

Session Number: 8B

Session Title: *Contributed Micro Papers: Issues in Income Distribution*

Paper Number: 6

Session Organizer: Edward Wolff

Discussant:

*Paper Prepared for the 28<sup>th</sup> General Conference of  
The International Association for Research in Income and Wealth  
Cork, Ireland, August 22 – 28, 2004*

**SETTING COLLEGE ADMISSION CRITERIA:  
SOCIAL BENEFITS AND COSTS**

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# **Setting College Admissions Criteria:**

## **Social Benefits and Costs**

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### **Abstract**

In this paper we argue that the salient tradeoffs implicit in setting college admissions standards are not between equity and efficiency but between different dimensions of equity. Inclusive standards, allowing broader access to higher education, result in a more equal distribution of wages while exclusive standards increase the potential for using higher education as an instrument of social mobility. When exclusive standards are combined with income-based affirmative action, large gains in intergenerational income mobility can be achieved at little cost in efficiency.

*Keywords: University admissions, affirmative action, distribution, mobility, immigration*

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# **Setting College Admissions Criteria:**

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### **Abstract**

In this paper we argue that the salient tradeoffs implicit in setting college admissions standards are not between equity and efficiency but between different dimensions of equity. Inclusive standards, allowing broader access to higher education, result in a more equal distribution of wages while exclusive standards increase the potential for using higher education as an instrument of social mobility. When exclusive standards are combined with income-based affirmative action, large gains in intergenerational income mobility can be achieved at little cost in efficiency.

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## Introduction

Differences of opinion on the appropriate level of college admissions standards are often framed as different resolutions of an underlying tradeoff between equity and efficiency: supporters of laxer, more inclusive standards stress the importance of helping applicants from less-advantaged backgrounds—racial minorities, the poor—overcome social and economic handicaps; advocates of more stringent standards draw attention to the inefficiency of admitting weak applicants who may have little chance of graduating and impose negative externalities on others.<sup>1</sup> We argue in this paper that the more salient tradeoffs implicit in college admissions policies are not between equity and efficiency but between different dimensions of equity. We show that lowering admissions standards entails relatively little cost in lost output but substantially reduces wage inequality while undermining the effectiveness of higher education as a vehicle of social mobility.<sup>2</sup> Conversely, when exclusive admissions standards are combined with income-based affirmative action<sup>3</sup>—so that inframarginal students from higher-income families are replaced by extramarginal students from lower-income families—substantial gains in social mobility can be achieved at little cost in efficiency. Thus the tradeoffs between equity and efficiency are less steep than the tradeoff between equality and mobility.

To demonstrate these effects we consider a general equilibrium model of an economy with graduate and non-graduate labor in which a centralized college system offers a course of study towards a (single) degree and sets entrance requirements that are a function of prior academic achievement and socio-economic background.<sup>4</sup> Young adults who meet these entrance requirements anticipate future wage rates and decide whether to enter the workforce immediately as non-graduates, or attend college and earn a degree with a probability that is correlated with their human capital.<sup>5</sup> Earning a degree enhances their human capital and opens the door to graduate occupations, where they earn a lifetime

income that is proportional to a weighted average of their imperfectly observed individual human capital and the average human capital of all graduates.<sup>6</sup> In equilibrium young adults' anticipations of future wages are required to match actual wage rates determined by supply and demand in the labor market.

The model is then calibrated to benchmark values of college enrolment shares, graduation rates, wage levels, and correlations among parental income, aptitude test scores, university grades, and filial income in the United States, and applied to simulate different admissions policies. These simulations identify the effect of college admissions criteria on output, distribution and mobility through their dual effect on the number of college students and on the composition of the student body. Increasing the size of the student body has an “inverse-U” shaped influence on efficiency—there is an intermediate level of student enrolment that maximizes national output—while monotonically lowering the return to a college degree, which both reduces inequality and inhibits social mobility. Holding constant the size of the student body while varying its composition—by varying the influence of the applicant's parental income—has relatively little effect on output or distribution but a strong effect on mobility.<sup>7</sup> Consequently, combining stringent admissions criteria that limit the size of the student body—and thus increase the return to higher education—with income-based affirmative action allows large gains in social mobility to be achieved at little cost in forgone output, as there is only a small productivity differential between the socially advantaged applicant displaced by affirmative action and the low-income applicant who benefits from it. The steeper tradeoff is between promoting income mobility on the one hand, and providing wide access to higher education and reducing wage inequality on the other hand.

An extension of the model considers the effect of immigration of non-graduate immigrant labor on the social costs and benefits of higher education when alternative

political objectives are pursued. We find that the choice of political goals is crucial in this case. Maximizing domestic output per capita calls for a large expansion of higher education, which results in a more equal but less mobile economy for the native born; maximizing native output per capita is achieved by restricting growth in higher education, which results in both greater mobility and greater inequality.<sup>8</sup>

Our formal approach builds on two important analytical perspectives on education: macroeconomic analyses of intergenerational mobility through the accumulation of human capital in the spirit of Loury (1981), Becker and Tomes (1979), Bénabou (1996), Durlauf (1996), and Hassler and Rodriguez-Mora (2000), to which we add structural detail; and more structured analyses of higher education as a “double filter” (Arrow, 1973) characterized by peer-group effects (Danziger, 1990; Loury and Garman, 1995; Betts, 1998; Epple, et al., 2000), which we extend here to consider tradeoffs between efficiency, equality and mobility in a general equilibrium context.

Several recent studies have considered related issues from similar perspectives. Costrell (1994) finds that lowering college admissions standards reduces pre-college scholastic effort, hence productivity, while also reducing inequality, implying a tradeoff between efficiency and equity. Betts (1998), positing that individuals’ wages are solely a function of formal qualifications, finds that raising standards benefits the most and least able, leading him to conclude that an egalitarian policy maker would favor higher standards.<sup>9</sup> Fernandez and Gali (1999) show that when capacity constraints combine with capital market imperfections, academic screening of applicants is needed to ensure that high-ability applicants from low-income families gain efficient access to education.<sup>10</sup> Finally, our analysis bears directly on recent studies of education systems in Europe that examine the role of public education in perpetuating class divisions (Bertocchi and Spagat,

1998), specifically attributing Italy's more equal but less mobile social structure compared to the United States to its more egalitarian university system (Checchi et al., 1999).

The paper is organized as follows: Section 1 describes the analytical model; Section 2 calibrates it to observed empirical values; Section 3 compares different admissions policies as they affect output, distribution and mobility; Section 4 considers an extension of the analysis to an economy open to migration of low-skilled labor; and Section 5 concludes.

## 1 The model

We posit an economy with a fixed population of households in which parents automatically bequeath innate abilities to their children and invest economic resources in their early development. Children reach young adulthood with a record of prior achievement that provides an imperfect indication of their abilities, and may then apply to study at a college that confers a single uniform degree, where graduation is contingent on passing a final examination. We consider college admissions criteria based on the applicant's record of prior achievement and possibly also on parental income.

### 1.1 The household, before applying to college

Consider an economy with a continuum of households of measure one, indexed by  $i$ , each comprising a parent and child. The parent is endowed with a (lifetime) income  $y_i$  that is distributed lognormally in the population,  $\ln y_i \sim N(\mu_y, \sigma_y^2)$ , and the child is endowed with an unobservable innate ability  $a_i$  that is correlated with parental income:

$$\ln a_i = \ln y_i + u_{ai} \tag{1}$$

where  $u_{ai}$  is an independent, normally distributed disturbance term with mean zero and

variance  $\sigma_{ua}^2$ .

Each parent then invests economic resources  $b_i$  in her child's early development so as to maximize a utility function that is taken to be logarithmic in consumption and education spending. Assuming that parents cannot borrow against their children's future income (this is a capital market imperfection that cannot be resolved) this implies that they spend a fixed proportion of their income on their children's early development:<sup>11</sup>

$$b_i = \delta y_i \quad (2)$$

where  $\delta$  is a common constant.

The child's innate ability and the parent's investment in early education together determine the child's (unobservable) pre-college level of human capital,  $h_i$ :

$$\ln h_i = A + \ln a_i + \gamma \ln b_i = A + \gamma \ln \delta + (1 + \gamma) \ln y_i + u_{ai} \quad (3)$$

where  $A$  and  $\gamma$  are constants, and (1) and (2) are used to substitute for  $a_i$  and  $b_i$ . It follows that  $\ln h_i$  is also normally distributed, with mean and variance

$$\mu_h = A + \gamma \ln \delta + (1 + \gamma) \mu_y \quad (4)$$

$$\sigma_h^2 = (1 + \gamma)^2 \sigma_y^2 + \sigma_{ua}^2 \quad (5)$$

Although human capital is not directly observable at this stage, indirect indicators are available—school grades, aptitude test scores, and so on—which we take to be summarized by a variable  $t_i$  that is imperfectly correlated with  $h_i$ :

$$t_i = \ln h_i + u_{ti} \quad (6)$$

where  $u_{ti}$  is an independent, normally distributed disturbance term with mean zero and variance  $\sigma_{ut}^2$ . After repeated substitution we have

$$t_i = A + \gamma \ln \delta + (1 + \gamma) \ln y_i + u_{ai} + u_{ti} \quad (7)$$

so that  $t_i$  is also normally distributed, with the same mean as  $h_i$  but larger variance:

$$\mu_t = A + \gamma \ln \delta + (1 + \gamma) \mu_y = \mu_h \quad (8)$$

$$\sigma_t^2 = (1 + \gamma)^2 \sigma_y^2 + \sigma_{ua}^2 + \sigma_{ut}^2 \quad (9)$$



## 1.2 The college system

There is a single college (or college system) in the economy that offers a single degree contingent on passing a final exam. All students spend  $T_e$  years in college, whether or not they graduate, and pay a fixed fee  $P$  that exactly equals the cost of tuition.<sup>12</sup> Graduation is a dichotomous variable: employers do not look at grades, and failing at college has neither a positive nor negative value in the labor market. It opens doors to jobs that require a college degree and enhances one's human capital by a factor of  $\beta > 1$ : a person entering college with human capital  $h_i$  exits upon graduation with human capital  $\beta h_i$ .<sup>13</sup>

The college publicly sets admission requirements that are a function of prior academic achievement  $t_i$  and parental income  $y_i$ , which are known to both the college and the candidate. To fix ideas we focus on linear admissions criteria of the form

$$\phi t_i + (1 - \phi) \ln y_i \geq \theta \quad (10)$$

The threshold parameter  $\theta$  can loosely be thought of as determining the size of the student body, while the parameter  $\phi$  determines its composition. We assume that  $\phi$  is positive, so that the left-hand side is always increasing in prior academic achievement,  $t_i$ , but parental income can affect admissions in different ways. Specifically we consider three types of admissions policies. The first ranks applicants by expected human capital, effectively maximizing students' total expected earnings, given the size of the student body. This implies weighing parental income *positively* and setting a value of  $\phi$  less than one.<sup>14</sup> The second ranks applicants "on merit," weighing only prior academic achievement and ignoring parental income, thus setting  $\phi$  equal to one. The third applies income-based affirmative action, weighing parental income negatively and setting  $\phi$  greater than one.

To graduate, students must pass a final examination at the completion of their studies. Examination grades are a stochastic function of human capital:

$$s_i = \ln h_i + u_{si} \quad (11)$$

where  $u_{si}$  is an independent, normally distributed disturbance term with mean zero and variance  $\sigma_{us}^2$ ; and the passing grade  $\underline{s}$  is public knowledge. Substitution shows that  $s_i$  is normally distributed with the same mean as  $t$  and  $h$ ,  $\mu_s = \mu_t = \mu_h$ , and variance:

$$\sigma_s^2 = (1 + \gamma)^2 \sigma_y^2 + \sigma_{ua}^2 + \sigma_{us}^2 \quad (12)$$

It follows that the joint distribution of the four variables  $\ln y$ ,  $\ln h$ ,  $t$  and  $s$  is multivariate normal, and the correlations between each pair of variables satisfy the following equations.

$$\rho_{yt} = (1 + \gamma) \sigma_y / \sigma_t \quad (13a)$$

$$\rho_{ys} = (1 + \gamma) \sigma_y / \sigma_s \quad (13b)$$

$$\rho_{yh} = (1 + \gamma) \sigma_y / \sigma_h \quad (13c)$$

$$\rho_{hs} = \sigma_h / \sigma_s \quad (13d)$$

$$\rho_{ht} = \sigma_h / \sigma_t \quad (13e)$$

$$\rho_{ts} = \sigma_h^2 / [\sigma_t \sigma_s] \quad (13f)$$

### 1.3 Production and the labor market

We assume an economy with competitive labor and product markets in which a continuum of firms produce a single homogeneous good using two types of human capital: graduate and non-graduate. All firms have the same constant-returns-to-scale production function:

$$Y_j = F(H_{nj}, H_{gj}) \quad (14)$$

where  $H_{nj}$  is the amount of non-graduate human capital employed by firm  $j$ , and  $H_{gj}$  is the amount of graduate human capital it employs. As  $F$  has constant returns-to-scale, total production in the economy can be represented as a function of total non-graduate and graduate human capital,  $H_n$  and  $H_g$ ,

$$Y = F(H_n, H_g) \quad (15)$$

Competition in labor and product markets implies that all firms pay the same wage rate per unit of human capital, equal to its marginal product by type of human capital:

$$w_n = \partial F / \partial H_n \quad (16)$$

$$w_g = \partial F / \partial H_g \quad (17)$$

and constant returns to scale imply that both  $w_n$  and  $w_g$  are uniquely determined by the ratio of non-graduate to graduate human capital,  $H_n / H_g$ .

We assume that the productivity of a worker in a non-graduate job is directly observable and proportional to her human capital  $h_i$ , implying that non-graduate  $i$  earns an annual income of  $w_n h_i$ . Young adults who choose not to attend university work for  $T_n$  years<sup>15</sup> and earn a discounted lifetime income of

$$Y_{ni} = h_i w_n [1 - \exp(-r T_n)] / r \quad (18)$$

where  $r$  is a common household discount factor. Those who choose to attend university but fail to graduate work for  $T_w = T_n - T_e$  years and earn a lifetime income of

$$Y_{fi} = h_i w_n [1 - \exp(-r T_w)] / r \quad (19)$$

Graduate workers are assumed to produce output that is less directly attributable, and so their individual levels of human capital are only gradually revealed to employers. To fix ideas, we posit that a graduate worker's lifetime income is proportional to a weighted average of her own human capital,  $\beta h_i$ , and of the average human capital of all graduate workers in her cohort,  $h_g$ .<sup>16</sup> The discounted lifetime income of a graduate then equals

$$Y_{gi} = [\alpha \beta h_i + (1 - \alpha) h_g] w_g [1 - \exp(-r T_w)] / r \quad (20)$$

where  $0 < \alpha < 1$  is a fixed parameter.

## 1.4 The decision to apply to college

We now consider the decisions of prospective candidates to apply for college admission, assuming that they are risk neutral and hence seek to maximize the expected present value

of their lifetime income. As admissions requirements are public knowledge, we consider only the decisions of prospective applicants who meet these requirements. Candidates form anticipations regarding the average level of graduate human capital,  $h_g^e$ , and the ratio of non-graduate to graduate human capital,  $R^e = H_n^e / H_g^e$ , which determines future wage rates per unit of human capital,  $w_n^e$  and  $w_g^e$ , and we assume that all applicants share the same anticipations, which we denote by  $\omega = (h_g^e, R^e)$ . A young adult whose values of  $y_i$  and  $t_i$  meet the college entrance requirements will apply if her expected net income from attending college is greater than her expected net income if she does not attend, conditioned on these values. Denote the joint multivariate normal density function of  $\ln y$ ,  $\ln h$ ,  $t$  and  $s$  by  $f(\ln y, \ln h, t, s)$ . Individual  $i$  expects to gain from attending college if

$$\int_{-\infty}^{\infty} \left[ \int_{-\infty}^{\underline{s}} Y_{fi}(\omega) f(\ln y_i, \ln h, t_i, s) ds + \int_{\underline{s}}^{\infty} Y_{gi}(\omega) f(\ln y_i, \ln h, t_i, s) ds \right] d \ln h - P \geq Y_{ni}(\omega) \quad (21)$$

where  $Y_{fi}$ ,  $Y_{ni}$  and  $Y_{gi}$  are defined by equations (18), (19) and (20), and depend on the anticipated values  $h_g^e$  and  $R^e$ .

## 1.5 Equilibrium

Equation (21) and the admissions requirement (10) implicitly define for each level of parental income  $y_i$  a threshold score  $\underline{t}(y_i; \omega)$  contingent on expectations regarding future levels of human capital, such that an individual with parental income  $y_i$  applies to college and is accepted if and only if her test score exceeds  $\underline{t}(y_i; \omega)$ . The density of children with pre-college human capital  $h$  who graduate from college is then

$$\varphi_g(h; \omega) = \int_{-\infty}^{\infty} \int_{\underline{t}(y; \omega)}^{\infty} \int_{\underline{s}}^{\infty} f(\ln y, \ln h, t, s) ds dt d \ln y \quad (22)$$

The density of children with pre-college human capital  $h$  who attend college but fail is:

$$\varphi_f(h; \omega) = \int_{-\infty}^{\infty} \int_{\ell(y; \omega)}^{\infty} \int_{-\infty}^s f(\ln y, \ln h, t, s) ds dt d \ln y \quad (23)$$

And the density of children with pre-college human capital  $h$  who do not attend college is<sup>17</sup>

$$\varphi_n(h; \omega) = \int_{-\infty}^{\infty} \int_{-\infty}^{\ell(y; \omega)} \int_{-\infty}^{\infty} f(\ln y, \ln h, t, s) ds dt d \ln y \quad (24)$$

Equilibrium is characterized by two equations in the two unknowns,  $h_g^e$  and  $R^e$ , ensuring that their realized values equal their anticipated values:<sup>18</sup>

$$h_g^e = \int_{-\infty}^{\infty} \beta h \varphi_g(h; \omega) dh \Big/ \int_{-\infty}^{\infty} \varphi_g(h; \omega) dh \quad (25)$$

$$R^e = H_n / H_g = \left[ \int_{-\infty}^{\infty} (T_e + T_w) h \varphi_n(h; \omega) dh + \int_{-\infty}^{\infty} T_w h \varphi_f(h; \omega) dh \right] \Big/ \left[ \int_{-\infty}^{\infty} T_w \beta h \varphi_g(h; \omega) dh \right] \quad (26)$$

## 2 Calibration

Calibrating the model to observed empirical variables provides a quantitative indication of the tradeoffs between output, distribution and mobility implicit in different admissions policies. The four variables  $\ln y$ ,  $\ln h$ ,  $t$  and  $s$  are assumed to have a multivariate normal distribution, where parents' income, children's admission test scores and final test scores are observable, but human capital is not. The parameters of the distribution—the means and variance-covariance matrix—are related to observed empirical values, as follows:

- The mean and variance of the logarithm of parental income,  $\mu_y$  and  $\sigma_y^2$ , are derived from the distribution of wages in the age category 35-54.<sup>19</sup> Median household income equals \$28,750, implying a value of  $\mu_y = 10.266$ , and average income is \$37,327, implying  $\sigma_y^2 = 0.522$ .

- The marginal distributions of prior test scores and final exam grades are assumed to be standardized normal, with  $\mu_t = \mu_s = 0$  and  $\sigma_t^2 = \sigma_s^2 = 1$ . This implies that the logarithm of human capital  $\mu_h$  also has zero mean.
- The correlation between prior test scores and final exam grades,  $\rho_{ts}$ , is set equal to 0.5, which approximates the correlation between SAT scores and first-year college grade-point-averages (Bridgman, McCameley-Jenkins and Ervin, 2000).<sup>20</sup>
- The correlation between parental income and prior test scores,  $\rho_{yt}$ , is set equal to 0.25—within the range of empirical estimates of the correlation between parental income and SAT scores, which vary between 0.17 to 0.3 (Hearn 1984, 1991; Owen 1985; Alwin and Thornton 1984; Paulhus and Shaffer 1981).<sup>21</sup>
- Because of the wide variation in grading standards, it does not seem reasonable to calibrate  $\rho_{ys}$ , the correlation in the model of parental income with final exam scores, to empirical correlations between parental income and college grade-point averages. Instead we assume that college grades have the same correlation with parental income as SAT scores, i.e.,  $\rho_{ys} = \rho_{yt} = 0.25$ .

The remaining entries of the variance-covariance matrix— $\sigma_h^2$ ,  $\sigma_{hy}$ ,  $\sigma_{ht}$ , and  $\sigma_{hs}$ —can then be calculated directly from these values (details of the derivations are in the Appendix.)

Continuing the calibration, we set the household discount rate equal to  $r = 5\%$ ; the number of college years  $T_e = 4$ ; the number of working years after college  $T_w = 40$ ; and tuition and other direct costs of a college education, excluding lost earnings,  $P = 20,000$ .<sup>22</sup> Production is assumed to follow a Cobb-Douglas function of the form  $Y = A_0 H_n^{1-\nu} H_g^\nu$ . We set  $\nu = 0.44$ , equal to the share of college graduates in total labor income, and choose  $A_0$

and  $\beta$  to fit the average wage level in the population.<sup>23</sup> Combining this value of  $\nu$  with the actual share of college graduates in each cohort—approximately equal to 28%—implies a ratio of the average wages of college graduates to non-graduates of 2.02, which is close to its actual value.<sup>24</sup> To complete the calibration of the benchmark case, we assume that admissions are based solely on test scores, and set the entrance threshold equal to  $\theta = -0.1$  (one tenth of a standard deviation below the mean), and the final pass score  $\underline{z}$  equal to 0.3 (three tenths of a standard deviation above the mean), so that the share of college enrollees in each age-group equals 55%, which is the actual share of individuals with more than 12 years of schooling in the 35-54 age category, in the United States; and the ratio of college graduates to enrollees equals 50%, again approximately equal to its empirical value. Finally, we set  $\alpha = 0.75$ . The intergenerational correlation of income in the calibrated model then equals 0.39, and the intergenerational correlation of the logarithm of income is 0.275. This latter figure is close to the OLS estimate of 0.294 for the father-son correlation in the logarithm of hourly wages in the United States estimated in Solon (1992, Table 4).<sup>25</sup>

### 3 Simulation

We simulate the model initially assuming that the economy has a fixed population, and consider three types of admissions policies:

- (1) Output maximization policies that rank applicants according to their expected human capital, which corresponds to setting a value of  $\phi = 0.84$  in equation (10);<sup>26</sup>
  - (2) Policies that rank applicants only according to prior test scores ( $\phi = 1.00$ );
- and

(3) Income-based affirmative-action policies that give positive weight to economic hardship, where we specify, in symmetry to (1), that  $\phi = 1.16$ .<sup>27</sup>

For each type of admission policy we vary the minimum requirement  $\theta$ , thus varying the number of college students and graduates in each cohort, and calculate mean income, the admission rate, the Gini coefficient, and the intergenerational correlation of income for each value of  $\theta$ .

Figure 1 describes the effect of admissions criteria on output, showing output levels as a function of college enrolment for each of the three types of admissions rankings.<sup>28</sup> Output is maximized overall when applicants are ranked by expected human capital and  $\theta$  is set so as to admit to college just under 45% of each cohort. For other types of admissions policies the output maximizing admissions rate is slightly higher. Unrestricted access to higher education reduces mean income, as individual schooling decisions are not efficient—weaker students ignore the negative externalities they generate for other graduates, and too many are willing to risk failure, though Figure 1 indicates that efficiency losses from setting excessively lax admissions requirements—without lowering graduation requirements—are moderate: about 0.25% of national product at the current enrolment rate of 55% irrespective of the type of admissions policy that is applied.<sup>29</sup> However, overly restrictive policies that shrink higher education far below its optimal size can substantially reduce output. Differences in output between the three types of admissions policies holding constant the share of college students shrink considerably as enrolment rates rise, with affirmative action achieving at its peak nearly 99.9% of maximum output.

Figure 2 highlights the impact of admissions standards on intergenerational income mobility, measured inversely as the correlation of income across generations—a lower correlation corresponding to greater mobility. It clearly demonstrates the positive



impact on mobility of more restrictive admissions standards, which decrease college enrolment, under each of the three types of admissions policy. Higher admissions standards increase the return to a college education, which especially benefits higher-ability applicants from low-income families. This indicates a tradeoff between broad access to higher education, which may be valued in its own right, and the greater equality of economic opportunity reflected in a lower correlation of income across generations. In addition, Figure 2 demonstrates the obvious positive effect of affirmative action on income mobility, which results in substantially lower correlation values than other admissions policies.

Figure 3 combines the findings of Figures 1 and 2, describing the tradeoff between output and income mobility implicit in the three types of admissions policies that we consider. The three possibility frontiers in Figure 3 highlight our previous results: affirmative action achieves near-maximum output, while offering substantial gains in intergenerational mobility. The envelope of the three curves indicates that the tradeoff between output and mobility is limited: reducing the intergenerational correlation of income below 0.36 entails substantial loss of output; and reducing output loss (in relation to maximal achievable output) below 0.2% entails a substantial loss of mobility.

Figure 4 describes the effect of college admissions policies on equality of the wage distribution, measured on the vertical scale as a decline in the Gini coefficient. The key variable in this regard is the level of admissions standards, which determines the size of college enrolment.<sup>30</sup> Raising standards and thus restricting college enrolment raises the wage ratio between graduates and non-graduates, resulting in a less equal distribution of wages. However the manner in which applicants are ranked—the choice of  $\phi$ —has relatively little effect on inequality.<sup>31</sup>

Combining the results illustrated in Figures 1 and 4, on the impact of enrolment on output and inequality, we find that increasing the level of college enrolment beyond its output-maximizing scale entails a tradeoff between aggregate output and equality of the wage distribution. The range of values in which this tradeoff is present is illustrated in Figure 5, where points in the lower right-hand corner of the graph correspond to lower levels of enrolment: inequality can be reduced by almost three percentage points in the Gini coefficient at a cost in forgone output of 0.2%.

The effect of college enrolment on the distribution of wages and on intergenerational income mobility, described in Figures 2 and 4, are combined in Figure 6 to highlight the sharp tradeoff between intergenerational mobility and equality of the wage distribution implicit in the choice of admissions standards. The envelope almost entirely follows the possibilities afforded by affirmative action policies. When admissions standards are relaxed (at the upper left-hand corner of the graph) the college wage premium falls promoting a more equal distribution of wages, but mobility is reduced; when they are raised, the number of graduates falls and the college wage premium rises, resulting in a less equal distribution of income but greater mobility. Higher standards enhance the effectiveness of higher education as an instrument of social mobility for those who succeed but widen the gap between success and failure. This recalls Checchi et al.'s (1999) observation that "... a centralized and egalitarian school system may not help poor children, and may take away from them a fundamental tool to prove their talent and to compete with rich children."

#### **4 An extension: Immigration of non-graduate labor**

We extend the analysis to allow immigration of a quota of low-skilled workers. Assume there is a perfectly elastic supply of non-graduate labor at a wage rate that is significantly

lower than the domestic non-graduate wage. The government allows a quota of non-graduate immigrants to enter the country and work as non-graduate labor, and we assume that the distribution of human capital in the immigrant population is the same as in the native population (before college graduation). Tables 1 and 2 compare the performance of the economy under two alternative political objectives, which differ in the weight attached to the welfare of immigrants. Table 1 assumes that entrance requirements are set so as to maximize total domestic output per capita, implicitly treating the welfare of immigrants and of the native born equally. In Table 2 the per capita output of the native-born population is maximized, ignoring the welfare of immigrants. Each table presents the results of the three types of admissions policies for each of four different quota levels: 0% (the closed economy case considered above), 5%, 10% and 20%. Performance measures include native and domestic per capita output, college enrolment rates, Gini coefficients, and native income mobility (measured as the intergenerational correlation of income.)

Turning first to Table 1, we find that when the economy is open to migration, domestic output is maximized through a large expansion of college enrolment, large enough to increase enrolment rates in the domestic population as a whole. This slightly increases native output per capita while slightly reducing domestic output per capita. The large expansion of college enrolment keeps graduate wages from rising, which results in only slight variation in both the Gini coefficient and the intergenerational correlation of incomes. Comparing the three types of admissions policies in this case, we find that the basic patterns of the no-migration case are retained: ranking applicants by expected human capital achieves small gains in output in relation to the other admissions policies, and entails some loss of social mobility.

In contrast, native output is maximized by a much smaller increase in college enrolment, which reduces the share of graduates in the population at large, though slightly

increasing the proportion of graduates among the native-born. This increases the return to a college degree, which benefits those who earn a degree, and substantially increases inequality, measured by the Gini coefficient, both among the native born and in the population as a whole under all three types of admissions policies. At the same time, the limited increase in college enrolment also promotes intergenerational income mobility in the native population, reducing the correlation between the incomes of parents and their children under all three types of admissions policies. Comparing the three types of admissions policies when native output is maximized, we find that migration slightly magnifies the differences between policy types: the advantage of human capital maximization in promoting aggregate growth is accented, as is the advantage of affirmative action in promoting intergenerational mobility.

Comparing the effect of these two different political objectives, we find that while the choice of social goals has some effect on total output—the difference never exceeds one percent—its greatest effect is on distribution and mobility. Policies that maximize native output result in fewer college graduates, a less equal distribution of income and greater income mobility among the native population, compared to policies that maximize domestic output.

## **4. Concluding remarks**

In this paper we show how college admissions criteria affect aggregate measures of output, distribution and mobility. Defining a general equilibrium model of centralized college admissions with peer-group signaling externalities in the labor market for college graduates and calibrating it to observed empirical values provides indicative quantitative measures of the tradeoffs between output, distribution and mobility implicit in the choice of admissions policies.

We find that increasing the number of college students, with or without affirmative action, generates a more equal income distribution but reduces intergenerational income mobility and slightly reduces total output. Income-based affirmative action policies that give applicants from low-income families an edge in admissions, without increasing total college enrolment, can achieve large gains in intergenerational mobility with only a small loss of output.

These results pertain to an economy closed to migration. The effect of opening the economy to non-graduate immigrant labor depends on the social goals that are pursued. If the government seeks to maximize domestic output per capita—weighing immigrant welfare similarly to native welfare—college enrolment is substantially increased; if the government seeks to maximize native output per-capita, ignoring the welfare of immigrants, growth in higher education is restricted. Consequently, maximizing domestic output per capita results in a more equal but less mobile economy than maximizing native output per capita.

These findings suggest that the key tradeoffs implicit in college admissions policies are not between efficiency and equity but between different dimensions of equity: between income mobility on the one hand, and wage equality and broader access to higher education on the other hand.

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<sup>1</sup> These may include peer-group externalities both in the education process and the labor market (Epple et al., 2000). Students in public universities also fail to take into account the subsidies from which they benefit. Screening gains added importance when there are capacity limits on the number of university places and capital market imperfections limit the scope for external financing of college studies (Fernandez and Gali, 1999).

<sup>2</sup> A common measure of social mobility, which we use here, is the intergenerational correlation of income.

<sup>3</sup> We focus on income-based affirmative action rather than race-sensitive policies. Race-sensitive affirmative action has been widespread in higher education in the United States in recent decades (Bowen and Bok, 1998), but constitutional objections based on the Fourteenth Amendment and the Civil Rights Act are increasingly limiting the scope for such policies (Dworkin, 2003)—objections that do not apply to income-based affirmative action. Although socio-economic characteristics and race are clearly correlated, Cancian (1998) finds that “class-based affirmative action would result in a very different pool of eligible individuals than race-based programs.” Our theoretical framework could be applied to analyze the socio-economic implications of race-sensitive admissions policies.

<sup>4</sup> Thus we abstract from other important considerations that affect student admissions in practice such as racial, ethnic, geographic or religious diversity, or non-academic achievement in athletics, community service, and so on.

<sup>5</sup> This follows the characterization of the university as a “double filter” in Arrow (1973). The possibility of failure recalls mismatching effects described in Loury and Garman (1993), which arise when weaker students gain entry to highly selective colleges through affirmative action policies, and perform poorly, possibly earning less than had they attended less selective schools.

<sup>6</sup> Thus peer-group externalities in the labor market for college graduates provide the economic basis for applying academic criteria to regulate college admissions: weaker students, ignoring the negative externalities they impose on other graduates, may be willing to pay the cost of their education even when it is not socially efficient for them to attend college. Peer-group externalities in the education process do not enter in our model.

<sup>7</sup> Family income is allowed as a factor in determining admissions, but does not affect the



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probability of successfully graduating once one has been admitted.

<sup>8</sup> This bears on Stiglitz (1975), which offers a seminal analysis of the positive political economy of screening in education; and on Razin and Sadka (1995), which contrasts the fiscal effects of unskilled and skilled immigrants on the native population.

<sup>9</sup> In related contexts, Iyigun (1999) emphasizes the importance for income mobility of allocating sufficient public resources to elementary and high school education in the early stages of economic development, and Judson (1998) links micro and macro perspectives on the allocation of resources to primary education.

<sup>10</sup> We abstract from both capacity constraints and capital market imperfections, showing that screening college applicants may be desirable even when students have sufficient access to credit for funding their studies and the supply of college places is elastic.

<sup>11</sup> Though parents presumably have some indication of their children's ability, we assume that this does not affect their investment: the logarithmic form implies that parents invest equally in "stronger" and "weaker" children.

<sup>12</sup> Extending the analysis to allow fees also to depend on test scores and parental income is straightforward, but we found it had little effect on the results, presumably because college fees are small compared to lifetime income and we assume perfect capital markets for funding college costs, and because we focus on the choice between studying or not studying rather than on the choice of school or degree program. Analyses that highlight the potential for test-based stipends to increase efficiency generally assume that capital markets are imperfect (e.g., Fernandez and Gali, 1999). Analyses of the choice between different institutions (e.g., Danziger, 1990; Epple et al., 2000) show that it is in the interest of individual universities to charge students with high ability lower tuition because of the positive externalities they are perceived to generate for other students.

<sup>13</sup> The model is readily extended to allow for  $\beta$  to be affected by the quality of the student body and by the university's graduation requirements (the more stringent the requirements the greater the productivity gain.) This does not enter our analysis because we chose not vary graduation requirements; and because peer group effects are taken to influence labor market outcomes through a signaling effect, rather than by increasing the productivity of the education process.

<sup>14</sup> This follows from the model, as we show in the Appendix, where the conditional mean

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of the logarithm of pre-college human capital  $E(\ln h_i | t_i, \ln y_{it})$  is shown to be an increasing function of the prior test score  $t_i$  and of the logarithm of parental income  $\ln y_i$  (cf. note 26). It is also supported indirectly by empirical evidence of a positive association between first-year college grades and parental socio-economic status, after controlling for psychometric test scores (Aitken, 1982; Kane and Spizman, 1994; among others).

<sup>15</sup> The supply of labor is assumed to be inelastic, except the decision to attend college.

<sup>16</sup> A graduate entering the workforce is an unknown quantity, and receives a wage equal to the average marginal productivity of skilled workers in her cohort. Over time her individual qualities are revealed and she earns a salary that more closely approximates her individual marginal product. Thus wages are determined by both individual human capital and the signal embodied in the degree (Weiss, 1995).

<sup>17</sup> Thus  $\int_{-\infty}^{\infty} [\varphi_g(h; \omega) + \varphi_f(h; \omega) + \varphi_n(h; \omega)] dh = 1$

<sup>18</sup> There exists such a value if the right hand side of (25) varies continuously with the anticipated value of  $h_g^e$ , which is satisfied if the density function  $f$  is non-atomic, and if  $h_g(h_g^e) > h_g^e$  for small values of  $h_g^e$ , and  $h_g(h_g^e) < h_g^e$  for large values of  $h_g^e$ . This value is unique if (25) implies that  $h_g$  is decreasing in  $h_g^e$ , which seems intuitively reasonable, as the higher the value of  $h_g^e$  the greater are the gross benefits of a university degree and the wider is the applicant pool, implying a lower realized level of  $h_g$ .

<sup>19</sup> Data are from the Annual Demographic Survey (Bureau of Labor Statistics and Bureau of the Census, 1999). The age group 35-54 is taken as representative of child-rearing years.

<sup>20</sup> Kennet-Cohen, Bronner and Oren (1998) reports similar estimates from Israeli data.

<sup>21</sup> We choose a value near the higher end of the range because empirical estimates necessarily measure the correlation between family income and SAT scores only among those for whom such scores are available, indicating an interest in attending college, while in the model  $\rho_{y,t}$  represents this correlation in the population as a whole.

<sup>22</sup> Varying the cost of tuition had little effect on the simulation results (cf. note 12).

<sup>23</sup> The model does not allow us to separate their individual values; we set  $A_0\beta^v = 64,936$ .

<sup>24</sup> Letting  $N_g$  and  $N_n$  respectively denote the number of graduates and non-graduates in the workforce,  $N_g / N_n = 0.28/0.72 = 0.389$ . Then  $v / (1 - v) = w_g H_g / w_n H_n = 0.44/0.56 = 0.786$ , and the ratio of average wages of graduates to non-graduates is:

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$$(w_g H_g / N_g) / (w_n H_n / N_n) = [v / (1 - v)] / (N_g / N_n) = 0.786 / 0.389 = 0.202$$

<sup>25</sup> Sons' income data are for 1984. Solon's instrumental variable estimate is larger, though probably upward-biased, as he notes.

<sup>26</sup> This value was found by numerical maximization of total output over a grid of possible values of  $\phi$  and  $\theta$ . This is only an approximate solution. The precise index for ranking applicants by the expected value of *post*-college human capital is

$$I(\ln y_i, t_i) = \int_{-\infty}^{\infty} \int_0^{\underline{s}} h f(\ln h, s | \ln y_i, t_i) d \ln h ds + \int_{-\infty}^{\infty} \int_{\underline{s}}^{\infty} \beta h f(\ln h, s | \ln y_i, t_i) d \ln h ds$$

where  $f(\ln h_i, s_i | \ln y_i, t_i)$ , the conditional joint density of human capital and exam grades, is a bivariate normal distribution, the parameters of which are derived in Appendix B. The index  $I$  is not linear in  $\phi$  and  $\theta$ . (Appendix B shows that the conditional expected value of *pre*-college human capital is linear in  $\phi$  and  $\theta$ .)

<sup>27</sup> This implies, approximately, that each halving of parental income imparts an advantage of one tenth of a standard deviation in test-score requirements. To see this, let  $y_H > y_L$  denote the parental income of two applicants and let  $t_H$  and  $t_L$  denote their test scores. Their admissions criteria are equal if  $1.16t_H - .16 \ln y_H = 1.16t_L - .16 \ln y_L$  which implies  $t_H - t_L = (0.16/1.16) \ln (y_H / y_L) \approx 0.1 \log_2 (y_H / y_L)$ .

<sup>28</sup> See also the first columns of Tables 1 and 2.

<sup>29</sup> The loss is greater to the extent that relaxing admissions standards adversely affects *pre*-college academic effort (Costrell, 1994) or reduces the efficiency of the education process through actual (not merely perceived) peer-group effects (Epple, et al., 2000).

<sup>30</sup> We vary admissions requirements but hold constant the graduation requirement  $\underline{s}$ .

<sup>31</sup> Holding constant the size of the student body, the ranking system affects inequality in two ways: a more efficient ranking increases the correlation between human capital and college studies, which increases inequality, but also increases the ratio of graduate to non-graduate human capital, which lowers the college wage premium, reducing inequality. Our calibration indicates that the latter effect is slightly stronger.

## Appendix: The joint distribution of $\ln h_i$ , $s_i$ , $\ln y_i$ and $t_i$

### A. The variance-covariance matrix of $\ln h_i$ , $s_i$ , $\ln y_i$ and $t_i$

The missing elements of the variance-covariance table are the elements incorporating the unobserved variable  $\ln h_i$ , the logarithm of human capital.

From equation (13a) we obtain

$$1 + \gamma = \rho_{yt} \sigma_t / \sigma_y \quad (\text{a1})$$

and substituting this in equation (13c) gives

$$\rho_{yh} = \rho_{yt} \sigma_t / \sigma_h \quad (\text{a2})$$

implying that

$$\text{cov}(y, h) = \rho_{yh} \sigma_y \sigma_h = \rho_{yt} \sigma_y \sigma_t = 0.181 \quad (\text{a3})$$

after substituting the calibration values from the text. From equation (13f):

$$\sigma_h^2 = \rho_{ts} \sigma_t \sigma_s = 0.5 \quad (\text{a4})$$

and from equation (13d):

$$\text{cov}(h, s) = \rho_{hs} \sigma_h \sigma_s = \sigma_h^2 = \rho_{ts} \sigma_t \sigma_s = 0.5 \quad (\text{a5})$$

Similarly, from equation (13e):

$$\text{cov}(h, t) = \rho_{ts} \sigma_t \sigma_s = 0.5 \quad (\text{a6})$$

Thus all the elements of the variance-covariance matrix can be expressed as functions of the observed correlations and variances.

## B. The conditional joint distribution $\ln h_i$ and $s_i$ given $\ln y_i$ and $t_i$

Given parental income and the prior test score, the joint conditional distribution of the logarithm of human capital and the final exam score have expectations

$$E(\ln h_i | \ln y_i, t_i) = E(\ln h) + \frac{1}{(1 - \rho_{yt}^2)} \left[ \frac{\rho_{yt} (\ln y_i - E(\ln y))}{\sigma_y} (\sigma_t - \sigma_s \rho_{ts}) + \left( \frac{\rho_{ts} \sigma_s}{\sigma_t} - \rho_{yt}^2 \right) (t_i - E(t)) \right]$$

$$E(s_i | \ln y_i, t_i) = E(s) + \frac{\sigma_s}{(1 - \rho_{yt}^2)} \left[ \frac{(\ln y_i - E(\ln y))}{\sigma_y} (\rho_{ys} - \rho_{ts} \rho_{yt}) + \frac{(t_i - E(t))}{\sigma_t} (\rho_{ts} - \rho_{ys} \rho_{yt}) \right]$$

and variance-covariance matrix

$$\sigma_{\ln h_i | \ln y_i, t_i}^2 = \rho_{ts} \sigma_t \sigma_s - \frac{\rho_{yt}^2 \sigma_t}{(1 - \rho_{yt}^2)} (\sigma_t - \rho_{ts} \sigma_s) - \frac{\rho_{ts} \sigma_t \sigma_s}{(1 - \rho_{yt}^2)} \left( \frac{\rho_{ts} \sigma_s}{\sigma_t} - \rho_{yt}^2 \right)$$

$$\sigma_{s_i | \ln y_i, t_i}^2 = \sigma_s^2 - \frac{\sigma_{ys} \sigma_s^2}{(1 - \rho_{yt}^2)} (\rho_{ys} - \rho_{ts} \rho_{yt}) - \frac{\rho_{ts} \sigma_{ss}^2}{(1 - \rho_{yt}^2)} (\rho_{ts} - \rho_{ys} \rho_{yt})$$

$$\text{cov}(\ln h_i, s_i | \ln y_i, t_i) = \rho_{ts} \sigma_t \sigma_s - \frac{\rho_{ys} \rho_{yt} \sigma_s}{(1 - \rho_{yt}^2)} (\sigma_t - \rho_{ts} \sigma_s) - \frac{\rho_{ts} \sigma_t \sigma_s}{(1 - \rho_{yt}^2)} \left( \frac{\rho_{ts} \sigma_s}{\sigma_t} - \rho_{yt}^2 \right)$$

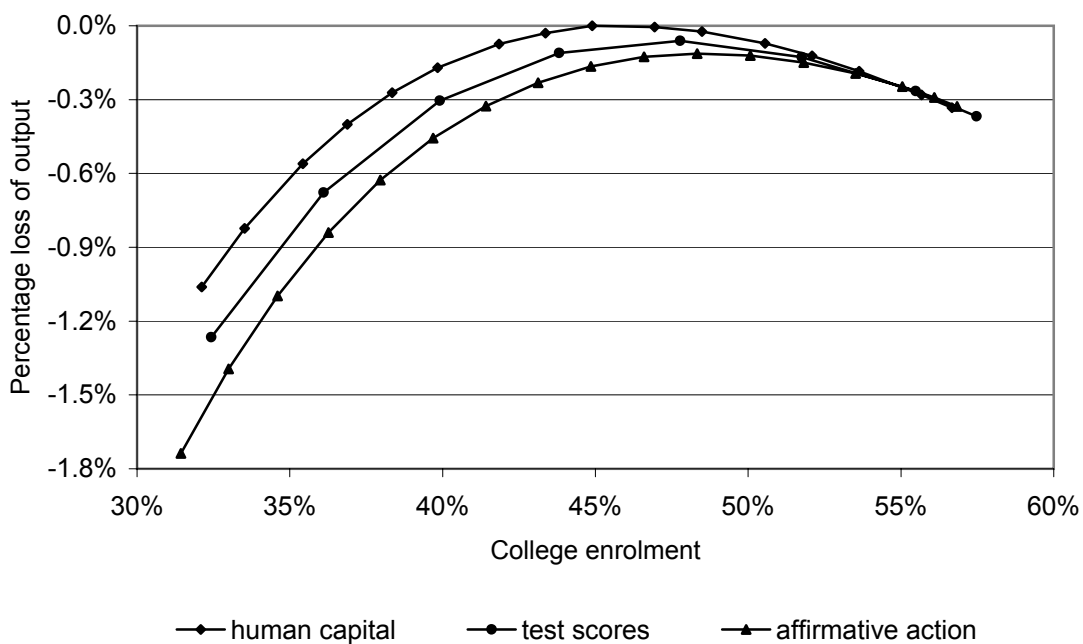
**Table 1. Comparison of outcomes under different admissions and migration policies at maximum domestic output per capita**

<i>Migration quota</i>	<b>0</b>	<b>5%</b>	<b>10%</b>	<b>20%</b>
<i>Human capital admissions criteria</i>				
Domestic output per capita	34,598	34,538	34,474	34,332
Native output per capita	34,598	34,604	34,623	34,724
Percent native population attending college	44.9%	50.6%	55.7%	66.5%
Percent domestic population attending college	44.9%	48.1%	50.6%	55.4%
Native Gini coefficient	0.314	0.312	0.313	0.316
Domestic Gini coefficient	0.314	0.311	0.311	0.312
Native intergenerational income correlation	0.399	0.399	0.398	0.393
<i>Pure test-based admissions criteria</i>				
Domestic output per capita	34,577	34,519	34,455	34,308
Native output per capita	34,577	34,585	34,623	34,721
Percent native population attending college	47.8%	51.8%	55.7%	67.1%
Percent domestic population attending college	47.8%	49.3%	50.7%	55.9%
Native Gini coefficient	0.308	0.311	0.315	0.316
Domestic Gini coefficient	0.308	0.310	0.313	0.312
Native intergenerational income correlation	0.382	0.381	0.380	0.381
<i>Affirmative action admissions criteria</i>				
Domestic output per capita	34,559	34,503	34,440	34,296
Native output per capita	34,559	34,561	34,575	34,664
Percent native population attending college	48.3%	53.6%	58.9%	70.2%
Percent domestic population attending college	48.3%	51.1%	53.5%	58.5%
Native Gini coefficient	0.309	0.308	0.309	0.311
Domestic Gini coefficient	0.309	0.307	0.307	0.308
Native intergenerational income correlation	0.374	0.376	0.377	0.379

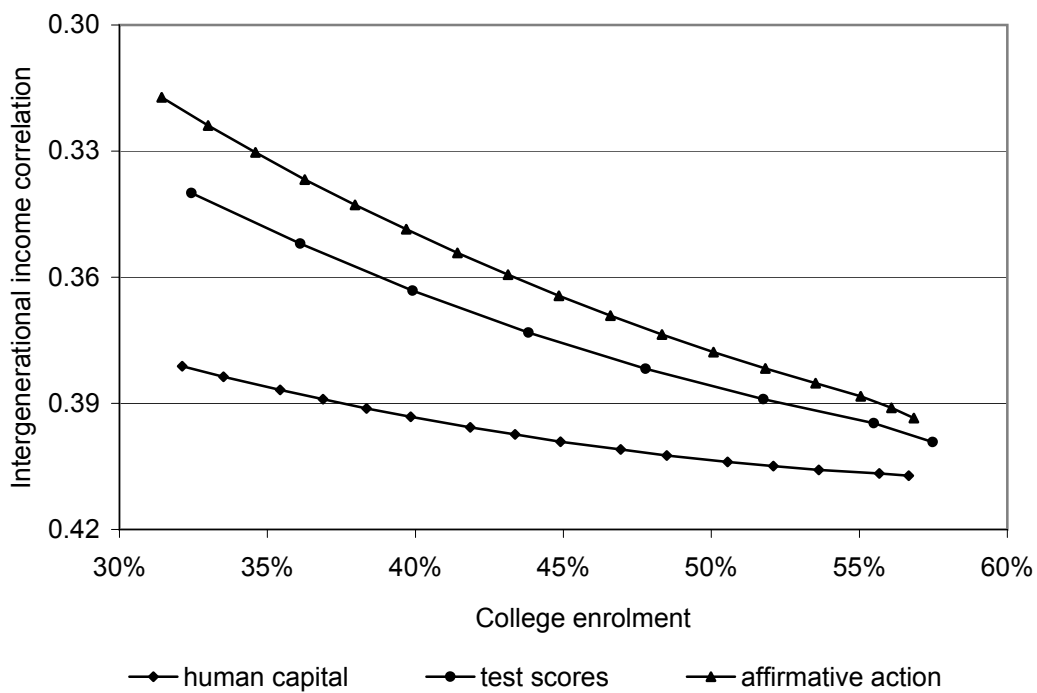
**Table 2. Comparison of outcomes under different admissions and migration policies at maximum native output per capita**

<i>Migration quota</i>	<b>0</b>	<b>5%</b>	<b>10%</b>	<b>20%</b>
<i>Human capital admissions criteria</i>				
Domestic output per capita	34,598	34,524	34,406	34,121
Native output per capita	34,598	34,626	34,707	34,982
Percent native population attending college	44.9%	46.9%	46.9%	48.5%
Percent domestic population attending college	44.9%	44.7%	42.7%	40.4%
Native Gini coefficient	0.314	0.323	0.339	0.362
Domestic Gini coefficient	0.314	0.322	0.335	0.353
Native intergenerational income correlation	0.399	0.396	0.390	0.381
<i>Pure test-based admissions criteria</i>				
Domestic output per capita	34,577	34,500	34,378	34,043
Native output per capita	34,577	34,606	34,686	34,960
Percent native population attending college	47.8%	47.8%	47.8%	47.8%
Percent domestic population attending college	47.8%	45.5%	43.4%	39.8%
Native Gini coefficient	0.308	0.323	0.339	0.367
Domestic Gini coefficient	0.308	0.322	0.336	0.358
Native intergenerational income correlation	0.382	0.373	0.365	0.350
<i>Affirmative action admissions criteria</i>				
Domestic output per capita	34,559	34,477	34,350	34,064
Native output per capita	34,559	34,588	34,668	34,944
Percent native population attending college	48.3%	48.3%	48.3%	50.1%
Percent domestic population attending college	48.3%	46.0%	43.9%	41.8%
Native Gini coefficient	0.309	0.325	0.340	0.362
Domestic Gini coefficient	0.309	0.323	0.336	0.354
Native intergenerational income correlation	0.374	0.364	0.354	0.342

**Figure 1. College enrolment and output**

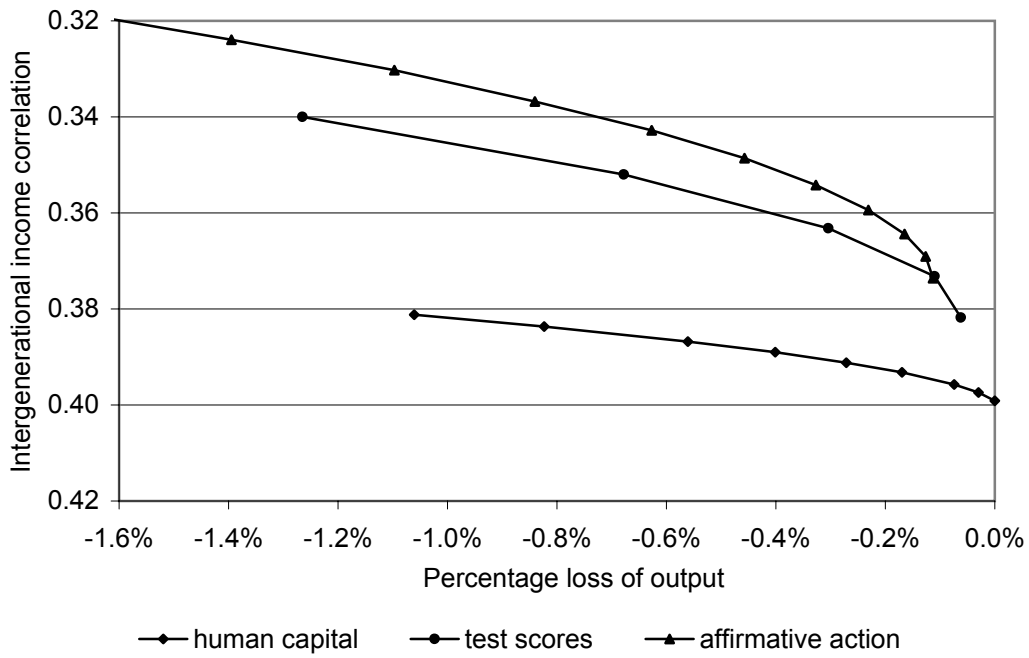


**Figure 2. College enrolment and income mobility**

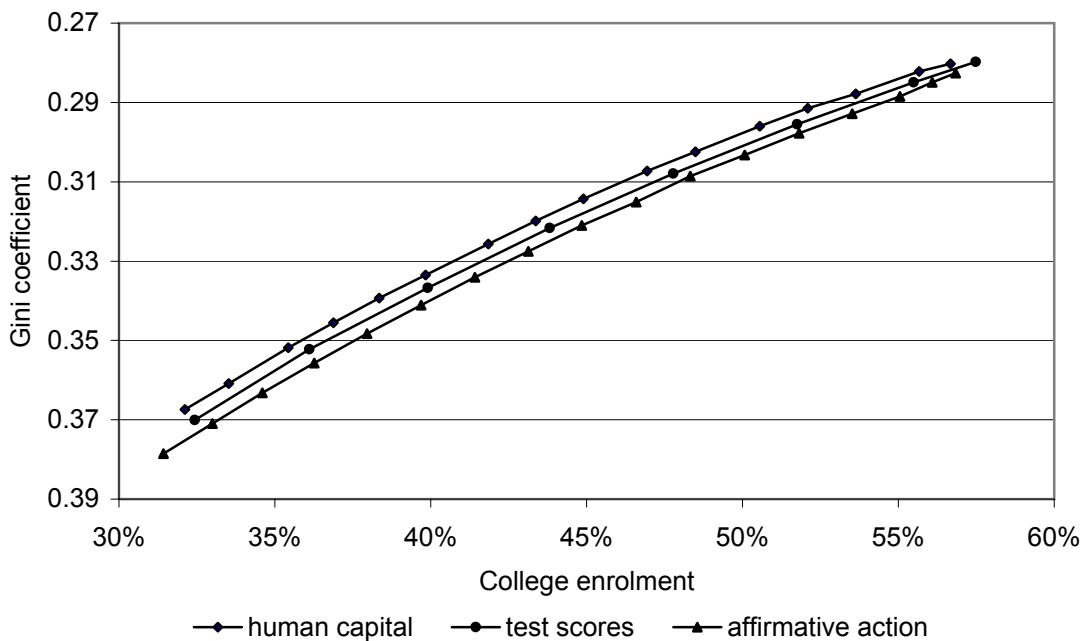




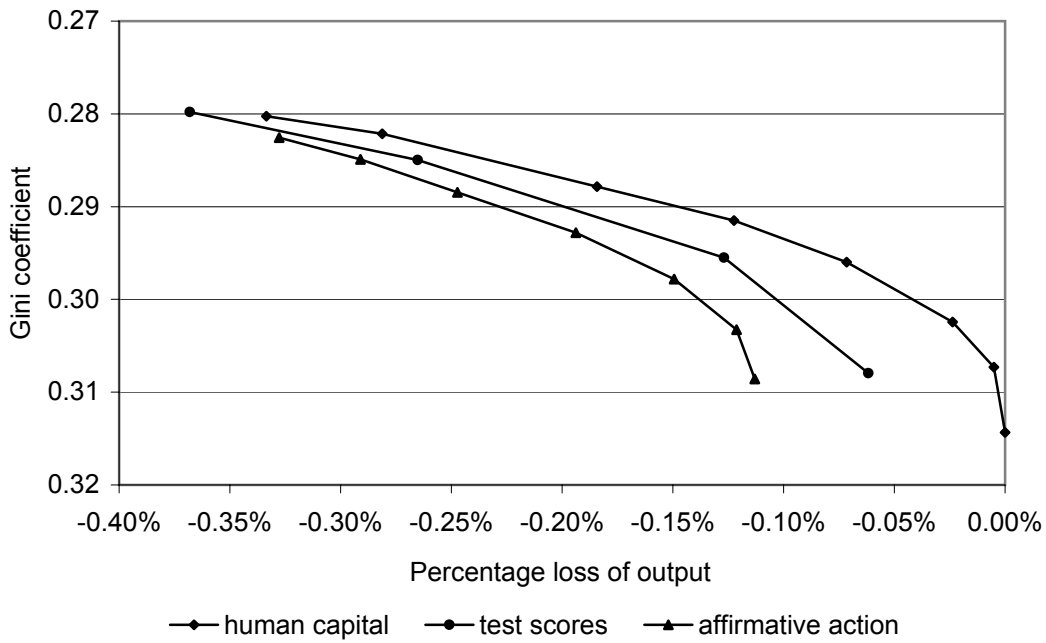
**Figure 3. The tradeoff between output and income mobility**



**Figure 4. College enrolment and the wage distribution**



**Figure 5. The tradeoff between output and the distribution of wages**



**Figure 6. The tradeoff between income mobility and the distribution of wages**

