \alpha_t - 1$, $W_H = \lambda_2$ and $W_L = \lambda_1$ in (14) leads to:

(15) $$\max \alpha_H h_i G_H(x_i) + \alpha_L l_i G_L(x_i) - \lambda_2 h_i - \lambda_1 l_i - m_i \; ; \quad \text{s.t.} \quad x_i \geq 0 \; .$$

Since (10) can be written as:

(16) Σ_i {max $\alpha_H h_i G_H(x_i) + \alpha_L l_i G_L(x_i) - \lambda_2 h_i - \lambda_1 l_i - m_i$; s.t. $x_i \geq 0$},

it follows that the solution to (10) must also be a solution to (15) for all i. To show that the market clearing conditions are satisfied note that the solution to (10) is also the solution to (9) and must therefore satisfy the constraints in (9). Furthermore, the lagrangian multipliers are strictly positive only when the constraints are binding. Thus for the suggested output price vector there exists an equilibrium and the equilibrium allocation coincides with the solution to (9). □

I now assume that the government rather than the students receives (pays) the equilibrium levels of the current wages w_t so that students do not have out of pocket expenses. I assume also that in equilibrium firms make zero profits. Under these assumptions:

Proposition 2: Government spending is not affected by the introduction of the ABS.

Proof: Note that zero profits imply:

(17) $$P_H h_i G_H(x_i) + P_L l_i G_L(x_i) - w_{Hi} h_i - w_{Li} l_i = m_i$$

Summing the left hand side of (17) over all i gives the government expenditure for the proposed scheme. Summing the right hand side of (17) is the total amount of money spent by the firms on material teachers' salaries, etc. Since Proposition 1 implies that $\Sigma_i m_i = M$, this is equal to the total amount spent by our planner on education. $\square$

If in equilibrium firms make positive profits the government can collect these profits by imposing lump sum taxes on schools.

An ABS is necessary to solve the externality problem: Suppose that the government does not pay for outputs and pays only for the employment of students: V_t dollars per type t student. I do not impose any restriction on current wages and therefore the firm faces the total wage cost of W - V ($\gtrless 0$) per student and choose non negative x_i, to solve:

$$(18) \qquad \max h_i G_H(x_i) + l_i G_L(x_i) - (W_L - V_L) l_i - (W_H - V_H) h_i - m_i.$$

Equilibrium for a non-negative voucher vector V = (V_L, V_H) is a non-negative vector $[\hat{x}(V), \hat{W}(V)]$ that satisfies:

(a) given $[V, \hat{W}(V)]$ the vector $[\hat{x}_i(V)]$ solves (18) ;

(b) market clearing[19]:

$\Sigma_i \hat{h}_i(V) \leq H$ with equality if $\hat{W}_H(V) > 0$;

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[19] Student unemployment with $W_t > 0$, will create a downward pressure on students' current wage until either $W_t = 0$ or there is full employment. I therefore require market clearing whenever $W_t > 0$.

$\Sigma_i \hat{l}_i(V) \leq L$ with equality if $\hat{W}_L(V) > 0$.

We can now state the effect of introducing a voucher system to a free market economy in which there is full employment: $\Sigma_i h_i(0) = H$ and $\Sigma_i l_i(0) = L$. In this case, the vouchers will end up in the pocket of the students as an increase in current wages without having an effect on the amount of education produced. Formally,

Proposition 3: If $[x(0), W(0)]$ is an equilibrium for a price vector $P = 0$, then $\hat{x}(V) = x(0)$ and $\hat{W}(V) = W(0) + V$ is an equilibrium for a voucher vector V.

Proof: Choose $\hat{W}(V) = W(0) + V$. Given this choice and $P = 0$, the problem (14) is the same as (18). Since $x_i(0)$ is a solution to (14) it therefore follows that $\hat{x}_i(V) = x_i(0)$ is a solution to (18). Furthermore, the market clearing conditions: $\Sigma_i h_i(0) = H$; $\Sigma_i l_i(0) = L$ imply the market clearing conditions: $\Sigma_i \hat{h}_i(V) = H$; $\Sigma_i \hat{l}_i(V) = L$. □

Thus differential vouchers lead to the same outputs as the free market.

4. CONCLUDING REMARKS

In the absence of external effects an ABS is the same as DVS: Schools are paid on the basis of the number and mix of students. In the presence of external effects, an ABS pays schools for educational outputs in addition to payments for the employment of students. At a minimum, an ABS will achieve the same educational outputs as a centrally planned system, without coercion. More realistically, an ABS will improve productivity relative to a government run operation because parents choice acts as an effective monitoring device: Schools that do not use their inputs efficiently will eventually go bankcrupt.

An ABS can work even when educational outputs are measured indirectly by the quantities of inputs used. An ABS creates the incentives to spend the entire budget on educational inputs, while in a DVS some of the budget will be spent on stipends in kind.

How should we go from a government run operation to an ABS. One way is to start with a DVS. Suppose that after few years of experience with DVS and considerable public debate, there is a majority for more education. Then the government pays schools for any additional educational outputs. That is, for amount of calsses above the observed average in the DVS regime. There is no need for an extra budget to do that: the vouchers should be reduced to finance the payments for the educational outputs (see Proposition 2). Next, suppose we want to change the composition of classes: more history and less vocational training, for example. Then we quote a higher price for history classes. Finally, suppose we want to increase efficiency and we are willing to pay the necessary price for measuring educational outputs. Then we add a bonus to schools that produce more knowledge per unit of inputs.

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