Affirmative Action in College Admission Decisions and the Distribution of Human Capital

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Abstract: This paper presents a model consisting of a large number of students who differ by race and by the stock of human capital of their parents. Students choose effort levels in high school and college. College attendance is dependent on the student's decision to attend college and the college's decision to accept the student. Colleges in this paper enact admission policies that are not colorblind. The computational experiments reveal that under affirmative action, some minority students who were already attending college without affirmative action acquire less human capital because affirmative action reduces their incentive to exert effort in high school.

Key Words: Affirmative Action, College

JEL Codes: I21, I28

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I. Introduction

Affirmative action in general, and affirmative action in college admissions specifically, is a controversial topic with strong moral feelings on both sides of the issue, but the first step is it to see what effects affirmative action in college admissions will have. Recently there has been an increased attempt to model affirmative action in college admissions, but despite the fact that there is a wide distribution of people who apply for college, most papers have taken a game theoretical approach, and have ignored the distributional issues and the different stages of education when modeling affirmative action in higher education.

This paper examines the distributional issues of affirmative action policy in higher education. Rare to the literature on affirmative action in higher education, the model has heterogeneous agents that differ by race and the stock of human capital of students' parents. Also rare to the literature on affirmative action in higher education, students choose effort levels in both high school and college, and this allows examination of how effort in both schooling choices will be affected by affirmative action. The main result of the paper finds that affirmative action can lower the incentive for minorities to invest as much in high school education, and some can actually end up with less total human capital as a result of affirmative action.

Recent developments in the legality of affirmative action of higher education has been widely reported. In 2003 the Supreme Court ruled on two cases involving affirmative action with regard to college admission decisions, sparking renewed interest in these policies. These were their first rulings since 1978 on affirmative action in college admissions.[1,2] The first case, Gratz v. Bollinger, involved undergraduate admissions. It was filed in 1997 on behalf of two students who were rejected by the University of Michigan's College of Literature, Science, and the Arts (Schmidt (2002)). The college policy was to automatically distribute 20 points out of a possible 150, one-fifth of total points needed to guarantee admission, to every underrepresented minority (Online Newshour (2003)). The second case involved the University of Michigan's Law School and was filed on behalf of Barbara Grutter, who was rejected in 1997. The law school did not use a point system but rather had a more vague admission policy that favored minority applicants (Schmidt (2002)).

The plaintiffs in these two cases argued that the University of Michigan was operating an illegal quota system. The University of Michigan argued that a race-conscious admissions policy is permissible because: (i) there are benefits offered by a racially diverse campus, (ii) it is necessary to remedy past and present discrimination, (iii) biased test scores make it impossible to assess individuals unless heed is paid to race, and (iv) it helps remedy specific acts of discrimination (Schmidt (2002)).

The Supreme Court voted five to four in favor of the University Law School's policy, finding that it fairly sought a "critical mass" of minority students. With regard to the undergraduate case, the Supreme Court ruled six to three against the point based system, stating that the policy was not "the correct way to achieve education diversity".

[1] In 1978 the Supreme Court ruled against the U.C. Davis Medical School for designating 16 of 100 slots of the incoming class for minorities because it constituted a quota (Online Newshour (2003)).

[2] In 1995 the Supreme Court ruled that a scholarship program at the University of Maryland that gave more money to minorities violated the 14th amendment. In 1996 the U.S. 5th Circuit Court of Appeals ruled that a plan at the University of Texas Law School that admitted some minority students with lower GPA and test scores than white applicants who were rejected violated the 14th amendment.

The implication of these rulings is that educational institutions can consider race and employ affirmative action if they structure it correctly.[3]

While much attention has been paid to the constitutional issues of a race-based admission policy, relatively less attention has been directed toward examining the goals of affirmative action, whether a Michigan type policy could achieve these goals, and the possible unintended consequences of these policies. The stated goals of affirmative action in college admission policies are to:

1. Increase diversity in colleges: Surveys of college professors and students show that the majority believe diversity in the classroom develops critical thinking, leadership skills, and improves students' cognitive and personal development (ACE (1998), ACE (2000)).
2. Remedy past discrimination: Past discrimination may be one of the major causes of minorities having lower human capital than Caucasians.
3. Provide a systematic effort to fight current discrimination: Current discrimination (real or perceived), particularly in the job market, may lower the incentives for minorities to invest in human capital, and affirmative action may be a remedy for this underinvestment.
4. Counteract bias in test scores: There is a perception in certain segments of the population that standardized tests are biased against minorities.

This paper does not address the issues of the possible effects of diversity in the classroom or biased test scores, but rather the possible consequences of affirmative action on the distribution of human capital and effort of both minorities and non-minorities.

[3] Texas and California also eliminated their affirmative action programs for college admissions between 1996 and 1998.

These consequences could have large implications on affirmative action's ability to remedy past discrimination and fight current discrimination. These consequences will also help to highlight some of the possible costs of increasing diversity in college.

There were two early empirical studies examining affirmative action in college admissions. Loury and Garman (1993) found that, holding performance constant, blacks gain more (in regard to future wage) than whites from attending more select colleges. However, allowing performance to vary may offset this gain since they found a direct relationship between future wage and GPA. Therefore, blacks who attend the most select colleges may have also earned a higher wage if they attended a somewhat less select college because their GPA would have been higher. Bowen and Bok (1998) study several select institutions in 1951, 1976 and 1989. Among other things, they compare the graduation rate of black students to that of white students. They present some evidence that minority students are less likely to graduate than white students.

More recent empirical studies examine how the elimination of affirmative action in Texas and California affects the number of minorities taking or sending test scores to state institutions. Thomas (2004) finds that after Texas ended their affirmative action program, minorities were less likely to send their SAT scores to selective Texas institutions than whites, but minorities were more likely to send their scores to out of state selective institutions. Card and Krueger (2005) examine the effects of California and Texas eliminating their affirmative action program on the percentage of minority SAT test takers that sent their scores to selective state institutions. They find that ending affirmative action did not change the percentage that sent their test results. Dickson

(2006) found that when affirmative action was ended in Texas, 1.6% fewer Hispanic students and 2.1% fewer black students took a college admissions test.

Long (2004) examines both an empirical model and a theoretical model of students in Texas. He finds that after the elimination of affirmative action, minority students shift where they send their SAT scores, from higher quality colleges to lower quality colleges. For whites and Asian-Americans this phenomenon is the opposite. His theoretical model finds the probability of acceptance has an impact on students' application decisions. Arcidiacono (2005) creates a model and runs simulations on actual data to see what would have happened if policies had been different. He estimates a four stage model using The National Longitudinal Study of the Class of 1972. He finds that removing affirmative action does not have a large effect on minorities' earnings but does affect minorities' educational outcomes.

Recently a few theoretical papers have begun to examine some aspects of affirmative action in college admission decisions, but many focus on different issues and questions than those examined in this paper. The majority of papers focus on comparing affirmative action to an alternative policy of a college attempting to achieve diversity. Chan and Eyster (2003), Epple, Romano and Sieg's (2003), and Fryer, Loury, and Yuret (2003) all compare affirmative action to other possible policies to achieve diversity.

Two papers have examined issues in affirmative action similar to this paper; both use a game theoretic approach and one is focused on the labor market. Fu (2006) examines questions similar to those in my paper. Fu (2006) views college admission as an auction where one minority candidate and one non-minority candidate compete for one seat in the college. Due to discrimination in the labor market (or even just perceived discrimination), the minority candidate has less of an incentive to invest in the effort to get into college than does the non-minority student. Under certain affirmative action policies not only does the minority candidate exert more effort but, because of this increased effort and uncertainty over the amount of effort the minority candidate is exerting, the non-minority candidate also exerts more effort. Thus under affirmative action, total human capital may increase because both students exert more effort. While Fu (2006) has some very important results, the two-student, one-seat format does not get at the distributional issues of affirmative action.

Coate and Loury (1993) find that affirmative action in the labor market has an effect on training, similar to the effect that this paper finds on high school effort. They find that when affirmative action is instituted in the labor market, firms are forced to hire unqualified minorities to hit hiring targets and this lowers the incentives of minorities to invest in training; thus affirmative action in the labor market may actually widen the skill gap between minorities and whites.

The motivation for the model in this paper draws upon another strain of the literature. This paper models education in two stages. Other papers that have modeled education in two stages are Su (2004) and Driskill (2002).

This paper contains heterogeneous agents differing by the human capital of their parents and their race. Each individual decides the amount of effort to put forth in pre-college education and college education if they are accepted. The college (or colleges) sets a level of human capital needed to attend college. The main result of this paper shows that certain minority students will acquire less human capital under an affirmative action policy. This is due to the fact that when the affirmative action policy is enacted, some minorities who would have attended college without affirmative action now need to exert less effort in pre-college education to be allowed to attend college. Unlike the previous literature, the distribution of agents endogenously choosing effort levels in these two different stages allows for the examination of how the incentives of effort in school will be affected by the introduction of affirmative action.

II. The Model

There is a large number of students distinguished by two characteristics. The first distinguishing characteristic is race r; there are two racial groups which are called c for Caucasian and m for minorities (African-Americans and Hispanics)[4]; n_c will represent the number of Caucasians and n_m will represent the number of minorities. The second distinguishing characteristic is the stock of human capital of the student's parent. For the Caucasian students the parental distribution of human capital is F_c, while the distribution for the minority parental human capital is F_m. The mean and median of F_c are always greater than the mean and median of F_m.

Each student lives for three periods. The first period is ages 6 through 18, which are approximately the years of primary and secondary education. These will be called the "high school years." The second period, called the "college years," covers ages 18-22 and the final period is the rest of life, called "adulthood."

All students in the model attend school in the high school years, but not all students attend college. Whether a student attends college depends on the student's decision to attend college and the college's decision to admit the student.

[4] Grouping the two types of minorities together is done to simplify the model. Including two seperate types of minorities would not change the basic results.

In the high school years, the parental stock of human capital *h* is combined with the student's effort or time input e_1 to produce human capital h_1 according to the production function:

$$h_1 = A_1 e_1^{\delta_1} h^{\psi_1} \tag{1}$$

where $A_1, \delta_1,$ and ψ_1 are positive constants and $\delta_1 + \psi_1 < 1$. If a student does not attend college, he enters the labor force where his stock of marketable human capital is $h_1 = h_2$ until the end of life.

If a student goes on to college, the stock of human capital h_1 is combined with effort or time input e_2 and parent's human capital h to produce more human capital h_2 according to the technology:

$$h_2 = A_2 e_2^{\delta_2} h_1^{\psi_2} h^{\alpha} \tag{2}$$

where $A_1, \delta_2, \psi_2,$ and α are positive constants and $\delta_2 + \psi_2 + \alpha < 1$. Thus human capital is dependent on effort in college (e_2), how much human capital students enter college with (h_1) and parent's human capital (h).

For simplicity the majority of the analysis will consider the case where there is exactly one college, but later in this section a two college example will also be included. The college has a simple admissions policy. Each student is accepted if:

$$h_1 \geq \gamma_r \bar{h} \tag{3}$$

for some exogenous $\bar{h}$ where $\gamma_c = 1$ and $\gamma_m \leq 1$. If $\gamma_m = \gamma_c = 1$, the college admissions policy is race neutral. If $\gamma_m < 1$, college admissions use an affirmative action policy. The college also sets E, which is the total enrollment allowed, and follows a rule that any minority who chooses college and meets the admission requirement is given preference over a Caucasian. So the rule for the number of Caucasians allowed to attend college becomes:

$$NA_C = E - N_M \tag{4}$$

where NA_C stands for the number of Caucasians allowed into college (they must also meet the admission requirement) and N_M is the number of minorities who choose college and meet the admission requirement (3).

A wage function is included where w_2^r denotes wage per effective unit of human capital of college graduates of race r, and w_1^r denotes the wage rate per effective unit of labor for race r for high school graduates. Assume:

$$\begin{aligned} w_2^m &= \nu_2 w_2^c, \quad 0 < \nu_2 \leq 1 \\ w_1^m &= \nu_1 w_1^c, \quad 0 < \nu_1 \leq 1 \end{aligned} \tag{5}$$

so that ν_1 and ν_2 measure the extent of (perceived) wage discrimination in each of the two labor markets.

All individuals have identical utility functions:

$$U_r = \frac{1}{\sigma}\left[(1-e_1)^\sigma + \beta\left((1-e_2)\kappa w_1^r h_1\right)^\sigma + \beta^2\left(w_j^r h_2\right)^\sigma\right] \tag{6}$$

In expression (6) the term $(1-e_1)$ is interpreted as leisure in the high school years. The term $(1-e_2)\kappa w_1^r h_1$ is total wage income during college for a student who faces the wage w_1^r, has acquired human capital h_1, and allocates e_2 to studying so that $(1-e_2)$ units of time are left for work. If the student is not attending college κ =1 and if the student is attending college κ < 1 (students who focus on work full-time can earn a higher wage and full-time employment often carries benefits while part-time jobs seldom offer benefits). Finally, the term $w_j^r h_2$ represents the wage income during adulthood. For those who attended college $j = 2$; for those who don't go to college $j = 1$ and $h_2 = h_1$, meaning their post-college wage is the same as their post-high school wage.

Each student chooses effort levels e_1 and e_2 (if he attends college) to maximize utility in (6) given the college admissions policy and given the wages w_1^r, w_2^r. For those who have decided and are allowed to attend college the problem is:

$$U_{College} = \underset{e_1,e_2}{Max}\frac{1}{\sigma}\left[(1-e_1)^\sigma + \beta\left((1-e_2)\kappa w_1^r h_1\right)^\sigma + \beta^2\left(w_2^r h_2\right)^\sigma\right] \tag{7}$$

$$\begin{aligned} s.t. \quad & h_1 = A_1 e_1^{\delta_1} h^{\psi_1} \\ & h_2 = A_2 e_2^{\delta_2} h_1^{\psi_2} h^\alpha \qquad \left(= A_2 e_2^{\delta_2}(A_1 e_1^{\delta_1} h^{\psi_1})^{\psi_2} h^\alpha\right) \\ & h_1 \geq \gamma_r \bar{h} \end{aligned}$$

and for those students who have chosen to only attend high school the problem is:

$$U_{High School} = \underset{e_1}{Max}\frac{1}{\sigma}\left[(1-e_1)^\sigma + \beta\left(w_1^r h_1\right)^\sigma + \beta^2\left(w_1^r h_1\right)^\sigma\right] \tag{8}$$

$$s.t. \quad h_1 = h_2 = A_1 e_1^{\delta_1} h^{\psi_1}$$

So the actual problem for a student is:

$$Max\{U_{College}, U_{High\,School}\} \tag{9}$$

For those who choose to attend college this simplifies to:

$$U_{College} =$$
$$\underset{e_1,e_2}{Max}\frac{1}{\sigma}\left[(1-e_1)^\sigma + \beta\left((1-e_2)\kappa w_1^r A_1 e_1^{\delta_1} h^{\psi_1}\right)^\sigma + \beta^2\left(w_2^r A_2 e_2^{\delta_2}(A_1 e_1^{\delta_1} h^{\psi_1})^{\psi_2} h^\alpha\right)^\sigma\right] \tag{10}$$

$$s.t. \quad h_1 \geq \gamma_r \bar{h}$$

(Partial) Equilibrium

Given an arbitrary government policy of $\{\mathrm{E}, \gamma_{\mathrm{c}}, \gamma_{\mathrm{m}}, N_m\}$, a competitive (partial) equilibrium is a sequence of allocations $\{e_1, e_2\}_{i=1}^{n_c+n_m}$ for each household, stock of individual human capital $\{h_2^i\}_{i=1}^{n_c+n_m}$, and an aggregate stock of human capital such that:

(i) For all individuals, $\{e_1, e_2\}_{i=1}^{n_c+n_m}$ solves (9) subject to:

$h_2 = h_2(\gamma_r, E,)$

(ii) $\mathrm{N_m} = \sum_{i=1}^{U^r_{College} < U^r_{High\ School}} i$

where $\mathrm{N_m}$ is the number of minorities who want to attend college.

(iii) $\mathrm{H}_2 = \sum_{i=1}^{n_c} h_2^{c,i} + \sum_{i=1}^{n_m} h_2^{m,i} = \sum_{i=1}^{n_c+n_m} h_2^i$

(iv) Equation (4) is satisfied.

Given this definition of equilibrium, certain Caucasians who qualify under the admission requirement $\gamma_c \bar{h}$ may not be allowed in due to the cap on enrollment (E). If this is the case, the number NA_c will be the Caucasians with the highest human capital entering college.

The first order conditions for those who attend college are:

$$\begin{aligned}&(1-e_1)^{\sigma-1} = \delta_1\beta\left[(1-e_2)\kappa w_1^r A_1 e_1^{\delta_1} h^{\psi_1}\right]^{\sigma} e_2^{\sigma\delta_2-1} + \delta_1\psi_2\beta^2\left[w_2^r A_2 e_2^{\delta_2}(A_1 h^{\psi_1})^{\psi_2} h^{\alpha}\right]^{\sigma} e_1^{\delta_1\psi_2\sigma-1}\\&\left[\kappa w_1^r A_1 e_1^{\delta_1} h^{\psi_1}\right]^{\sigma}(1-e_2)^{\sigma-1} = \beta\delta_2\left[w_2^r A_2 (A_1 e_1^{\delta_1} h^{\psi_1})^{\psi_2} h^{\alpha}\right]^{\sigma} e_2^{\sigma\delta_2-1}\end{aligned} \quad (11)$$

For those who choose, or are forced, to attend only high school the problem simplifies to:

$$U_{HighSchool} = \underset{e_1}{Max}\frac{1}{\sigma}\left[(1-e_1)^{\sigma} + \beta(1+\beta)\left(w_1^r A_1 e_1^{\delta_1} h^{\psi_1}\right)^{\sigma}\right] \quad (12)$$

and the first order condition is:

$$\left(1-e_1\right)^{\sigma-1}=\delta_1\beta(1+\beta)\left[w_1^r A_1 h^{\psi_1}\right]^{\sigma-1} e_1^{\sigma\delta_1-1} \tag{13}$$

Since the equations from (11) are not linear in e_1 and e_2 and (13) is not linear in e_1 there is no choice but to solve both of these numerically.

III. Solving the Model and Results

To solve the model numerically, 3000 Caucasians (c) and 1000 minorities (m) are selected due to the fact that the U.S. Census reports that approximately 12% of the population is black and 14% is Hispanic. The U.S. Census is also used to help select the initial distribution of parents' income (the *h*'s). According to the 2000 Census of households, the mean and median incomes for White non-Hispanics, Hispanics, and Blacks were \$61,240 and \$45,910, \$42,411 and \$33,455, and \$40,067 and \$30,436, respectively. The distribution of the *h*'s is lognormal. For the minorities, the average of the Hispanic and Black mean and median incomes are placed in a lognormal distribution. Then a series of 3000 values for the Caucasians and 1000 values for the minorities are randomly generated until both mean and median income are within 1000 dollars of the above values for each group.[5] The mean and median income of the distributions are 61,239 and 45,938 for the Caucasians and 41,239 and 31,967 for the minorities.[6]

When selecting parameters, some intuitive rules are followed which match the U.S. economy in several areas. The first rule is that $\alpha \le \psi_1$. This implies that parents' human capital should not have more influence over their children's college performance than their high school performance. The second rule is that for all individuals $h_2 > h_1$.

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[5] For example, to set the distribution for the Caucasians we set 45,910=e^{μ} and $e^{\mu+(\sigma^2/2)}$=61,240.

[6] The *h*'s for the Caucasians are distributed log-normally with mean 10.73444 and a standard deviation of 0.75910 while the *h*'s for the minorities are distributed log-normally with mean 10.37179 and standard deviation 0.71463.

The final rule is that in a world with no college constraint (everyone who wants to be admitted to college is allowed in), high school effort (e_1) should be between 0.41 and 0.6 and college effort (e_2) should be between 0 and 0.6.[7] In the model with no college constraint, e_1 ends up being roughly between 0.41 and 0.59, and e_2 ends up roughly between 0 and 0.47.

The model matches the U.S. economy in four ways: the minority percentage of the total population, mean and median income of Caucasians and minorities (both of which were discussed above), enrollment rates of Caucasians and minorities in colleges, and the growth of human capital between generations. The model compared to the U.S. economy is found in Table 1 and the values of the parameters are found in Table 2. According to the Digest of Education Statistics, in 1999 the enrollment rates of 18-24 year olds in degree-granting institutions were 39.4%, 30.4%, and 18.7% for Whites, Blacks, and Hispanics, respectively. In the model $\bar{h}$ is set so that approximately 25% of minorities and 40% of Caucasians are allowed to attend college.[8] According to the Bureau of Labor Statistics the average annual growth rate of human capital (output per hour worked) is approximately 1.8%. A generation is between 25 and 30 years. Thus human capital should grow between 1.56 and 1.71 times from one generation to the next . In the model total human capital growth from one generation to the next is 168%.

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[7] These estimates come from the following informal analysis: grade school and high school students have roughly 84 waking hours a week (if they sleep an average of 10 hours a night). Those who do the bare minimum go to school about 7 hours a day 5 days a week, that is 35 divided by 84 hours or 0.41. Students who put out more effort could also add 2 hours of homework on week nights and 5 hours for the weekend, thus 50 divided by 84 hours or 0.595. Similar reasoning is used for e_2.

[8] If there was no $\bar{h}$ restriction in the model, whoever wanted to attend college could. This results in 2807 (93.4%) Caucasians attending college and 879 (87.9%) minorities attending.

Table 1: U.S Economy versus Model		
	U.S. Economy	Model w/o Affirmative Action
Percentage of the population that is minority	Blacks= 12% Hispanics= 14%	Minority=25%
Mean and Median Income (parent's human capital) for minorities (Average of combining Blacks and Hispanics)	Mean=41,239 Median=31,945	Mean=41,239 Median=31,967
Mean and Median Income (parent's human capital) for Caucasians	Mean=61,240 Median=45,910	Mean=61,239 Median=45,938
Enrollment rate of Caucasians in degree granting institutions	39.4%	43.5% (1305/3000)
Enrollment rate of minorities in degree granting institutions	Blacks= 30.4% Hispanics= 18.7%	23.6% (236/1000)
Growth of Human Capital Between Generations	156-171%	168%

Table 2: Parameter Values
$\beta = .99$ (Discount for different states of life)
$\frac{1}{1-\sigma} = \frac{4}{3}$ (Elasticity of intertemporal substitution)
$w_1^c = w_1^m = w_2^c = w_2^m = 1$
$A_1 = 6500$
$A_2 = 1150$
$\delta_1 = .04$ (Elasticity of h_1 w.r.t. time)
$\delta_2 = .51$ (Elasticity of h_2 w.r.t. time)
$\psi_1 = .2$ (Elasticity of h_1 w.r.t. parent's human capital)
$\psi_2 = .28$ (Elasticity of h_2 w.r.t. h_1)
$\alpha = .2$ (Elasticity of h_2 w.r.t. parent's human capital)
$\kappa = .6$ (Discount for not working full - time)
$h_c \sim \log normally(10.37179,\ 0.75910)$
$h_m \sim \log normally(10.37179,\ 0.71563)$
$\bar{h} = 57{,}000$

Table 3: Basic Results from the Affirmative Action Experiment				
	Caucasians		Minorities	
	W/O AA	With AA	W/O AA	With AA
Number (%) of students attending college	1305 (43.5%)	1154 (38.5%)	236 (23.6%)	387 (38.7%)
Percent of College Population	84.6%	74.9%	15.4%	25.1%

The first experiment reduces the threshold that minorities need to attend college and holds college attendance constant (thus for every new minority that attends college one less Caucasian is allowed to attend). The amount of human capital needed for minorities to attend college is reduced by 5.7% ($\gamma_m = .943$) because in the model this is the level of affirmative action that yields the result that minorities are the same percentage of the college population as they are in the population at large (note that the level of affirmative action is critical to the number of minorities in college). Now the number of college attendees, human capital, and effort levels for the entire distribution of Caucasians and minorities is examined.

There are both expected and surprising but intuitive results from this experiment. Some of the basic results are listed in Table 3. After affirmative action the percentage of minorities attending college increases from 23.6% to 38.7% and the percentage of Caucasians attending college falls from 43.5% to 38.5%. Prior to affirmative action the college population is 15.4% minority while after affirmative action it rises to 25.1%.

The distributional results are examined by plotting parents' human capital (h) on the x-axis and effort (e_1 or e_2) or human capital of the students (h_1 or h_2) on the y-axis. These results are displayed in Figures 1 through 8.

For the Caucasians the results are not surprising. Nothing changes for those who would either attend or do not attend college regardless of the affirmative action policy. Total human capital drops for those who attend college without affirmative action but are crowded out (from attendance) by the new minorities under affirmative action (Figure 1 - *h* between 52,100 and 57,741). The results for the other variables differ for each individual depending on his level of parent's human capital. Some of these individuals who were crowded out of college now have less human capital prior to the college years (Figure 2 - *h* between 52,138 and 57,289). These were the students who were induced to work very hard just to reach the entrance requirement ($\bar{h}$). The effort of these students without affirmative action is shown in the spike in the "No AA" series in Figure 3 (*h* between 52,138 and 57,289). Since they will not be accepted, they would rather consume more leisure in the high school years. Other Caucasians that were crowded out now have more human capital prior to the college years (Figure 2 *h* between 57,377 and 57,741) because they were not induced to make a large investment in human capital to reach college. Under affirmative action they only have one period to acquire human capital and have to live with it for two periods. See Figure 3 *h* between 57,377 and 57,741 for their effort levels.

Turning to the minorities, one expected result is that nothing changes for those who would not attend college prior to and with affirmative action (Figures 4-6 *h* less than 39,105). Another result, while intuitive, is surprising but speaks to a possible unintended consequence of affirmative action (and is the most important result of this experiment). Some minority students acquire less total human capital because of the affirmative action policy (Figures 4a and 4b *h* between 52,147 and 61,092). These are some of the individuals who would attend college with and without affirmative action. These are students who, in the state without affirmative action, were induced to exert a large amount of effort in the high school years just to meet the admission requirement (see the spike in Figure 6 for the No AA series and how their h_1 decreases in Figures 5a and 5b with affirmative action). With affirmative action these students do not need to work as hard in the high school years and end up entering college with less human capital. Therefore, they never accumulate as much human capital as they did without affirmative action. Other minority students (*h* greater than 61,092) who were not bound by the admission constraint on h_1 and go to college prior to and subsequent to the affirmative action policy end up with the same human capital in either state.

The minorities who are allowed into college only under affirmative action acquire more total human capital under affirmative action (Figures 4a and 4b *h* between 39,105 and 52,107). Similar to, but in the opposite direction of the Caucasians who were crowded out, some of the minorities who attend college only under affirmative action have more human capital prior to the college years under affirmative action (Figures 5a and 5b *h* between 39,105 and 42,774) and some have less (Figures 5a and 5b *h* between 42,909 and 52,107). The individuals that have more are the ones who under affirmative action are forced to exert a large amount of effort just to meet the new lower admission requirement (see the small spike in the "AA" series of Figure 6). For completeness college effort is included in the Appendix in Figures A1 and A2.

Table 4 measures how large the effects of affirmative action will be. As expected from Figures 1 through 6, Table 4 shows that some Caucasians (5%) have less human capital due to affirmative action. The most interesting result of Table 4 is that while

Figure 1
Caucasians: Total Human Capital

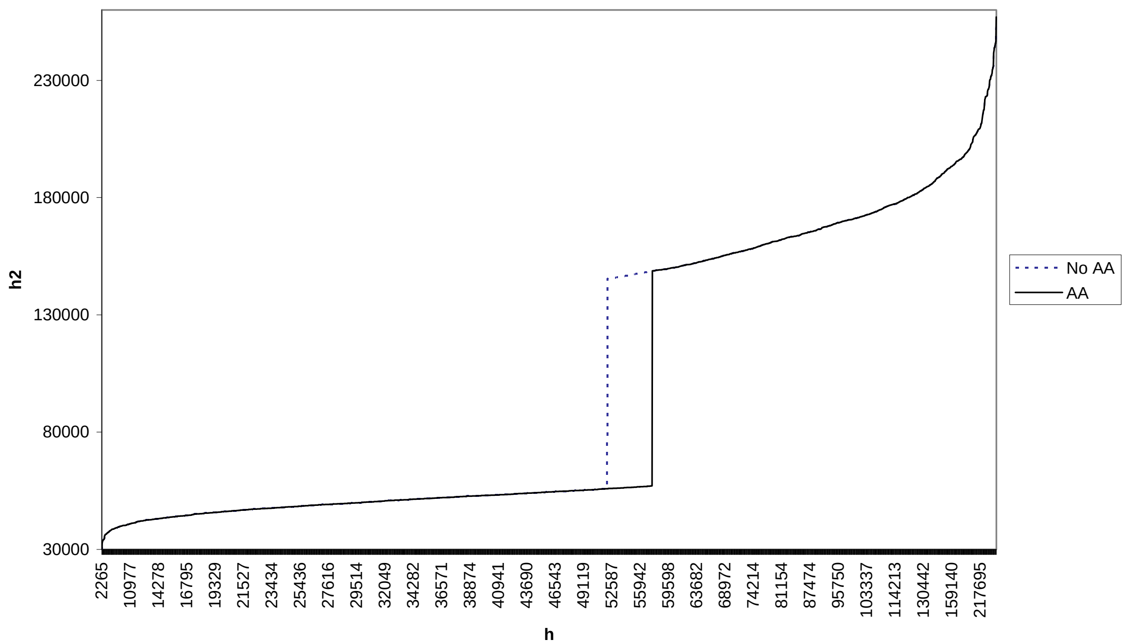

Figure 2
Caucasians: Pre-College Human Capital

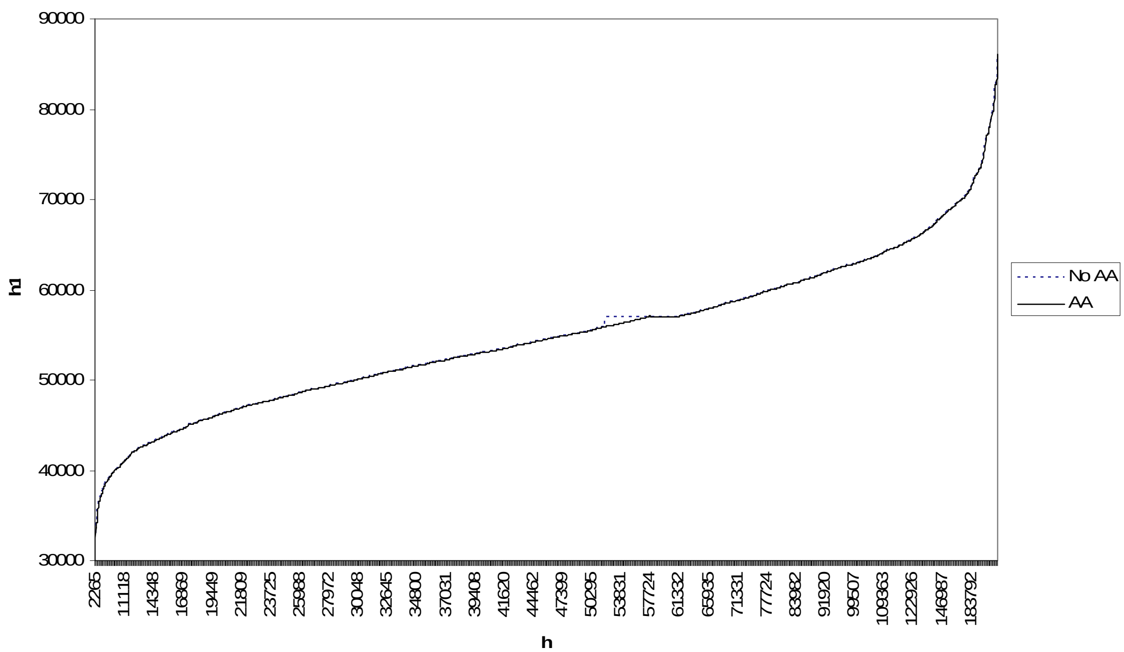

Figure 3
Caucasians: High School Effort

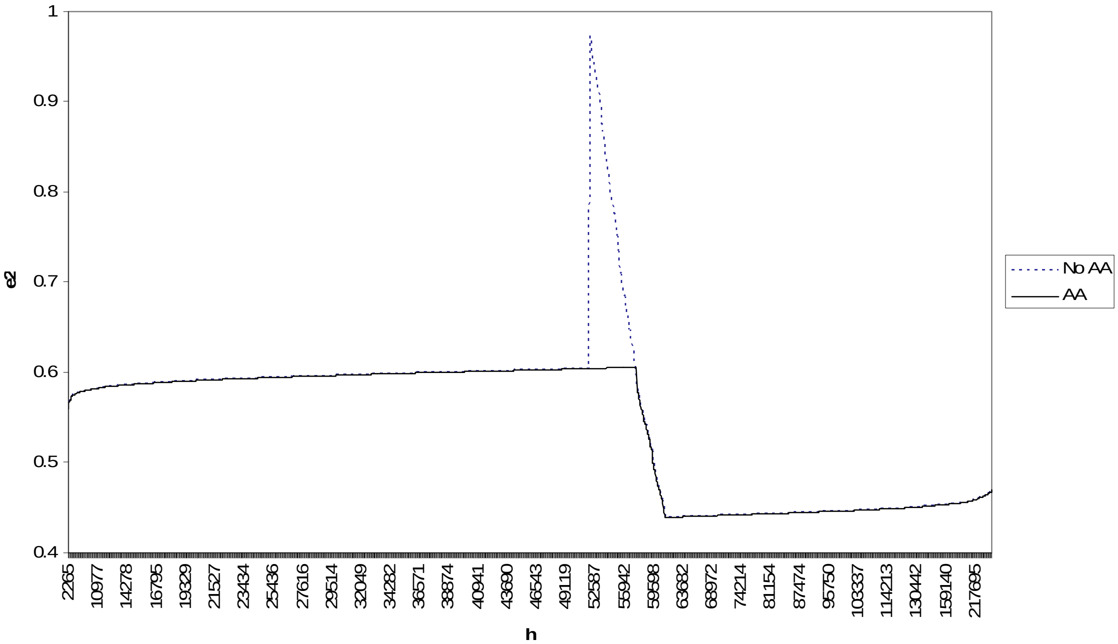

Figure 4a
Minorities: Total Human Capital

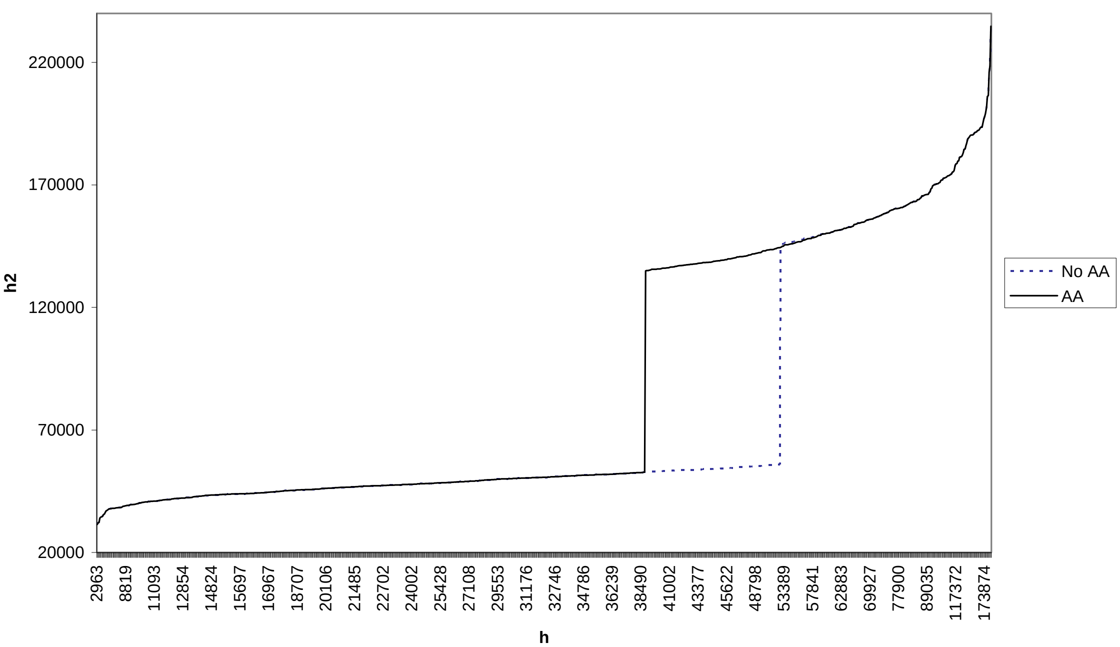

Figure 4b
Minorities: Total Human Capital (Closer View)

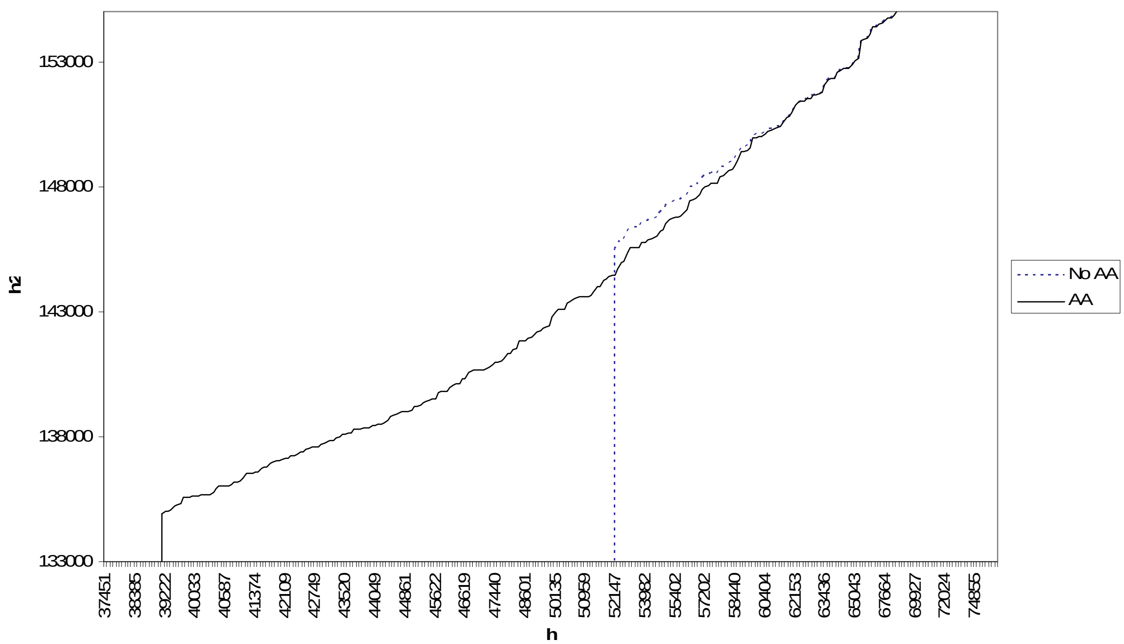

Figure 5a
Minorities: Pre-College Human Capital

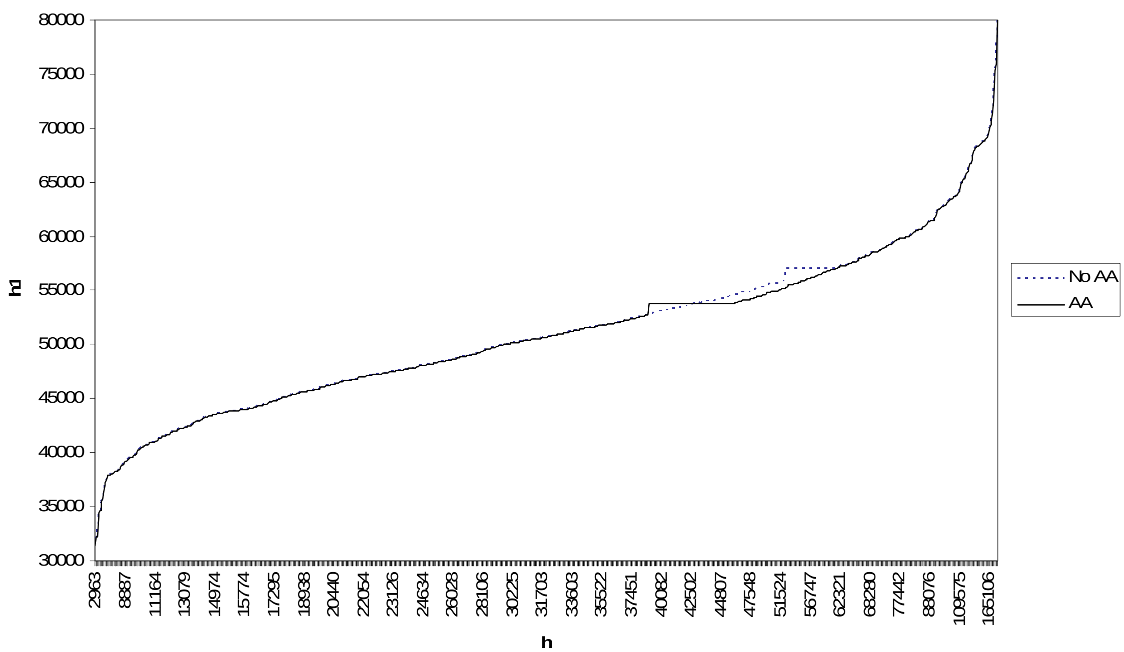

Figure 5b
Minorities: Pre-College Human Capital (Closer View)

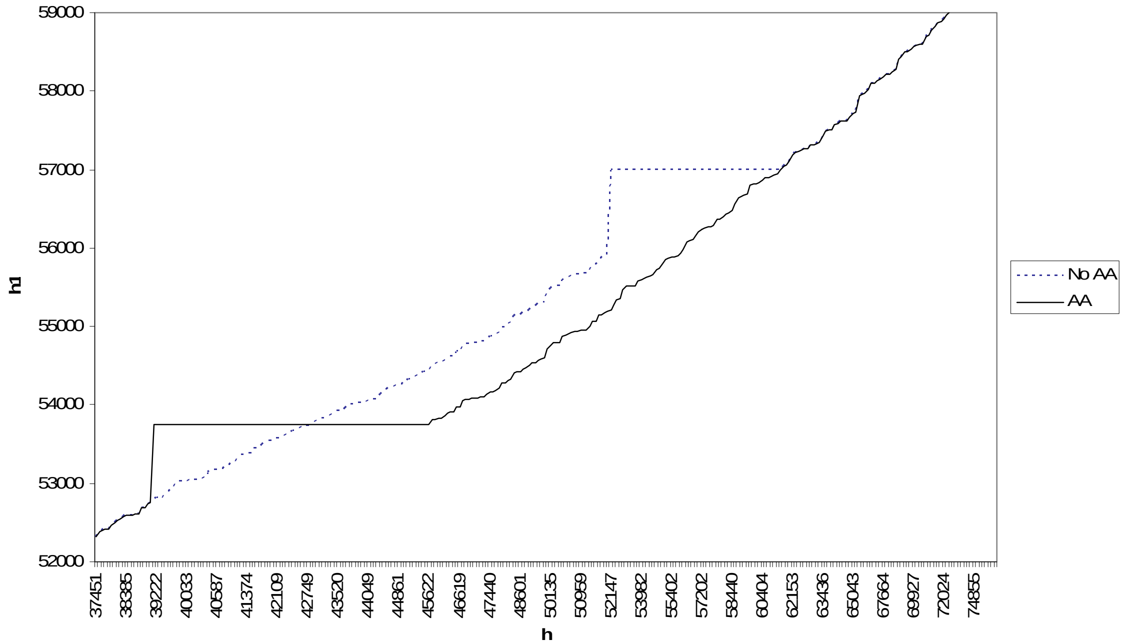

Figure 6
Minorities: High School Effort

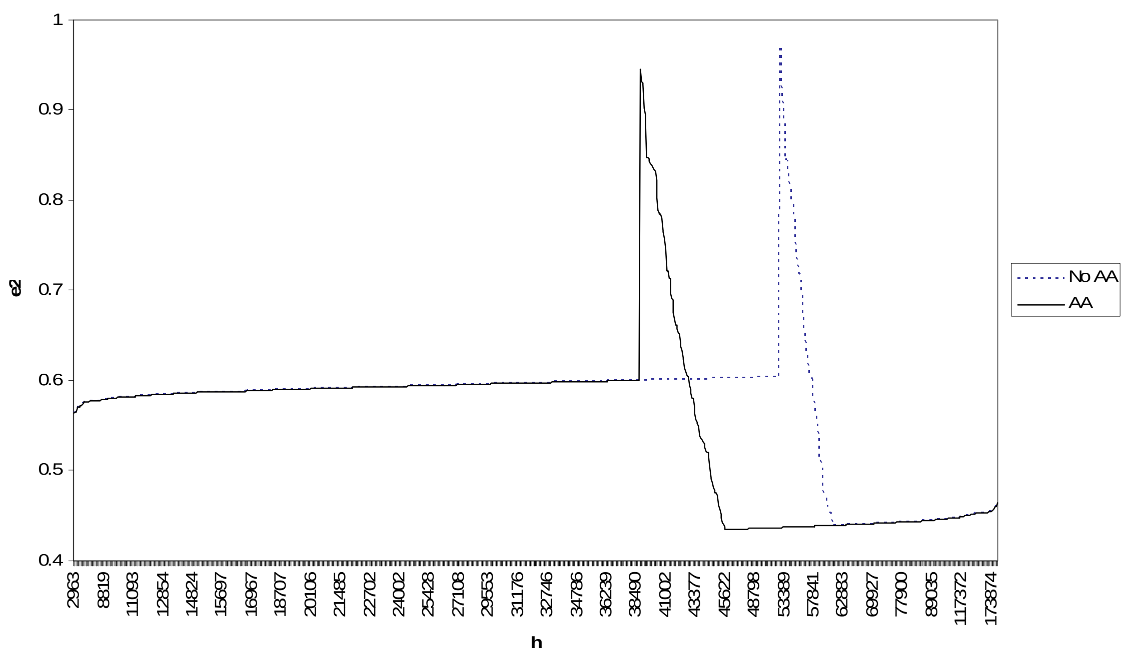

Table 4: Percentage of individuals with changes in human capital	
Percentage of minorities with more human capital after affirmative action:	5.7%
Percentage of minorities with less human capital after affirmative action:	15.1%
Percentage of Caucasians with more human capital after affirmative action:	0%
Percentage of Caucasians with less human capital after affirmative action:	5.0%
Percentage of population with more human capital after affirmative action:	1.4%
Percentage of population with less human capital after affirmative action:	7.6%

some minorities have more human capital (5.7%) due to affirmative action, a much larger percentage have less human capital under the affirmative action policy (15.1%).

Now the model is extended to two colleges, a "tier 1 college" and "tier 2 college" to see if the results will change. Again the percentage of individuals who attend college without affirmative action is set to match the U.S. economy. As in the U.S. economy approximately 25% of minorities attend college and approximately 45% of Caucasians attend college. The added restriction for this model is that 50% of the college population is allowed to attend the tier 1 college. Two affirmative action experiments are performed. The difference between the two colleges is that the tier 1 college provides a better education (in the following equations $A_2^E > A_2^S$). Specifically A_2^S is 5% smaller than A_2^E. If the individual attends the tier 1 college the human capital equation is:

$$h_2 = A_2^E e_2^{\delta_2} h_1^{\psi_2} h^{\alpha}$$

and if the individual attends the tier 2 college

$$h_2 = A_2^S e_2^{\delta_2} h_1^{\psi_2} h^{\alpha} .$$

Because the tier 1 college is also harder to get into, an individual needs more human capital after high school (h_1). Altering the model to include two colleges means that some of the parameters must be altered. Specifically A_1 now increases from 6,500 to 6,600, A_2^E equals 1,250, A_2^S equals 1,187.5, $\bar{h}^E$ (the minimum amount of human capital needed to get into the tier 1 college) equals 63,000, and $\bar{h}^S$ (the minimum amount of human capital needed to get into the tier 2 college) equals 57,500. The growth rate between generations is 1.78. Similar to the model with one college, certain Caucasians may meet the admission standards $\bar{h}^E$ or $\bar{h}^S$, but are not allowed to attend that college because the admission is capped. In this case the Caucasians with the highest human capital will be allowed to attend.

Now two experiments are performed. In the first experiment there is affirmative action in both colleges, so about 50% more minority students attend the tier 1 college and the affirmative action level is set at the tier 2 college so the same number of minorities attend with and without affirmative action. Again attendance is held constant in each school so that for each new minority allowed to attend a specific college a Caucasian is crowded out, and if fewer minorities decide to attend a specific college more Caucasians are allowed to attend, that is if they so choose and they meet the admission requirement. This is referred to as experiment 1. Specifically, examining Table 5, with affirmative action, 47 more minorities attend the tier 1 college (from 95 to 142). The same number attend the tier 2 college (157 in both cases). Some Caucasians are crowded out of the tier 1 college; 685 attend the tier 1 college under affirmative action down from 732. The same amount of Caucasian students attend the tier 2 college, but not all of these will be the same individuals that attended without affirmative action. Some of the Caucasians crowded out of the tier 1 college now crowd out some of the Caucasians whose parents had lower human capital from the tier 2 college.

In the second experiment there is only affirmative action in the tier 1 college (so about 50% more minority students attend), and again for each new minority allowed to attend a Caucasian is crowded out. This is referred to as experiment 2. Specifically, examining Table 6 shows that again 47 more minorities attend the tier 1 college. They move from the tier 2 college. Since there is no affirmative action in the tier 2 college these 47 students are not replaced by other minorities, thus 47 less minority students attend the tier 2 college. For the Caucasian students the movement between colleges is the opposite; those students crowded out of the tier 1 college simply attend the tier 2 college and no crowding out occurs. In this case the same number of minorities attend college with and without affirmative action, but the types of colleges they attend is different.

To accomplish these goals γ^{E}, the affirmative action in the tier 1 college, is set equal to 0.968 for both experiments, and γ^{S}, the affirmative action in the tier 2 college, is equal to 0.9795 in experiment 1. The results for both of these experiments are similar to the case of one college.

In experiment 1, where there is affirmative action in both colleges two groups of minorities end up with less human capital under affirmative action, and two groups of minorities end up with more human capital under affirmative action. First the two groups of minorities that end up with less total human capital due to affirmative action are examined. Group 1 (group 2) contains some of the students who attend the tier 1 (tier 2) college with and without affirmative action, and now that the admission requirement is

Table 5: Attendance in Different Colleges When Affirmative Action Exists in Both Colleges (Experiment 1)				
	Minorities		Caucasians	
	Tier 1 College	Tier 2 College	Tier 1 College	Tier 2 College
W/O Affirmative Action	95 (9.5%)	157 (15.7%)	732 (24.4%)	619 (20.6%)
With Affirmative Action	142 (14.2%)	157 (15.7%)	685 (22.8%)	619 (20.6%)

Table 6: Attendance in Different Colleges When Affirmative Action Exists Only in the Tier 1 College (Experiment 2)				
	Minorities		Caucasians	
	Tier 1 College	Tier 2 College	Tier 1 College	Tier 2 College
W/O Affirmative Action	95 (9.5%)	157 (15.7%)	732 (24.4%)	619 (20.6%)
With Affirmative Action	142 (14.2%)	110 (11.0%)	685 (22.8%)	666 (22.2%)

lowered they do not need to work as hard in high school to get into the tier 1 (tier 2) college. For group 1 (group 2) see graphs 7a through 9, h between 80,423 and 91,235 (h between 50,610 and 58,781). This is due to the same incentive structure that prevailed in the one college example; as the admission requirement is lowered minorities do not need to work as hard to get into their college of choice. Also note from Figure 10 all of group 2 and some of group 1 now exert more effort in college than without affirmative action, but still do not accumulate as much human capital as without affirmative action because they enter college with less human capital.

Now the two groups of minority students that end up with more human capital under affirmative action are examined. Graphs 7a through 9 demonstrate that those who previously attended the tier 2 college and are now able to meet the new lowered admission requirement at the tier 1 college (h between 68,280 and 79,960), and those who previously did not attend college and now can meet the lower admission requirement in the tier 2 college (h between 45,406 and 50,264) now end up with more total human capital.

Next the effects of affirmative action on Caucasian students is examined. The results are fairly straightforward. Those students who are crowded out of either college due to affirmative action end up with less total human capital, and they exert less effort in high school (see figures 11 through 14 h between 50,295 and 52,098, and between 80,198 and 83,396).

Now the size of the effects of affirmative action on human capital are examined. A larger percentage of minority students end up with more human capital after affirmative action, but a larger percent of the population ends up with less human capital under affirmative action (Table 7).

The results of experiment 2 are similar to experiment 1. The figures are included in the appendix (A3a through A10). The major differences are that there are fewer positive and fewer negative effects for minorities and fewer negative effects for Caucasians. First, no new minorities move from not attending college to attending college since there is no affirmative action in the tier 2 college. Second, since there is no affirmative action in the tier 2 school, no minority students who attend the tier 2 college with and without affirmative action end up with less human capital. Third, no Caucasians are crowded out of the tier 2 school as they were in experiment 1.

Figure 7a
Minorities: Total Human Capital
(Affirmative Action in Both Colleges)

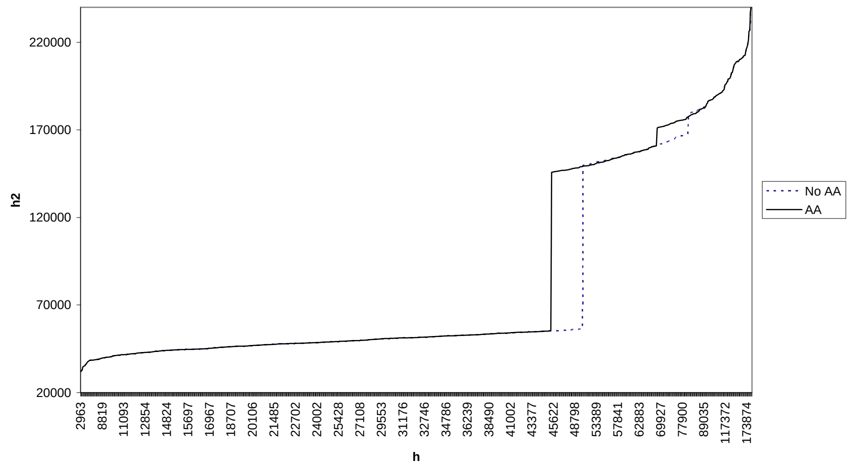

Figure 7b
Minorities: Total Human Capital (Closer View)
(Affirmative Action in Both Colleges)

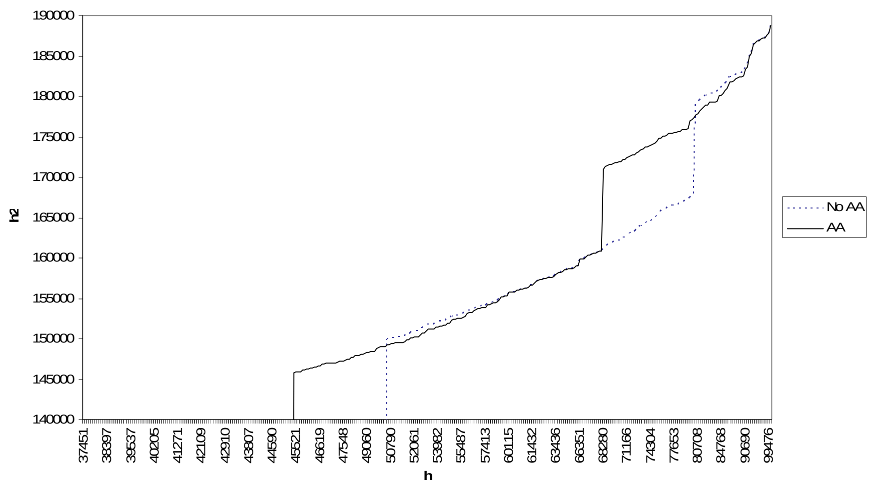

Figure 8a
Minorities: Pre-College Human Capital
(Affirmative Action in Both Colleges)

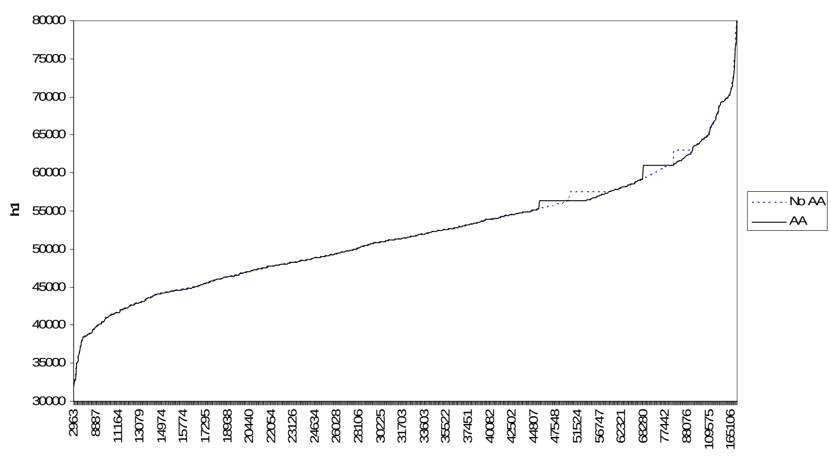

Figure 8b
Minorities: Pre-College Human Capital (Closer View)
(Affirmative Action in Both Colleges)

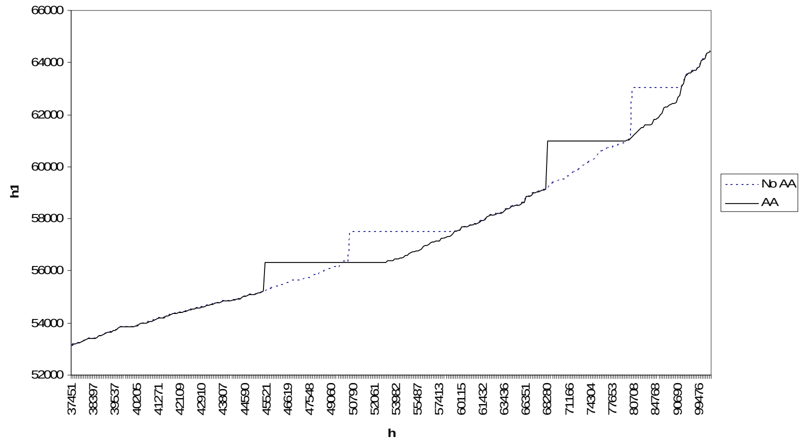

Figure 9
Minorities: High School Effort
(Affirmative Action in Both Colleges)

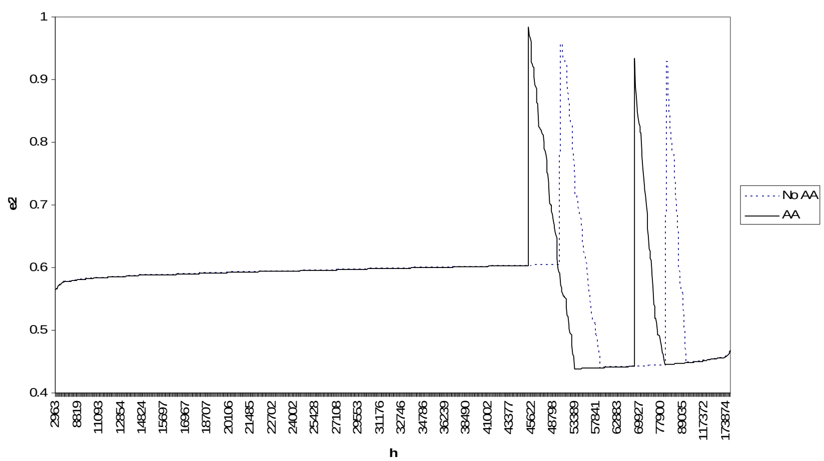

Figure 10
Minorities: College Effort
(Affirmative Action in Both Colleges)

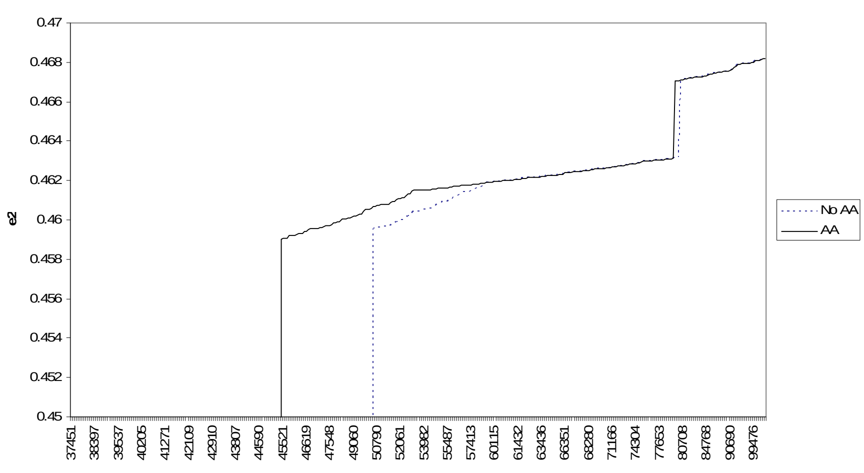

Figure 11
Caucasians: Total Human Capital
(Affirmative Action in Both Colleges)

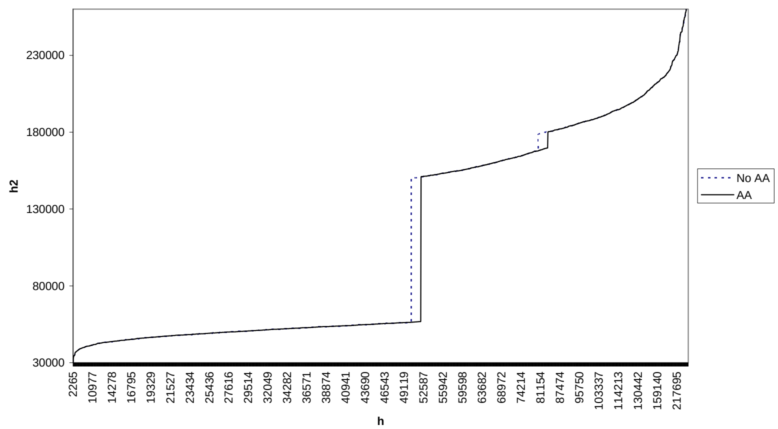

Figure 12
Caucasians: Pre-College Human Capital
(Affirmative Action in Both Colleges)

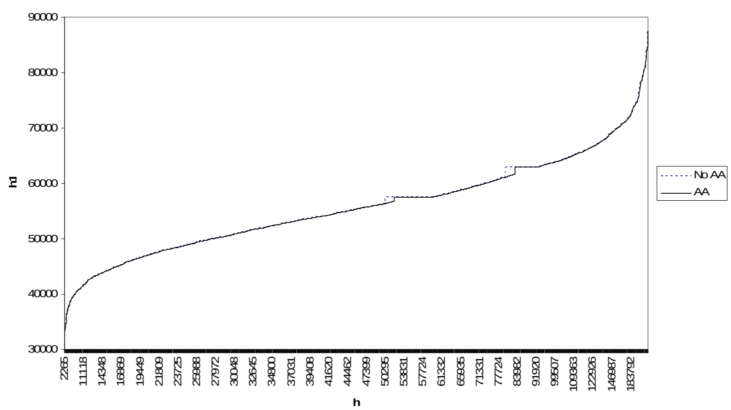

Figure 13
Caucasians: High School Effort
(Affirmative Action in Both Colleges)

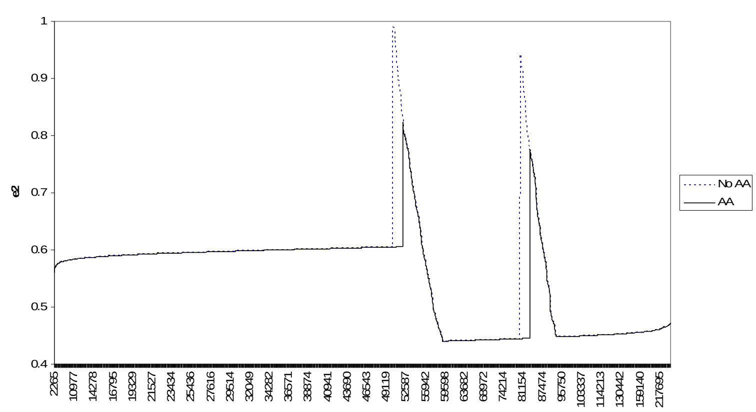

Figure 14
Caucasians: College Effort
(Affirmative Action in Both Colleges)

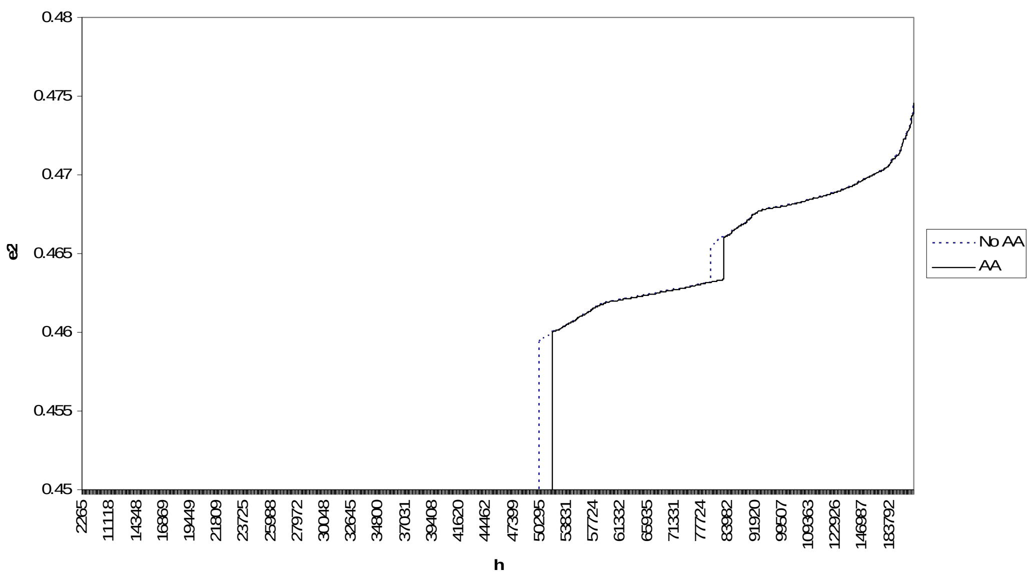

Table 7: Percentage of individuals with changes in human capital		
	A.A. in both Colleges	A.A. In Tier 1 Only
Percentage of minorities with more human capital after affirmative action:	9.4%	4.7%
Percentage of minorities with less human capital after affirmative action:	8.5%	2.7%
Percentage of Caucasians with more human capital after affirmative action:	0%	0%
Percentage of Caucasians with less human capital after affirmative action:	3.1%	1.6%
Percentage of population with more human capital after affirmative action:	2.3%	1.2%
Percentage of population with less human capital after affirmative action:	4.5%	1.9%

IV. Conclusion

This paper shows that affirmative action increases the enrollment of minority individuals, but it also has the unintended consequence of decreasing the human capital of some minority students already attending college in addition to reducing the human capital of some Caucasians. Future work should include expanding the model to compare an affirmative action policy to a colorblind policy where the college still tries to attain a certain level of diversity. Also, the model should be expanded to include colleges caring about the quality of student they admit. Since colleges, and schools in general, provide a unique service in that they partially depend upon customers (students) as inputs, if a college begins to admit a lower quality student it may lower the quality of its degree.

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Appendix

Figure A3a
Minorities: Total Human Capital
(Affirmative Action in Tier 1 College Only)

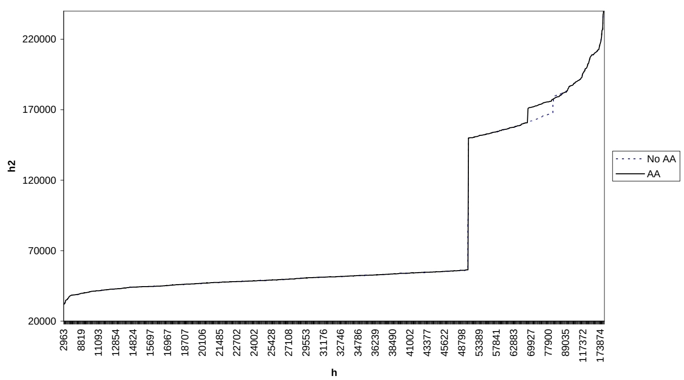

Figure A1
Caucasians: College Effort

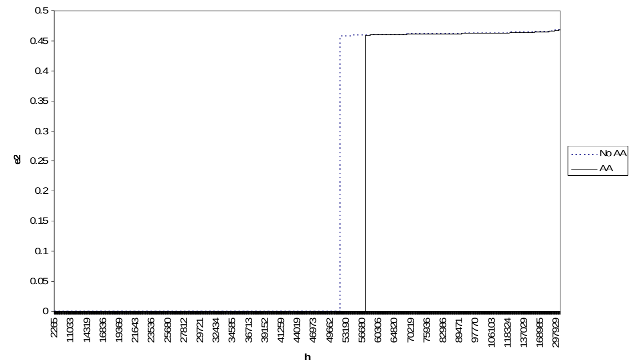

Figure A4a
Minorities: Pre-College Human Capital
(Affirmative Action in Tier 1 College Only)

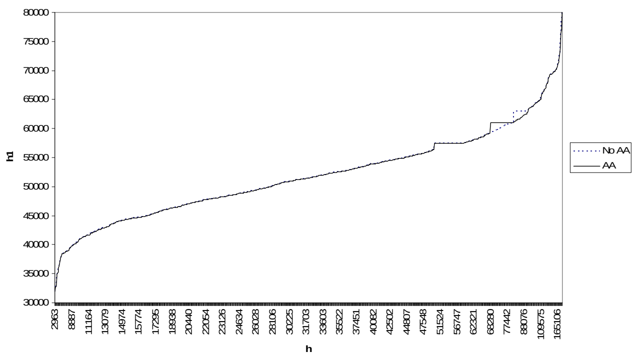

Figure A3b
Minorities: Total Human Capital (Closer View)
(Affirmative Action in Tier 1 College Only)

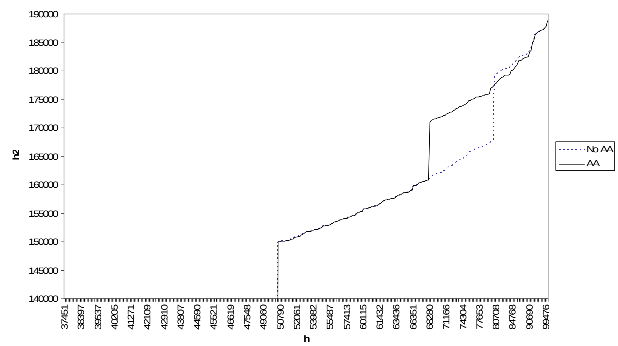

Figure A2
Minorities: College Effort

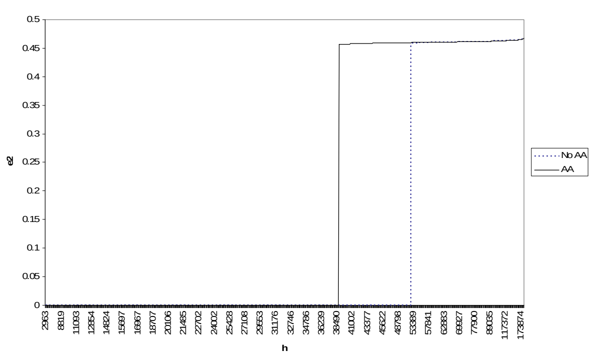

Figure A4b
Minorities: Pre-College Human Capital (Closer View)
(Affirmative Action in Tier 1 College Only)

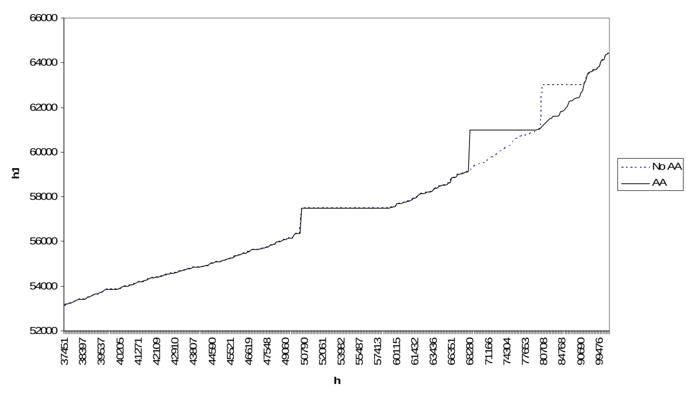

Figure A5
Minorities: High School Effort
(Affirmative Action in Tier 1 College Only)

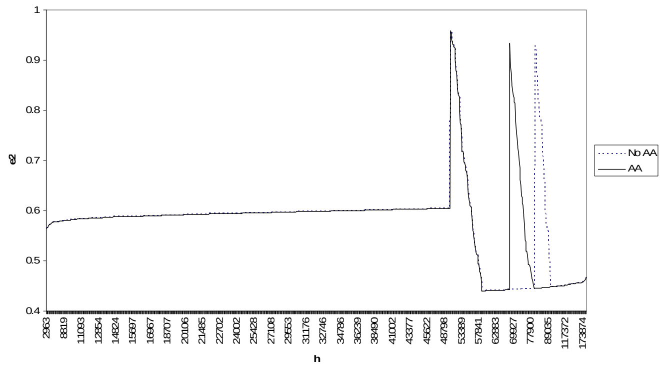

Figure A6
Minorities: College Effort
(Affirmative Action in Tier 1 College Only)

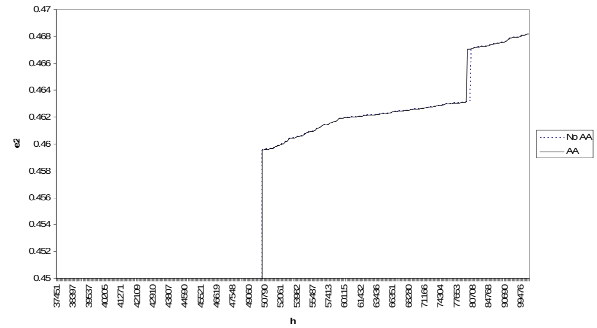

Figure A7
Caucasians: Total Human Capital
(Affirmative Action in Tier 1 College Only)

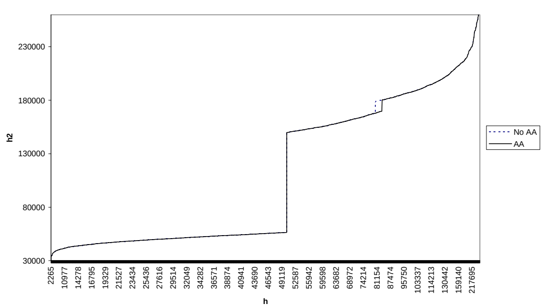

Figure A8
Caucasians: Pre-College Human Capital
(Affirmative Action in Tier 1 College Only)

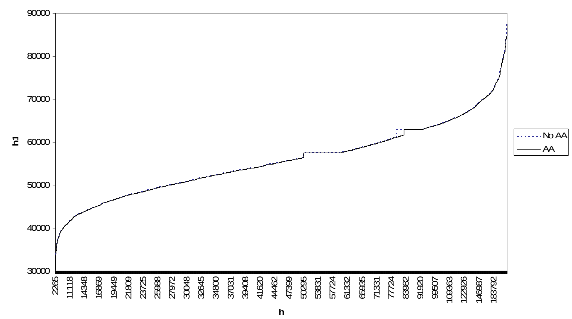

Figure A9
Caucasians: High School Effort
(Affirmative Action in Tier 1 College Only)

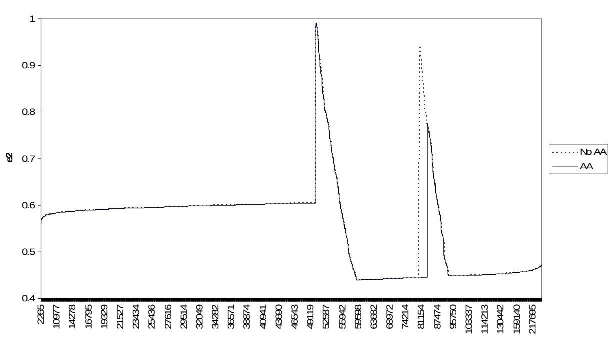

Figure A10
Caucasians: College Effort
(Affirmative Action in Tier 1 College Only)