This paper was published as:

Julian R. Betts and John E. Roemer, (2007), “Equalizing Opportunity for Racial and Socioeconomic Groups in the United States Through Educational Finance Reform,” in Ludger Woessmann and Paul E. Peterson (Eds.) **Schools and the Equal Opportunity Problem,** Cambridge, MA: MIT Press.

"Equalizing Opportunity for Racial and Socioeconomic Groups in the United States Through Educational Finance Reform"

by

Julian R. Betts**

Department of Economics

UCSD, La Jolla, CA 92093-0508

(858) 534-3369

and

The Public Policy Institute of California

jbetts@ucsd.edu

and

John E. Roemer

Departments of Political Science and Economics

Yale University

New Haven CT 06520

john.roemer@yale.edu

June 2005

An extended version of this chapter, which contains regression results, can be obtained as a UCSD Department of Economics Discussion Paper 2005-14, available at http://econ.ucsd.edu/publications/papers2005.shtml, and also as a Cowles Foundation Discussion Paper (forthcoming 2006). The research for this project has been partially funded by the John D. and Catherine T. MacArthur Foundation and the Public Policy Institute of California. For many helpful suggestions we thank two anonymous referees, Paul Peterson and Ludger Woessmann, audiences at numerous conferences including the CESifo/PEPG conference in Munich, the Association for Public Policy Analysis and Management (APPAM), the North American Winter Meetings of the Econometric Society, and the annual meetings of the Canadian Economic Association, and at departmental seminars including the University of Texas, Austin, the Massachusetts Institute of Technology, Stanford University, Claremont Graduate University and the University of California, Santa Cruz. We also would like to thank Ron White for valuable research assistance.

**corresponding author

1. Introduction

Education is perhaps the main tool that democracies use to attempt to equalize economic opportunities among citizens. It is commonly thought that opportunity equalization, in that dimension, is implemented by the provision of equal educational resources to all students. We will argue here that that is not so, and we will attempt to compute the distribution of educational spending in public schools in the United States that would equalize opportunities for a measure of economic welfare, namely, earning capacity.

Notably, in the United States lawsuits over the last 35 years have challenged the constitutionality of public education finance systems in most states. Subsequent court orders have typically acted to reduce gaps in spending per pupil between have- and have-not districts, while increasing the power of state governments to control spending.[1] Further, these court cases have tended to shift in focus over time from the simpler view of equal opportunity described above, namely equalizing resources, towards an alternative that instead espouses equalizing *outcomes* such as test scores and graduation rates. This approach is much closer, but still not identical, to the definition of equal opportunity presented in this paper. This shift away from equal resources to equal outcomes has been embraced by the "school adequacy" movement, which through court cases has argued that all schools should be held to a set of minimum outcome standards. In many cases adequacy proponents have successfully argued that holding all schools to equal absolute standards means that society must spend *more* on schools that serve less affluent students. Hoff (2004) writes that "Plaintiffs' success in adequacy-based school finance suits began with the 1989 Kentucky Supreme Court decision that declared the state's school system unconstitutional and ordered the legislature to appropriate enough money 'to provide each child in Kentucky an adequate education.' The decision shifted the legal debate away from 'equitable' funding, or money spread fairly among districts to 'adequate' funding, or whether the state spends enough."

In one well known adequacy case, the Campaign for Fiscal Equity v. State of New York, the plaintiff sued on the grounds that the status quo did not offer New York City students the "sound, basic education" promised by the state constitution. In late 2004 a court referee panel recommended an increase in spending for New York City schools by $5.6 billion, or 45 percent. (Hoff, 2004)

Over the last thirty years, and throughout the last century, public school systems have also radically increased real spending per pupil. (See e.g. Hanushek and Rivkin, 1997 or Betts, 1996.) Significant bodies of empirical work examine the impact of school spending on adults' earnings. This literature has yielded mixed results, but most papers indicate that increased school spending is associated with, at best, rather small gains in adult earnings.[2] Relatively little work has used this literature to estimate the magnitude of educational reform required to equalize opportunities across workers from different backgrounds. An analysis requires estimates of the impact of finance reform on earnings for each type of worker, and an analysis of the required reallocation, or increase, in education dollars needed to level the playing field. This paper seeks to provide estimates of the extent to which increasing spending per pupil contributes to creating equality of opportunity.

We intend our work as a positive analysis of what is possible, rather than as a normative analysis of what should be done. Indeed, proponents and opponents of equal opportunity alike should share a desire for a better understanding of what re-targeting of educational dollars might achieve, and the attendant costs.

Using the National Longitudinal Survey of Young Men (NLSYM) data set, we find that implementing an equal-opportunity policy across men of different races, using educational finance as the instrument, and ensuring that no race received less than the average observed nationally, would require spending nine times as much on black students, per capita, as on white students. Even the lower bound of bootstrapped confidence intervals for the policy estimates suggests large reallocations between races. An equal-opportunity policy across men from different socio-economic backgrounds that ignores race does almost nothing to equalize wages across races. Similarly, an alternative definition of equal opportunity, which holds that all students should receive identically funded schools, and letting the wage results fall as they may, does almost nothing to reduce the wage gaps between racial groups. The main reason for this is that a policy of "equally funded schools" takes no account of the large gaps in human and social capital that exist among very young, even pre-school children.[3]

For inter-racial allocations, we find evidence of a tradeoff between equity and total product, with reallocation lowering the wage bill by about 5%. In contrast, for reallocations based on parental education, equalization increases the wage bill by about 2% because the impact of school spending appears to be slightly higher for those with less highly educated parents.

The next section outlines the theory of equal opportunity, and discusses the evolution of equality of opportunity in the United States over the last thirty years. Section 3 describes the data and discusses estimates of the impact of school spending. Section 4 summarizes the algorithm used to compute the equal-opportunity policy and the optimal spending per pupil by group. It also examines the implications of a "race-blind" equal-opportunity policy for the black-white wage gap. Section 5 compares the costs and benefits of reallocating educational expenditures. Section 6 provides a summary of the paper's policy implications.

2. The Theory of Equality of Opportunity

Our goal is to calculate the reallocation of educational spending needed to equalize opportunities among students for future earning capacity. To do so first requires a short review of a theory of equal opportunity that one of us has recently elaborated (Roemer [1998]), a theory that attempts to formalize the 'level the playing field' metaphor. The troughs of the playing field, in that metaphor, are the disadvantages that individuals suffer, with regard to attaining some goal (here, the capacity to earn income), due to *circumstances* for which society believes they should not be held accountable -- such as their race, or the socio-economic status of their parents. In contrast to circumstances, an equal-opportunity ethic maintains that differences in the degree to which individuals achieve the goal in question that arise from their differential expenditure of *effort* are, morally speaking, perfectly all right. It is crucial to understand that by effort we mean not only the extent to which a person exerts himself or herself, but all the other background traits of the individual that might affect his or her success, but which we exclude from the list of *circumstances*. The partition of causes into circumstances and effort is the central move that distinguishes an equal-opportunity ethic from an equal-outcome ethic. Although an equal-outcome ethic implicitly holds the individual responsible for nothing, an equal–opportunity ethic emphasizes that an individual has a claim against society for a low outcome only if he expended sufficiently high effort. [4]

Five words constitute the relevant vocabulary: circumstances, type, effort, objective, and instrument. A *type* is the set of individuals with the same circumstances. The *objective* is the condition for which opportunities are to be equalized, and the *instrument* is the policy intervention -- in our case, educational finance—used to effect that equalization. Roughly speaking, the equal-opportunity (EOp) policy is the value of the instrument which ensures that an agent's expected value of the objective is a function only of his effort and not of his circumstances. Thus, educational finance, if it is to equalize opportunities for future earning capacity, should ensure that a young person's expected wage be a function only of his effort and not of his circumstances.

Suppose that a list of circumstances has been specified, as has a scalar measure of effort, e. First, we partition the relevant population into T types. Let the expected value of the objective for individuals in type t be a function $u^t(x,e)$, where x is the 'resource' that the individual is allocated by the policy instrument. Suppose for the moment that all those in type t are allocated an amount x^t of the resource -- in our case, educational finance. The ensuing distribution of effort in that type will be denoted by a probability distribution $\mathbf{F}^t(\cdot, x^t)$. (x^t is a parameter of the distribution.) These distributions will differ across types, even if different types receive the same amount of the resource. Note that the distribution functional $\mathbf{F}^t$ is a *characteristic of the type*, not of any individual. This apparently trivial remark is important.

Equality of opportunity holds that individuals should not be held responsible for their circumstances, that is, their type. In constructing an inter-type-comparable measure of effort, we must recognize that some individuals come from types that have 'good' distributions of effort, and some from types with 'poor' distributions -- for coming from a type with a poor distribution of effort should not count against a person. We therefore take the inter-type comparable measure of effort to be the *quantile* of the effort distribution in his type at which an individual sits. We say that all individuals at the π^{th} quantile of their effort distributions, across types, have tried equally hard.[5]

To restate this important point, it would be wrong to pass judgments on the quality of effort expended by individuals in different types by looking at their pure expenditure of effort, for those raw effort levels are polluted, as far as our theory is concerned, by being drawn from distributions for which we do not wish to hold the individuals responsible. The *distribution* of effort of a type is a characteristic of the type, not of any individual, and as such, it is a circumstance as far as the individual is concerned. To the extent that an individual's effort is low in absolute terms because he belongs to a type with a low mean effort, the individual should not be held responsible. We therefore say that the best measure of an individual's effort is his effort relative to effort of others in his type, as captured by his rank or quantile on the effort distribution of his type. We thus treat two individuals in different types, who sit at the same quantile of the effort distributions of their types, as having tried equally hard.

Our task is therefore: to find that value of the policy which makes it the case that, *at each quantile*, the expected value of the objective *across types*, is 'equal.' Since equality will virtually never be possible, we really mean 'maximin' where we just wrote 'equal.' Unfortunately, even this instruction is incoherent, for it amounts to maximizing many objectives simultaneously, and so some second-best approach must be taken. We make the compromise as follows.

Let $v^t(\pi,x^t)$ be the (average) value of the objective for individuals in type t, at quantile π of the effort distribution in type t, if the type is allocated x^t in resource. (In the application we will study, $v^t(\pi,x^t)$ is the logarithm of the wage at the πth quantile of the wage distribution of individuals of type i if x^i was invested in their education.) For a given value of π in the interval [0,1], there will be a policy $x(\pi) = (x^1,x^2, \ldots,x^T)$ solving:

$$\underset{x^1,x^2,\ldots,x^T}{Max}\ \underset{t}{Min}\ v^t(\pi,x^t)$$

subject to $(x^1,\ldots,x^T) \in X$

where X is the feasible set of policies. $x(\pi)$ is the policy that maximizes the minimum value of the objective for all agents of all types at effort quantile π. If $x(\pi)$ were the same policy for all π, that would be, unambiguously, the equal-opportunity policy. But that will almost never be the case in actual applications, and so our compromise will be to average these policies: that is, we declare the equal-opportunity policy to be:

$$x^{EOp} = \int_0^1 \underset{(x^1,\ldots,x^T)\in X}{ArgMax}\ \underset{t}{Min}\, v^t(\pi,x^t)\,d\pi. \tag{2.1}$$

If X is a convex set, then x^{EOp} is feasible.

For example, suppose we look at ten deciles of wages in each type. We would compute, for each decile, the investment policy that maximized the minimum wage in that decile, across the various types. This would, in general, give us ten different investment policies. We declare the EOp policy to be the average of these ten policies.

Thus, given a specification of the circumstances, the effort measure, the objective, and the instrument, and given the data necessary to calculate the functions v^t, we can solve for the equal-opportunity policy. Note that the equalization of opportunities according to this formulation is always *relative* to a given resource constraint, specified by the feasible set X. In what follows, we apply this theory -- which the reader can find elaborated at more length, and philosophically justified, in Roemer (1998) -- to educational policy in the United States.

Equality of Opportunity in Practice

As argued in Roemer (1998), one conception of equal opportunity is the principle of non-discrimination. This approach says that employers should judge job applicants solely on their productivity, rather than upon traits such as race or nationality. This requirement lies at the heart of the Civil Rights Act of 1964. But a second definition of equal opportunity, and the one that we use in this paper, argues that non-discrimination is insufficient for equalizing opportunities. One must compensate for historical inequities to the extent that they adversely affect the circumstances of living individuals.

Donohue (1994) argues persuasively that American employment law has evolved from a 'non-discrimination' view toward an approach resembling our conception of equal opportunity. His prime example is the 1991 Americans with Disabilities Act (ADA). The ADA requires employers to supply extra resources to disabled workers, so that their productivity better reflects their effort.

As a second example, in 1975 the Education for All Handicapped Children Act began to require schools to provide additional educational services to handicapped children. This provides a clear example of equal-opportunity legislation, since it attempts to level the playing field by spending *more* than the average on students with learning or physical disabilities.[6]

A third example derives from federal subsidies for K-12 education. Title I spending flows to schools serving disproportionate shares of disadvantaged students. More recently, the federal No Child Left Behind Act of 2001 directs districts to allocate funding for "supplementary services", that is, tutoring, for students in schools that have failed to meet the individual state's definitions of Adequate Yearly Progress for several years in a row.

The admission policies of American universities provide a fourth example of how equal opportunity, rather than non-discrimination, has come into common use. Typically, universities have set lower admissions standards for minorities to compensate for precollegiate differences in human capital acquisition among races. Recent court decisions and voter initiatives have led public universities in Texas and California to end their policy of using race when making admission decisions. In both states, universities now use alternative forms of affirmative action in admissions, that, for instance, take into account whether either parent of a student has attended university. As we will show, a switch from a race-based equal-opportunity program to one that conditions on socioeconomic traits such as parental education leads to radically different recommendations.

3. Data and Regression Results for Spending per Pupil

Data

We choose as objective the logarithm of an individual's weekly wages as a young adult. We model log weekly earnings from the NLSYM, computed as the log of the product of hours per week and hourly wages, and adjusted to 1990 prices using the Consumer Price Index. Spending per pupil in the student's district, gathered from a 1968 survey of high schools, is also included in the analysis as the policy instrument. Betts (1996) finds that existing estimates of the impact of spending per pupil on wages based on the NLSYM fall roughly in the middle of published empirical estimates.[7] Furthermore, the confidence intervals of the black-white estimates we obtain encompass most of the results in the published literature. The regression sample for each race consists of all wage observations between 1966 and 1981 for workers who were 18 or older and who were not enrolled in school or college in the given year. We drop a wage observation if weekly earnings are below $50 or above $5000 in 1990 prices. See the working paper mentioned in an earlier endnote for the underlying regression models. [8]

Outline of the Empirical Estimates on Spending per Pupil

We will examine the reallocation of spending per pupil that would be necessary to equalize opportunities for weekly earnings. Such reallocations have been at the heart of court-mandated school reform over the last quarter century. We first focus on reallocations across types of student, given a fixed educational budget. However, since such reallocations are virtually certain to reduce spending per pupil for certain types, we also calculate EOp solutions where the constraint is not a fixed budget but a requirement that no type receive less than a pre-specified amount per pupil. Since no students become worse off in an absolute sense, this second approach is perhaps more politically realistic, but potentially quite costly.

Recall that we partition each person's traits into two sets, those against which we wish to indemnify the person (circumstances), and those for which we hold the person accountable (effort). The former traits are used to partition people into types; the latter traits are treated as the person's choice variables. If we define many types, for instance by distinguishing people not only by race but also by, e.g., parental education, our EOp policy will typically call for a more differentiated allocation of spending.

With this in mind, we begin with a relatively conservative approach, in which we define only two types -- black and white --thus holding each person in our sample accountable for all other traits, such as family background, and geographic location (both region of the country and rural/urban/suburban residence). The use of two types also allows for an intuitive discussion of the optimal policy. We then consider outcomes using parental education as an additional or alternative factor in determining type.

The theory outlined earlier emphasizes that the impact of school spending on earnings for a given type of worker may vary with the person's ranking in the earnings distribution, conditional upon school spending. Quantile regression provides a technique that almost perfectly fits with this theory. We estimate models of log weekly wages that condition on spending per pupil in the district in which the worker attended school. We estimate a series of quantile regressions for a given type of worker:

$$\log w_i^t = \alpha^{tq} + \beta^{tq} x_i^t + Z_i^t \theta^{tq} + \varepsilon_i^t \text{, q=0.1,0.2,…,0.9} \qquad (3.1)$$

where t indexes the worker's type, i indexes the observation, q is the discrete quantile that corresponds with the continuous variable π in the theory developed earlier, w_i^t is weekly wages, x_i^t is spending per pupil for observation i and worker type t, Z_i^t is a row vector of other regressors, ε_i^t is an error term and the other Greek symbols indicate coefficients. Here

$$Quan_q\left(\log w_i^t \mid x_i^t, Z_i^t\right) = \alpha^{tq} + \beta^{tq} x_i^t + Z_i^t \theta^{tq} \qquad (3.2)$$

is the conditional quantile for the given quantile q. We estimate this model nine times for each type of worker for quantiles q=0.1, 0.2,…, 0.9. What quantile regression allows us to do is to estimate the impact of spending per pupil on workers at different points in the conditional wage distribution. By conditional wage distribution we mean the ranking of workers in terms of the outcome variable, after conditioning, or taking account of, the individual worker's values for spending per pupil and the other regressors in Z_t^i.

The coefficient estimates are calculated by minimizing the following objective function for the q-th quantile for type t:

$$\sum_i \left| \log w_i^t - \alpha^{tq} - \beta^{tq} x_i^t - Z_i^t \theta^{tq} \right| \lambda_i \qquad (3.3)$$

where λ_i are weights defined by

$$\lambda_i = \begin{cases} 2q, \text{ if } \log w_i^t - \alpha^{tq} - \beta^{tq} x_i^t - Z_i^t \theta^{tq} > 0 \\ \qquad 2(1\text{-}q), \text{ otherwise} \end{cases} \qquad (3.4)$$

A key feature of quantile regression is that by construction a proportion 1-q of the observations will have positive residuals with the remaining observations having negative residuals. In this way, the weights will give proportionately more weight to workers whose log earnings, conditional upon the regressors, are "close" to the quantile in question.[9]

We condition not only on spending x_i^t but also on a vector of other regressors Z_i^t. These other variables, while exogenous to the worker, might influence his earnings. Without taking account of family background, for instance, our estimates of the impact of school spending could suffer from omitted variable bias. Accordingly, we include in our vector Z_i^t the worker's age and its square, dummies for whether the person's mother and father were present in the home when the person was 14, and the number of siblings. In addition, in the black/white typology we also condition on the level of education of the more highly educated parent. Of course, lacking experimental data, there is still a chance that additional omitted variables could bias our results in an unknown direction.

We do not condition on the worker's own level of education because this is a choice variable, and the impact of spending per pupil may work partly through its influence on students' subsequent years of education completed. If we had controlled for years of education, but spending per pupil influenced this variable, then we would be understating the impact of spending per pupil on students' later wages. Betts (1996) finds weak evidence in the literature that spending per pupil is positively associated with years of education.

This method has two distinct advantages. It is entirely consistent with the theory in that π is defined conditional upon x_i^t. Second, the pattern of coefficients obtained from the nine quantile regressions performed for each worker type allows for non-linearities in the relation between wages and spending per pupil x_i^t and other regressors.

These quantiles conform closely to the quantiles of "effort", that is, the person's percentile ranking by log wages, conditional upon type and spending per pupil. Thus, roughly speaking, the coefficient estimates for q=0.9 describe the determinants of wages for people ranked at the 90th percentile of log wages after conditioning upon the regressors, or, in terms of the theory, for people ranked at the 90th percentile of effort. Recall that "effort" is short-hand for what we more accurately called the aspect of autonomous volition in a person's behavior. In reality, effort is multi-dimensional, and includes not only years of schooling but marital status, region, and other personal choices. Further, an individual who earns a high wage simply by virtue of inheriting his father's good job will be classified as one who expended high effort. It is important to bear in mind the *conservative* nature[10] of this assumption when considering the estimates presented below.

Regression Results

We obtained quantile regression estimates based on three different partitions of the sample of workers into types. First, we partition workers into blacks and whites. Second, we examine a race-blind typology that assumes that workers should be compensated not for their race but rather the level of education of their parents. Finally, we discuss a hybrid typology that divides black and white workers separately into two approximately equally sized groups, based on the years of schooling of the more highly educated parent.

Because of space constraints, we do not display the quantile regression results, although they are available on request from the authors. The empirical results generally conform to past results using this and similar datasets. Family socioeconomic status, especially number of siblings and parental education are strongly related to log wages of workers later in life. Earnings rise with age but at a decreasing rate. Spending per pupil appears to be positively and significantly related to earnings, as past research with the NLS-YM has suggested. (See Betts, 1996, for a review.) In the final typology, that divides workers based on both race and parental education, the estimated effect of school spending is estimated less precisely than for the other typologies.

While we found that the estimated effect of school spending varies among types at q=0.5, there is no definitive relationship between the coefficient on school spending and the degree of a person's advantage.

The next step involves using these regression estimates to compute the EOp policy. We need to boil down the individual predicted wages from these models to a simple summary consisting of the pair (a^{tq}, b^{tq}) that predicts average log wages for type t conditional upon quantile q and spending per pupil x^t:

$$v^t(q,x^t) = a^{tq} + b^{tq}x^t \qquad (3.5)$$

where $v^t(q,x^t)$ is the log of weekly earnings predicted for workers of type t at quantile q who received spending per pupil of x^t. Our estimate of b^{tq} is simply β^{tq} from (3.1). To obtain our estimates of the part of predicted weekly log earnings that does not depend on school spending, a^{tq}, we must first identify those workers in type t who belong to a given quantile q. Therefore after each quantile regression we rank observations i in type t by the residuals and assign observation i in type t a ranking ρ_i^{tq} such that $\rho_i^{tq} \in [0,1]$, and $\rho_i^{tq}=1$ indicates the wage observation with the largest residual in the quantile regression for that type. We selected observations i in type t with ρ_i^{tq} within ±0.05 of a given q, and calculated the mean predicted log wage of those workers assuming that x^t=0 and that all workers are aged 30, that is

$$a^{tq} = \hat{\alpha}^{tq} + (Z_i^t \mid age = 30)\hat{\theta}^{tq} \qquad (3.6)$$

where circumflexes indicate estimated coefficients. We remove variations in predicted wages related to age because it is unlikely that policymakers would aim to remove all age-related variations in earnings among types. However, we leave in our estimate of a^{tq} variations related to other background variables such as the number of siblings. In sum, these intercept estimates are estimates of predicted earnings of workers who are close to the given quantile, after setting the workers' age to 30 and spending per pupil to zero.

The EOp policy will not remove variations in predicted earnings *within* types, but the policy will attempt to compensate for variations *across* types at given quantiles.

4. Calculation of the Spending Allocations that Implement Equal Opportunity

a) Main Results

We solve a discrete version of program (2.1), where the effort quantile, π, takes on nine values, which we denote $q = 1,\ldots,9$. For each quantile q and type t, we have an estimated relationship, as described in section 3:

$$v^t(q,x^t) = a^{tq} + b^{tq}x^t \qquad (4.1)$$

where v is logarithm of the future wage and x^t is the amount invested in the education of the student. The set X is defined by the budget constraint:

$$\sum_t p^t x^t = R \qquad (4.2)$$

where p^t is the fraction of individuals of type t, and R is spending per student. Thus for each q we solve:

$$\begin{aligned} &x(q) = \underset{x}{ArgMax}\ \underset{t}{Min}(a^{tq} + b^{tq}x^t) \\ &\text{subject to } \sum_t p^t x^t = R \end{aligned}, \qquad (4.3)$$

and we then define the equal-opportunity policy as:

$$x^{EOp} = \frac{1}{9}\sum_{q=1}^{9} x(q). \qquad (4.4)$$

Program (4.3) is solved by solving a series of linear programs. Typically, at the solution of (4.3), the most disadvantaged type will be the worst-off at the solution, and so the solution of (4.3) is the solution of the following linear program, where type one is the most disadvantaged type, and, in our example there are four types:

$$\begin{aligned} &\underset{x}{Max}(a^{1q} + b^{1q}x^1) \\ &\text{subject to } a^{tq} + b^{tq}x^t \geq a^{1q} + b^{1q}x^1, \quad t = 2,3,4 \qquad (4.5) \\ &\text{and } \sum_t p^t x^t = R. \end{aligned}$$

To solve (4.3), we solve four linear programs, where, in turn, each of the four types is assumed to be the worst-off type at the solution, and we then take the solution to be the one of these four which maximizes the value of (4.3).

We report on various aspects of the EOp policies. In order to generate confidence intervals for these policies, we bootstrapped the EOp policy using a bootstrap sample of 1500. One remark is in order. For a small proportion of the bootstrap estimates, the coefficient $b^{1q}<0$. The solution to (4.5) in these cases would entail $x^{1q}=0$. Instead of taking this to be the solution, we set $x^{tq}= R$ for all (t,q) for which $b^{tq}< 0$.

Beginning with the simple black/white typology, we first calculated the optimal allocation of educational funding under the assumption that average spending per pupil (R) is \$2500 in 1990 prices, which is approximately the average in the NLSYM sample.[11]

Egalitarian policies are criticized for being ‘inefficient’, that is, for decreasing output. It is possible, but not certain, that reallocation of educational spending between types will cause the overall wage bill to shrink, if the marginal product of educational resources is higher for the type from which funding is being removed. Therefore we also calculate the ratio of the wage bill that is predicted to result from the EOp policy to the wage bill under the *equal resource* policy, in which all students receive the same amount of the financial resource. Our calculations based on the black/white typology assume that 12.0% of the population is black and that 88.0% is white, which matches the population frequencies in 1966 in the NLSYM.[12]

We also calculate the required aggregate budget which assures that, under the EOp policy, all types would receive at least (approximately)$2,500 per capita. Such a 'no-lose' option might be politically necessary in order to implement an EOp policy in reality.

For each of our 1500 bootstrap estimates under the ‘no-lose’ scenario, we calculated the value of R at which the most advantaged type would receive an investment in the interval ($2450, $2550). These results are reported in the bottom three lines of Tables 1 and 2.

We report the results for two partitions of the sample into typologies: (i) a two-type typology, black (B) and white (W), and (ii) a four type typology, where the circumstance is the educational level of the more highly educated parent. We also briefly discuss results from a third typology obtained by crossing race and parental education.

(i) Type partition: Black and white

The results are reported in Table 1. At the EOp solution, in our point estimate, blacks receive approximately 18 times what whites receive when $R = 2.5$. The .025 and .975 values of this ratio from the bootstrap samples are 7.76 and 79.17. We can thus assert, conservatively, that equalizing opportunities for this typology, and at this budget, requires an investment in black students of *at least seven or eight times* the investment in whites.

If *R* is increased to the point where whites receive approximately \$2,500 per capita, then this ratio falls, so that blacks receive approximately nine times as much per capita, and the confidence interval on this ratio from the bootstrap samples is (5.39, 21.49).

The columns labeled w^B and w^W show estimated average weekly earnings of black and white workers under the two scenarios in thousands of dollars, and corresponding confidence intervals. The predicted wages after EOp policy is implemented in Table 1 are much higher for blacks than is the raw earnings of blacks reported in Table A-1. The average wages of the two types are not equalized exactly. The lack of perfect equalization follows directly from the stipulation that all students of a given race receive the same x^t. (Policymakers under an EOp policy would aim to equalize outcomes on average across types while not attempting to remove variations in the outcome within types that are attributed to variations in "effort".)

The second and third columns from the right-hand side of Table 1 report the average weekly wage at the equal-resource (ER) and EOp solutions, respectively (in thousands of dollars), and the last column is the ratio of these two numbers, our measure of 'efficiency.' We see there would be a substantial decrease in the average wage if we implemented the EOp policy for this typology, in comparison to implementing the equal-resource policy. Under both the fixed-budget and the 'no-lose' EOp policies, the total wage bill drops by roughly 5%.

The reallocation of school resources needed to equalize opportunity between black and white men is substantial. Note, though, that our wage sample covers the years 1966-1981. To check whether it is possible that today smaller reallocations would be required, we examined data on usual weekly earnings of full-time male workers by race, as reported for the year 1996 in the Current Population Survey. The ratio of blacks' earnings to those of whites in 1996 was 71.0%, compared to 72.2% in our sample over the period 1966-1981. In absolute terms, the black-white wage gap in the NLSYM data was $149 per week in 1990 prices (Table A-1). In 1996, the same gap was $140.[13] Some readers may be surprised that the ratio and absolute gap in wages between black and white males changed so little between 1966-81 and 1996. However several papers including Bound and Freeman (1992) have documented the slowing of the convergence in wages between blacks and whites during the 1980's.

Thus, although our wage observations are centered in the 1970's, the black-white wage gap has changed so little over the last two decades that our results would be virtually unchanged if we used recent wage distributions.

(ii) Type partition based on parental education

Table 2 reports the results for the partition of the sample into four socio-economic types, based upon the educational attainment of the more highly educated parent.

The inequality in educational spending needed to equalize opportunity is strikingly less, in this typology, than in the Black-White typology. The ratio of spending for the groups with the highest and lowest spending are 4.9 and 2.9 for the fixed-budget and 'no-lose' scenarios, less than a third of the spending disparities required in the black/white typology. We also note that the size of the average wage at the EOp policy is consistently larger than in the equal-resource policy. Thus, both equity and efficiency are improved, here, at the equal-opportunity policy. This reflects the generally larger wage responses to increased spending among the two lower parental education types relative to the two more advantaged types.

(iii) Type partition: Low-Black (*LB*), High-Black (*HB*), Low-White (*LW*), High-White (*HW*)

This typology yields four types in total -- it is an appropriate partition if society takes into account that more than race influences a young person's chances in life. We chose cutpoints in parental education that would divide the black and white samples into approximately equal halves.

Because of space constraints we do not present the results, although they are available from the authors. As expected, when we divide the white and black populations into higher and lower socioeconomic groups, the ratio of spending between the highest and lowest groups under the EOp policy becomes larger. The reason is that we have shifted parental education from the list of many factors determining "effort", and have labeled it a circumstance against which we seek to indemnify workers. Here the ratio of maximum spending per pupil to lowest spending among types is 23.9 and 9.2 for the R=2.5 and the X_{min} scenarios respectively, compared to 17.8 and 8.9 for the B/W typology.

b) Do Race-Blind EOp Policies Do Much to Reduce Black-White Inequality?

As we wrote earlier, the emerging view in the United States seems to be that affirmative action, at least with regard to university admissions, is desirable when it favors students of low socio-economic status, but not when it is used to favor students of color.[14] In our language, this view holds that the type partition into types based on socio-economic circumstances is ethically acceptable, but not so for the types that predicate on race. The natural question is, to what extent will opportunities be equalized by recognizing differential socio-economic, but not differential racial, circumstances?

Our results suggest a pessimistic conclusion. Far less would be invested in black students under the EOp policy associated with the socio-economic typology of Table 2 than under the EOp policies which predicate upon race. It is, however, important to note that the large investments in blacks, of Table 1, contrasted with the relatively small investment in the most disadvantaged socio-economic type of Table 2, are due not only to the extra disadvantage of blacks, but also to the fact that blacks are a small share of the population (low *p* values), and so it is relatively cheap to subsidize them in the EOp policy. In other words, it would be wrong to infer that blacks are three times as disadvantaged as the most disadvantaged socio-economic type (*E1)* because approximately three times as much is invested in the former compared to the latter at the EOp policies in their *respective* typologies.

To study more formally the impact on blacks if EOp policies condition on socioeconomic status rather than education, we calculate the percentage of black men in the regression samples in each of the earnings quintiles before and after the various EOp policies are put into place. We adjust each worker's earnings as follows. For a given typology, we assign each worker a level of spending x^t dependent on his type in that typology. To calculate the earnings that would result for that worker, we multiply the change in spending that he would receive by the coefficient on spending from the black/white typology, and the worker's actual quantile. We then find the quantile q that for worker i solves

$$q_i^t = \underset{q \in \{0.1,0.2,\ldots0.9\}}{ArgMin} \left| q - \rho_i^{tq} \right| \text{ where } t=B,W \qquad (4.6)$$

for each wage observation i in the black and white types. This is simply the quantile that most closely matches the given wage observation. In addition, to put workers of different ages on an equal footing, we adjusted the wages of each worker to the predicted value had he been 30.

Table 3 shows the results. The top row shows that in the raw data, blacks predominantly occupy the bottom two earnings quintiles. We next examine the outcome under a conservative definition of equality of opportunity in which all that society needs to do is to ensure equal funding per pupil at all schools. The second row shows the result when all students receive spending of 2.5. The results are similar to the raw data. This suggests that the court struggles over the last three decades to *equalize* spending across schools, even when successful, will have done little to equalize earnings between blacks and whites.

We then estimate the wages each worker would earn if various reallocations were put into effect under Roemer's definition of equality of opportunity. The fixed-budget EOp policy (B/W, r=2.5) greatly improves the earnings of blacks relative to whites, so that the median black now occupies the middle earnings quintile, and the percentage of blacks in the top earnings quintile triples. The alternative B/W EOp policy, with r=4.85, pushes blacks away from the middle three quintiles and toward the top and bottom quintiles, where they are now over-represented. Again, however, the median black belongs to the middle earnings quintile, suggesting a dramatic interracial equalization compared to the raw data or the school spending equalization shown in the first two rows.

A quite remarkable result is shown in the next two rows: when type is defined independently of race, by using only parental education, the EOp reallocations leave the distribution of black workers across earnings quintiles little changed from the status quo in row 1. Even though 42% of blacks in the sample are in the type with low parental education, and so receive spending of 5.36, this is a small reallocation relative to the more advantaged type, which receives 1.10. Moreover, 19% of whites also fall into the bottom socioeconomic group, while representing 70% of workers in this group. Together, these facts explain why the race-blind EOp policy does so little to narrow the black-white gap in earnings.

Note that this striking result obtains because of the large numbers of whites in the lower categories of various measures of socioeconomic status in the United States. We believe that our finding therefore will apply to attempts to equalize opportunity in realms apart from K-12 education: using proxies for race, such as parental education, will lead to equality-of-opportunity policies that only very partially equalize opportunity across races.

5. Comparing Costs and Benefits of Alternative Means of Equalizing Opportunity

We now compare the costs and the benefits of various EOp policies. We work with the typology {B,W}. We measure benefits as the value of the EOp objective function, that is, the mean of the lower envelope of the earnings:q functions for blacks and whites. (The lower envelope is the function whose value is the value of the objective, at each quantile, of the worst-off type.) To be precise, we define the *weekly* benefits from a policy φ as

$\frac{1}{9}\sum_{q=0.1}^{0.9} \underset{t}{Min} \exp\left(v^t(q,\varphi)\right)$, where $\exp\left(v^t(q,\varphi)\right)$ is the average of the wage (the exponential of the dependent variable, the logarithm of the weekly wage) of individuals at the qth quantile of the effort distribution of type *t* when the policy is φ.

Table 4 shows the value of the EOp objective function for various scenarios. The table presents this mean in dollar terms to aid understanding. The "base case" scenario is one in which mean x is $2500 (r=2.5).[15] The value of the mean along the lower envelope, which in the base case consists of blacks at every quantile is $464.58 per week. The second row ("equal resources") shows the gains that would result if all schools spent exactly $2500 per pupil. As shown, the average gain in earnings for workers on the lower envelope is $1.10 per week, or about 0.25%. Again, we see evidence that a more conservative definition of equal opportunity, which calls merely for equalization of school resources, is quite ineffective. The next two rows show the mean of wages on the lower envelope for the two EOp solutions, first where average spending is held constant at $2500 per week, and then the cost-increasing intervention in which both types receive at least $2500 per week. The gains in average earnings along the lower envelope are very large in both cases, between $46 and $66 per week, with increases in the average wage well over 10% above the base case.

We now ask a related question: what are the relative sizes of the costs of implementing the various programs? Starting from a base of $2500 per pupil, equalizing spending at that level or implementing the EOp plan with mean spending r=2.5 have no impact on costs. Of course, even equalization of spending across schools, let alone the radical reallocation suggested by EOp with r=2.5, may not be politically feasible, since some types (whites, in the present analysis) face lower spending per pupil after the reallocation.

Consider next the cost of the EOp program with minimum spending of $2500 per person of either type. To evaluate its cost per pupil, we assume that any change in spending occurs from kindergarten through the year in which the pupil leaves school, which is appropriate since our measure of spending per pupil is measured for the school district in which the student attended school. Using the empirical distribution of years of schooling, we then calculate the cumulative change in spending per pupil from kindergarten up to the year in which the student left school (or Grade 12 in the case of high school graduates). We convert all expenditures to their value in the year in which the student would have been in Grade 12, using a discount rate of 2.67%, which is the mean real interest rate between 1953 and 1997.[16]

The EOp plan increases the mean earnings along the lower envelope by $65.79 per week. But the costs of achieving EOp in this way are extremely large: in terms of present value of spending in the year in which the person turns 18, the cost is over $34500 per person. This figure is obtained by dividing total program cost by the number of people in the entire population. All of this additional spending is directed toward blacks, who on average would receive an extra \$293,000 while in school. This is spread out over the entire population, bringing the cost down to roughly \$34500 per person.

Note that in Table 4 it is inappropriate to compare the costs and benefits directly since the costs are the present value of accumulated spending for all students in all grade levels, while our measure of benefit focuses on workers who are on the lower envelope only, and represents the gains during a typical week, rather than over the entire working lifetime. Clearly, though, both the benefits and the costs are sizeable. The predicted earnings gain works out to about \$3400 per year for each black worker assuming 52 weeks of work or paid vacation annually. If we think of this as an investment project, the upfront cost of \$293,000 per black would yield an annual payback of about 1.2%.

There are two reasons why the rate of return on increasing school expenditure through the EOp algorithm is relatively small. The first reason is that spending per pupil has a modest impact on students' subsequent earnings. The second reason is that under the "no-lose" EOp plan average spending rises dramatically. Furthermore, the value of the EOp objective at its optimum, viewed as a function of r (the per capita resource endowment), is a concave increasing function, and the ratio of this 'value function' (our 'benefit') to r is a convex, decreasing function. Therefore, the benefit-cost ratio of an EOp program that increases spending dramatically will be small.[17]

6. Concluding Comments

We conclude by summarizing the most important policy implications of our analysis.

First, even though court battles on educational finance have typically centered on the goal of equalizing spending across schools, our analysis suggests that this alone will do little to equalize opportunity, especially across races. The reason is that the impact of school spending on students' subsequent wages is rather modest compared to the racial gap in earnings. We estimate that full equalization of spending per pupil would increase the weekly earnings of workers along the lower envelope by only $1.10 or about 0.2%. Notably, some of the more recent court cases have moved beyond a conservative "equal spending" credo to the notion of "adequacy", which calls for spending more on the students most in need.

Second, in order to equalize opportunity across races, government would have to reallocate spending radically. Our results vary depending on whether overall spending is held constant, or spending is increased such that no type experiences a decrease in school funding. In the first case, equalizing opportunity between races entails spending eighteen times as much on blacks as on whites. In the second case, nine times as much must be spent on blacks. These estimates are of course uncertain. However, we have directly controlled for statistical uncertainty by bootstrapping our estimates of optimal policy. We note that even the lower bound of our 95% confidence interval yields black/white spending ratios of eight and five, which similarly suggest that mere equalization of spending can accomplish little.

A key issue difficult to overcome is that we extrapolate well beyond the range of spending per pupil observed in our data. Our estimates may be too high because, in extrapolating so far, we are missing increasing returns to school expenditures. However, we note that Betts and Johnson (1997) use the large range of spending per pupil observed at the state level over the period 1920-1959 and do not find strong evidence of increasing returns to school resources, and in fact find some evidence of the opposite. Similarly, spending per pupil has risen dramatically since an average of about $2500 per pupil in 1968, our survey year, to about $5600 per pupil in 1999-2000 nationally, and as high as $9060 in the District of Columbia.[18] In spite of more than a doubling in spending nationally, and almost a quadrupling in D.C. relative to the national average in 1968, we know of no evidence of an "education miracle" over this period either nationally or in high spending areas such as D.C. and New Jersey. In other words, if there were strongly increasing returns in the education production function we should have seen these begin to emerge over time. Our central point remains: mere equalization in spending achieves little.

Third, we compared the costs of the EOp reforms with the annual payback measured by the increase in weekly earnings along our objective function. Under the EOp policy that holds spending constant, the cost is by definition zero but the benefits to workers along the lower envelope are substantial -- an increase in earnings of 10%. The political drawbacks of this zero-cost reallocation are clear: it is financed by reducing spending for whites. Such a reform is likely to be much less politically feasible than a more expensive one that guarantees that no student sees a reduction in school spending. Our second EOp policy sets a floor on spending per pupil for both races, and is predicted to achieve more, increasing weekly earnings of workers along the lower envelope by just over 14%. But the cost is about $293,000 per black student, or about $34,500 per student when distributed across all students.

Fourth, it matters enormously whether a program to equalize opportunity takes race into consideration. This insight is important given recent moves in California and Texas to eliminate race as a factor that is considered in university admissions. We found that a "color-blind" EOp program that equalizes opportunities between types of student differentiated only by parental education does almost nothing to change the distribution of blacks across earnings quintiles. In the language of our model, given such a race-neutral policy, any variations in earnings that are correlated with race would be attributed to variations in “effort” rather than “circumstance”. Thus, a color-blind EOp program based on socioeconomic traits other than race costs relatively little, but achieves relatively little as well. We believe that this finding, because it merely reflects the demographics of the U.S. population, has similar implications for equal-opportunity reforms well beyond the K-12 sector.

Both opponents and proponents of equal opportunity should want information about the costs of implementing equal opportunity through educational finance reform. This paper has offered a positive analysis of the benefits and costs of such policies. But it is important to discuss the practical implementation of the educational financial reforms analyzed here. Implementing such reforms, which allocate more money to disadvantaged types than to advantaged ones, is a remote possibility in a society that has not yet fully implemented the more moderate 'equal resource' policy. It is important to separate the positive analysis from a discussion of what reforms are politically feasible, or even desirable. (One might believe, for example, that the cost in average income associated with equalizing opportunities subject to the dual type Black-White typology is too great.) Knowing what theory and the data imply, the public will be better prepared to reform educational finance subject to political reality and to their own values.

Finally, our findings suggest that money alone will not suffice to equalize educational opportunity. This realization suggests the urgent need for finding complementary means of improving educational and life outcomes for the disadvantaged.