School Structure and Academic Achievement: How the Middle School Model Affects Blacks and Whites

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Abstract

The black-white achievement gap is an inexplicable and damaging aspect of the school system. Previous research has suggested that differences in school structure between elementary and middle school play a role in determining motivation and academic success for black students. We utilize regression analysis on survey data previously collected through the Tennessee Student Teacher Achievement Ratio project and incorporate various measures of academic success, such as GPA, ACT scores, and CTBS scores. We use these to determine the impact of school structure on achievement across both races and confirm that graduating from elementary to middle school in the 5th or 6th grade has a differential negative impact on blacks. These results are robust to numerous specifications. Adoption of the middle school structure by school districts seems to be linked with decreasing academic performance in general and affects the achievement gap acutely. More distressing is that education has been defined by a shift to a middle school model over the past few decades. Policy implications of our research most include a reversion to the elementary school model, but are marred by possible selectivity bias in our data.

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1 Introduction

The black-white achievement gap is a longstanding, unresolved issue that exists within the educational realm. Since 1966, with the release of the Coleman report (Coleman et al.), research has demonstrated that black students consistently score lower on tests of academic achievement than their white counterparts. Despite slightly narrowing since its discovery, the black-white achievement gap has remained largely constant and, more importantly, inexplicable.

Numerous studies have made efforts to address what variables place black students at a disadvantage in academics and standardized testing. The two primary schools of thought are that the achievement gap stems from either a cultural bias towards educational success in the black community or that it is a manifestation of the correlation between race, socioeconomic status, and the resources that accompany it.

Evidence has been found going against both theories. For example, potential environmental variables such as school quality have been found to be insignificant (Levitt and Fryer, 2005) while cultural differences have shown to be nonexistent (Ferguson 2001, 2002). And while studies have been able to partially close the gap with different sets of regressors, no research has been able to fully explain the difference.

Previous research by Wang and Mirski (2009) suggested that, despite an absence of school effort and study skills, blacks approached academic performance levels comparable to whites in the years preceding the sixth grade. However, upon entering sixth grade, the gap drastically widened once more. Further analysis determined a significant difference in the black-white achievement gap for students who transferred from one school to the next in summer between grades 5 and 6 compared to those who did not. They posited that the widening of the black-white gap stemmed from the transition from elementary to middle school.

Additional research found that the transition from elementary is accompanied by a decline in motivation and self-esteem (Simmons and Blythe 1987), a decline in academic performance (Alspaugh and Harting 1995), an increase in disciplinary infractions (Cook et al. 2007), among a host of other academic, social, and disciplinary troubles. While puberty has been suggested as a potential underlying factor, the overwhelming consensus is that middle schools are larger, less personal, and place a greater emphasis on discipline and competition (Bedard and Do 2005). Furthermore, sixth graders become the youngest in their grade configuration and are exposed to the negative influence of older youth, which may negatively affect

academic performance.

Although advocates believe that middle school provides an environment separate from both younger and older children, who would exert a negative influence academically and socially, research has found that the movement to this school structure system is associated with a 1% to 3% decrease in timely graduation rate. (Bedard and Do, 2005) More notably, because on time graduation rates indicate the performance of weaker students, these findings suggest that the middle school most adversely affects weaker students.

Based on the aforementioned findings, it is troubling to note that the trend in school structure has been towards a middle school model, with 58% of sixth graders in 2001 enrolled in middle schools, up from 33% in 1986. Based on our own research, it may also be that not only are all students affected by the elementary-middle school transition, but black students are more severely affected than their white counterparts.

It is critical that the middle school model be further examined to determine whether it is a detrimental school structure for the education of both blacks and whites. In order to do so, this paper will examine the effects of the middle school model on grade point average (GPA), Comprehensive Test of Basic Skills (CTBS) scores, and on time graduation rates of black and white students.

2 Materials and Methods

For this study, data from the Tennessee Student Teacher Achievement Ratio (STAR) project was used. This data was originally meant for an analysis of the effect of classroom size on student achievement. The four-year longitudinal study was funded by the Tennessee General Assembly and included 79 public schools in Tennessee and over 7000 observations. The study was conducted for elementary school students, but after its conclusion, participants were tracked and contacted in eighth grade and high school. Moreover, since STAR contains numerous categories that identify race, academic achievement, and other covariates, the dataset lends itself particularly well to an analysis of the black-white achievement gap.

In particular, the dataset includes a measure of a school's grade span. Most schools in the dataset have students from kindergarten through sixth grade, but range from kindergarten to third grade through kindergarten through eighth grade. Descriptive statistics are shown in table (1). A variety of measures were used as a proxy for student achievement. Since the dataset includes both high school GPA figures as well as ACT scores, we are able to estimate the effect of a certain year of

graduation on academic achievement later in life. We also have 8th grade achievement figures for math, reading, science, vocabulary, and social studies from the Comprehensive Test of Basic Skills (CTBS). All CTBS administered tests range in value from 100 to 900, while ACT scores range from 1 to 36. GPA is given in terms of an average percentage.

Grade range of a school is displayed in terms of numeric integers, with 3 representing a school that administers kindergarten through fourth grade. Each school starts in kindergarten, with the vast majority of students (49.6%) in schools that range from kindergarten through sixth grade. However, since we do not have information on middle and high school grade ranges, we are not able to explicitly track where students go after they graduate from their first school. We assume that high school begins in 9th grade, and that students move on to schools with the next grade upwards. This means we assume that a student who attended a kindergarten through sixth grade school will next attended a seventh through eighth grade middle school and then move on to high school. However, this assumption may be biased, especially for the lower grades. This may occur because of the fact that schools ranging from for instance kindergarten to third grade may have an intermediate school between its middle school and high school. The cases for these lower range schools must thus be considered separately from the longer range schools. However, the assumption that students move to a middle then high school for high range starting schools should be strong enough, at least past the kindergarten through fifth grade schools.

We then proceeded to create a mathematical model of the black white achievement gap. This model was an extension of Derek Neal's (2005) intergenerational model. However, this paper extends the model to include a static state that accounts for different preferences and dispositions between black and whites. The model is a utility function in the form of a modified Cobb-Douglas production function. We then use diminishing marginal returns on education to formulate a steady state for each generation of parents and children, and derive an equation for the relative differences in human capital between blacks and whites. This model served as a useful starting point to begin understanding the reasons and factors that lead to a black-white achievement gap, and to identify how graduation year may affect the gap.

To empirically assess the impact of graduation year on the black white achievement gap, we ran multivariate ordinary least squares (OLS) regressions to determine the extent of the achievement gap. First we created a measure of the raw achievement gap for all students in the dataset. To create these, we created a binomial

variable "black" that is coded 0 for white students and 1 for black students. All other races were dropped from the sample. Thus, when regressed for an achievement measure such as ACT score or GPA, the coefficient on the binomial variable black should give the average differential achievement between blacks and whites for that particular achievement measure. For instance given the equation $Y = \beta_1 Black + \epsilon_0$, β_1 would give the standard deviation difference between blacks and whites in test score measure for a standardized achievement measure Y, with standard deviation 1 and mean 0. We conducted this regression for various measures of achievement. Next, we included numerous covariates in these regressions, such as free lunch eligibility, age, gender, grade level, and others, to find a standard deviation difference in academic achievement with controls in place. These allowed us to get a better measure of the true difference between black and white students irrespective of other factors, such as family background or age.

After we obtained estimates of the average black white achievement gap in standard deviations from the previous regressions, we looked at how much of the raw and controlled differences were attributable to graduation year. First, we attempted to see the effects of graduation year on the average achievement measures, irrespective of race. To perform these regressions, we created binomial variables that denoted the grade range of the school that a student entered into. These regressions allowed us to calculate the average effect, with and without controls, of graduating from a middle school of a certain grade range. Thus, we coded these binomial variables to equal 1 if the student had attended the school with a specified grade range, and 0 otherwise. For instance schk4 (School K-4) is coded 1 for all students that attended a school that served students from kindergarten to fourth grade, and 0 for all other students. We created a matrix of binomial variables that included each of the school grade ranges available in the STAR dataset. Although we do acknowledge the fact that this way of identifying the graduation grade may be erroneous in some areas, for instance for students who migrate from one school to another, we believe that the rate at which transfers and other unique events occur is low enough to yield a good estimate. For our analysis, we shall assume that the end grade for the school grade range represents the graduation year. We also do not need to worry about students who have not graduated yet, since the progressive STAR study followed all students until high school.

With the binomial variables of graduation year in place, we then regressed various achievement measures with the binomial variables as covariates. We dropped the sixth grade graduation variable for our regression, as it contained the largest amount of observations and would thus represent the smallest amount of variation when

analyzing the error term. This is because a regression with the complete matrix of binomial variables would be nonsensical, since each would equal 1. This essentially forces our regression through certain points and biases the results to the point where they are untenable. Thus, in order to analyze the regression, we must drop at least a single variable. Dropping the variable with the most observations means that its coefficient will be included in the error term. Since this variable has more observations, its variability will be lower, allowing for a better prediction of its coefficient. Of course, there are also extraneous parts in the error term, which can be viewed as the genuine error. We will not be able to distinguish the genuine error from the coefficient on sixth grade, but this does not mean anything more than placing another variable with the error term, since the error term gives a sense for how far off the coefficients from the regression shall be. Thus, this method has completely the same effects as a normal multivariate OLS regression, but with the sixth grade graduation year coefficient in a different position.

After the averages for all races were run using the graduation year binomial variables, both with and without controls, we created new binomial variables that accounted for race. We simply coded the binomial race indicator variable with the graduation year variable. This new variable we term as the $schk(n)black$ variable, where (n) denotes the graduation year of an individual. The term equals one if the student graduates in year (n) and is also black. Otherwise the variable is equal to 0. For example, the $schk4black$ variable will equal 1 if the given observation is both black and graduates from a school with a grade range spanning kindergarten to fourth grade. If only one of these conditions are met, or none of them, then the variable is coded 0.

These new binomial variables will now allow us to determine the differential impact of graduation year on black-white achievement. A multivariate OLS regression will be run to estimate the impact of graduation year on a given achievement measure. These achievement measures will be varied and include standardized tests and GPA. They span a number of years after graduation from the student's principal study school. This allows the full effects of graduation from a certain year to be observed, since it usually takes time for these effects to be revealed, especially in schools that may focus more on teaching to the test and less on a student's actual pursuit knowledge. However, waiting longer to test leaves room for other factors, including new teachers, different schools, varying social atmospheres, and changes in study habits. Thus, striking a balance in the length of time after graduation to test students is critical in reducing variation. We choose tests conducted in the eighth grade and the first three years of high school. Each test and achievement measure

will be regressed from the same year, allowing for a solid baseline for that year.

The baseline regression will be of the form $Y = \beta_1 Schk(n) + \beta_2 Schk(n)black + \beta_3 X + \epsilon_0$, where $Schk(n)$ is a vector of all graduation year binomial variables excluding sixth grade, $Schk(n)black$ is a vector of all multiplicative graduation year and race binomial variables, and where X represents a vector of all control covariates. The control covariates change across regressions. These include number of years in classes with low student-teacher ratios, gender, number of class aides, free lunch eligibility, school urbanity, teacher's highest degree attained, the teacher's number years of experience, days a student was present at school, and test measures that evaluate a student's study skills and non-participation scale. These last two measures come from the CTBS, where the study skills test measures "the ability to carry out independent study using information-processing skills that [students] can apply across subject areas" and the non-participation scale measures a student's engagement in extracurricular and co-curricular activities. The covariates for these regressions were chosen to provide a parsimonious set of regressors that would vary with each achievement measure. The changes in regressors allows for a better understanding of how each variable interacts with the other, and allows us to spot potential biases in the data more easily.

3 Results

3.1 Model Results

This model is an extension of Derek Neal's (2005) intergenerational model of the black-white achievement gap. Neal begins by creating a utility function based on a number of assumptions. First, Neal creates a world in which a family consists of a single parent and a single child. During each period, every mother will have a child and families are restricted to having two members. Neal distinguishes between parents and children by placing them in groups. During each time period, children and parents change groups, where children turn into parents, having their own children, and parents die off to form a third nonexistent group.

In Neal (2005), parents have complete control in decisions about their child's investment in human capital. The parent can either decide to invest in a child's education or spend money on current consumption. The parent, moreover, receives utility from improving a child's human capital, although only in the future. We denote c as current household consumption, h as a parent's human capital, and h' as a child's human capital. Thus, we can derive a utility function for the parent

of the form $U(c, h')$, where the parent gains utility from both current household consumption and future improvement's in a child's human capital. Neal believes that the assumption that parents gain utility from their children doing well is justified, since most parents are happier when their children succeed in school and life.

Next, Neal develops the constraints on each child for developing human capital. He posits that human capital is determined by innate ability, θ, the effective amount of time that a parent spends with the child, sh, and the purchased inputs that a parent spends on a child, d. Thus, Neal develops the following function for a child's human capital: $h' = g(\theta, sh, d)$. Parents will spend time either with their child, s, or working to obtain money for household consumption $(1-s)$. Thus, sh represents how effectively a parent spends time with her child, depending on the parent's own human capital and the time spent. Given a rate of 1 unit of income per unit time, $(1 - s)$ represents the amount of income a parent obtains for either household expenses or inputs for their child. Using these expressions, we can formulate an equation for income: $(1 - s)h = pc + td$, where p is the price of a consumption good and t is the price of investment in a child. Recall that d is the amount of purchased inputs for a child. Thus, a parent spends income with either household consumption or purchasing educational inputs for their child (which would represent, for example, schooling and tutoring). In addition, the parent partitions her time between work and her child.

Neal then considers a specific utility function that incorporates diminishing marginal returns. Neal argues that a parent's utility function will be concave down. This means that with increasing consumption and human capital in one's child, a parent will gain less and less utility. Diminishing marginal returns, moreover, can be justified by empirical data. Countries with extremely high GDP per capita are no happier than countries with high GDP per capita, but much happier than countries with low GDP per capita (see Easterlin 1974). Thus, Neal formulates the following constraints on the utility function:

$$U(c, h') = \ln(c) + \alpha \ln(h')$$
$$h' = \theta(sh)^{\gamma}(d)^{\sigma}$$
$$\gamma > 0, \quad \sigma > 0, \quad (\gamma + \sigma) < 1$$

Thus, Neal includes an augmented version of the Cobb-Douglas production function in his formulation of a child's human capital. Neal also adds α to adjust for the relative difference in magnitudes between consumption and child's human capital.

With the constraints given, Neal then derived a equation for a child's human capital throughout generations.

$$\ln(h') = \ln(\theta) + (\gamma + \sigma)\ln(h) + k(\alpha, \gamma, \sigma) - \Delta \ln(t),$$

where k is a function determined by its function parameters. Next Neal develops a static state variation of human capital, regardless of the time period. This inter-generational model, however, assumes that $k(\alpha, \gamma, \sigma)$ is the same for both blacks and whites. Neal also assumes that there is no difference in innate ability between the two races. Thus, Neal creates an equation that gives the difference in human capital between blacks and whites with the following: $\Delta \ln(h) = -(\sigma)/(1 - \gamma - \sigma) * \Delta \ln(t)$, where Δ denotes the difference between blacks and whites. However, Neal's model does not account for differences in preferences and cost functions between blacks and whites. Abstractly, Neal assumes that blacks and whites will invest in education in the same manner. We believe this assumption to be unrealistic, and thus augment the model to include these assumptions. Thus, the term $k(\alpha, \gamma, \sigma)$ does not go to zero when we measure the difference between blacks and whites. Thus, the new version of the Neal model becomes

$$\Delta \ln(h) = \Delta k_j(\alpha, \gamma, \sigma) - \Delta \ln(t)$$

, where k_j is function of preferences distinct from k. Here, k_j includes the differential biases in investment and consumption that occur between blacks and whites. Also, $\Delta \ln(t)$ represents the difference in cost between blacks and whites for investing in their children. This model thus allows one to see that test score differences arise through various mechanisms, which will be discussed in the conclusion and discussion sections.

3.2 Empirical Results

Results for an estimation of the black white achievement gap in the STAR dataset are displayed in table (2). The regression includes the binomial race variable and a measure of academic achievement, measured in standard deviations from the mean for each observation. The average raw difference between blacks and whites for all achievement measures used in table (2) is -0.518 standard deviations. The average controlled difference is -0.428 standard deviations. Thus, although the parsimonious set of controls explained part of the gap, the large majority of the achievement gap is still left unaccounted for. Also, there are interesting results among the different

tests of achievement. Black students perform in a consistent fashion on most of the CTBS scales, such as math, reading, science, and vocabulary. However, blacks do much better relative to whites in spelling and eighth grade GPA, with only a -0.178 and -0.268 standard deviation raw gap respectively. However, black tend to do much worse on the ACT, with a standard deviation of -0.761 for the raw estimation. This performance, moreover, is even worse than the CTBS total battery results, which come from another standardized test.

The results of the multivariate regression with graduation year binomial covariates are displayed in table (3). On the odd numbered columns, a regression with only the graduation year variables is displayed, and the even numbered columns display a regression with other control variables. Each pairing of two columns has different achievement measures as the independent variable, but the same covariates for the dependent variables. Since the $schk(n)$ variables are coded as binomial variables, with either 1 or 0, the coefficient can be interpreted as the difference from the mean test score in terms of standard deviations. Across all achievement tests, both with and without controls, we find that graduating from sixth grade has a negative coefficient. The $schk6$ variable is statistically significant at the 0.001 level for all the regressions except the one with controls using GPA as the achievement measure. Other variables have statistical significance on certain regressions. None of these variables, however, has the consistency or pervasiveness of the negative value for the $schk6$ variable. The only other obvious trend is the negative coefficients on the fourth grade graduation variable. Although not all the coefficients are statistically significant, the large majority of them are negative.

Table (4) presents results for regressions that include the multiplicative graduation year and race binomial variable. These regressions include both $schk(n)$ and $schk(n)black$ to allow for examination of the interaction between race and graduation year. Table (4) uses the CTBS Total Battery Scale Score as the achievement measure, which is a weighted average for all examinations from the CTBS exam for eighth graders. The most notable trend is that, with added regressors, $schk5black$ is always negative and statistically significant at the 0.001 level. Also interesting is how the $schk4$ variable is always negative and statistically significant to at least the 0.01 level. Like in table (2), we are not able to eliminate the achievement gap completely, though we are able to significantly decrease its magnitude by adding controls.

Examining tables (5) and (6) give similar results to those in (4). In particular, for eighth grade math and reading test scores, we find that $schk5black$ has much the same effects as it did for the total battery score. In each regression, for both math and reading, the $schk5black$ coefficient is negative and statistically significant

to at least the 0.01 level. Table (7) displays the baseline regression used in tables (4), (5), and (6) on a different achievement measure, the CTBS Science scaled score. Using science as the achievement measure changes the outcome of the regression, as the schk5 variable is no longer statistically significant. However, the *schk*5*black* term is negative and statistically significant for four out of the six specifications. The gap remains both economically and statistically significant, hovering at about -0.4 standard deviations across differently specified regressions. The coefficients on the regressions in table (7) with controls are relatively larger than the corresponding coefficients for those using math or reading as the achievement measure. The raw gaps between these, however, are not significantly different.

The same baseline specification is again run using the CTBS Social Studies scaled score as the achievement measure in table (8). Here, like with the other measures, the achievement gap is still large and statistically significant. However, *schk*3 has positive and statistically significant coefficients across most of the specifications. Also, *schk*8*black* is positive and statistically significant at the 0.001 level for all the specifications. However, the *schk*5*black* variable is only significant in some cases, and even in those cases, statistical significance reaches only the 0.01 level. However, the variable is significant to at least the 0.05 level for four out of the six specifications.

Table (9) uses the same baseline specifications, but with the CTBS Spelling scaled score as the dependent variable. Here, the achievement gap is completely accounted for by the control variables. In columns 5 and 6, moreover, the coefficient on black turns statistically significant and positive. This coefficient, however, also includes the sixth grade group excluded in the specification, which means one cannot interpret the result as closing the achievement gap. This effect will be discussed in more detail in the conclusion section. The other variables show similar trends to previous regression results. The *schk*5 variable is statistically significant to the 0.001 level and positive for all specifications, while the *schk*5*black* variable is negative and statistically significant to the 0.001 level.

Table (10) again uses the same baseline specifications, but the CTBS Vocabulary scaled score is used as the achievement measure. The results are similar to table (9), with most of the same trends recurring. The corresponding coefficients are also of similar magnitudes. The coefficient on black, however, is still negative and statistically significant, like all the achievement measures other than spelling.

Table (11) uses a completely different measure of achievement, namely the ACT test. This measure examines performance well after graduation from the initial middle school, as it was administered in the last two years of high school for the majority of the sample. The baseline specification shows that the raw ACT gap is

larger than any previous achievement measure. The coefficient on black in the first specification in column 1 without any controls is -0.716, while the coefficient on the CTBS Total Battery examination scaled score was -0.601. The *schk*5 variable is again positive and statistically significant across all specifications to the 0.001 level. The *schk*5*black* variable is more ambiguous than previous achievement measures, but still is negative and statistically significant, at least to the 0.05 level, for all specifications. Also, the *schk*8 variable is positive and statistically significant to the 0.05 level for all specifications-a trend that appeared for spelling as well.

Table (12) uses high school GPA as the dependent variable. With a number of specifications using this measure of achievement, the black coefficient is statistically indistinguishable from zero. This achievement measure has the common trend of a positive and statistically significant coefficient on *schk*5 for all specifications, but is ambiguous for the coefficient on *schk*5*black*. All coefficients on *schk*5*black* are negative, but two out of the six specifications are not statistically significant from zero. The *schk*8 coefficient is positive and significant for all specifications, while *schk*4 is negative and strongly statistically significant for most specifications.

4 Conclusions

4.1 Model Conclusions

From the augmented Neal (2005) intergenerational model, we are able to derive a number of observations. The final form of the model tells us about the intergenerational gap in human capital. In other words, this equation gives us the factors that make up the black-white achievement gap in a steady state. The variables are related with natural logarithms, which simply incorporates diminishing marginal returns. Remember that the formulation of the model used diminishing marginal returns as an assumption in the utility function, which leads directly to the appearance of natural logarithms in the final equation.

The augmented Neal equation includes two terms. Since we did not assume blacks had the preferences as whites, the preference function $\Delta k_j(\alpha, \gamma, \sigma)$ measures the difference in preferences and costs between blacks and whites for purchased inputs, parental time, and child investment. The other term $\Delta \ln(t)$ explicitly measures the difference in the cost of investment between blacks and whites. In other words, this term measures how much more expensive investment in human capital is for blacks (or cheaper as the case may be).

As a thought experiment, it is possible to incorporate the same assumptions

of Neal (2005). This can be done by setting $\Delta k_j(\alpha, \gamma, \sigma)$ to zero. Thus, we see that, much like Neal's (2005) model, the differential cost of investment becomes the main determinant of the achievement gap. The difference in our models, namely the terms corresponding to the proportion of effective parental time and purchased inputs for the child, arises primarily because of our use of a different preference function. Our preference function k_j already incorporates the σ and γ that Neal leaves in his final solution. Even so, the main conclusions are the same. If we assume $\Delta k_j(\alpha, \gamma, \sigma) = 0$, like Neal (2005) does, then higher investment costs for blacks vis--vis whites enlarge the achievement gap. Lower investment costs, moreover, decrease the achievement gap, ceteris paribus. The preference function, k_j, also shows that the willingness of blacks to invest in education, whether due to inherent cultural biases or a preference for greater leisure time and earlier work force entrance, has an effect upon the achievement gap. For instance, if blacks prefer earlier workforce entrance because of some bias, the educational achievement gap should increase. This situation is plausible for instance if cultural pressures or employer discrimination hinders blacks from staying in school.

Moreover, this model explains the other side of the coin-the cost of education. If it is relatively harder and more expensive in terms of opportunity cost for a black to attain an education, the achievement gap will also enlarge. Notice that the two effects of preferences and costs are inherently based in two different categories. It may be the case that because most blacks come from lower socioeconomic backgrounds or more difficult financial circumstances that it is harder for blacks to attain an education because of lower income-this case pertains to the higher cost of education term. It may also occur, however, that because of some cultural phenomenon, blacks prefer not to pursue education in fear of becoming a social pariah. The augmented Neal model incorporates a two terms for each of these two cases and clearly separates between the two cases.

The model also offers insight into the primary investigation of this paper-school structure and elementary school graduation year. Differences in the achievement gap due to changes in school structure can be categorized into both the preference and cost terms. In the case for preferences, blacks graduating from elementary school at an early age may be exposed to older children. If a middle school serves grades 6 through 8, then younger students may feel pressure from older children to disregard their studies and spend time in other activities. The presence of both younger and older populations may change the younger population's preferences for education. Moreover, there may a difference in the amount of change that occurs between blacks and whites. For instance, black students may feel more pressure from their peers to

follow to the norm than their white counterparts. This would explain why graduating from elementary school earlier could have adverse effects upon the achievement gap.

Another explanation is the possibility that earlier graduation from elementary school, such as graduation in the fourth or fifth grades, may make it relatively more expensive for blacks to pursue their education. For example, districts switching from elementary to middle schools may have lower quality education in middle school because of the lack of resources or the influx of students that increases the student-teacher ratio. A middle school may find funding more difficult to come across, resulting in lower quality education at the middle school level because of a larger student population and less personal teacher attention than in elementary school. This would increase the relative opportunity cost of education, making it more expensive in terms of a student's time to pursue academic achievement. Thus, the achievement gap could be enlarged through two mechanism-preferences and costs-because of elementary school graduation year.

4.2 Empirical Conclusions

Results from table (2) display the achievement gap in both its raw form and with controls. Although the gap is on average large and negative, there is considerable variation across different achievement measures. The average raw difference of -0.518 standard deviations comes close to the gap as estimated by most of the CTBS Battery tests. The total battery test, administered in 8th grade, has a raw achievement gap of -0.577 and a controlled gap of -0.473. Thus, the controls, which include a student's free lunch eligibility, classroom type, teacher credentials, and other measures, only account for a small part of the variation in the achievement gap. The majority of the gap, about 82%, is left unexplained by the controls, at least for the total battery score on the CTBS. None of regressions found the gap statistically insignificant, even with controls. Thus, the closing of the achievement gap remains illusory, even for the large set of covariates used in each one of the regressions.

We can, however, analyze the differences among achievement tests, even if they are not completely controlled for by the independent variables. Most of the CTBS test scores, such as the total battery, math, reading, science, social studies, vocabulary, are on a similar order of magnitude in terms of the raw black-white achievement gap. The CTBS Science scaled score seems to yield a somewhat larger gap than its other CTBS counterparts, but in fact is only 16% higher than the CTBS total battery derived gap.

The use of the CTBS Spelling scaled score as the measure of achievement changes

results dramatically. In fact, the raw gap falls to -0.178 standard deviations-significantly smaller in magnitude than the gap estimated by the CTBS total battery score. Using high score GPA also decreases the magnitude of the achievement gap, but by a smaller amount. The opposite occurs when using the high school ACT as the achievement measure. Blacks tend to score 0.761 standard deviations lower on average than white students, without controls. The large gap using the ACT is supported by the literature, as blacks seem to score worse on such standardized tests. The average achievement gap for the CTBS scales of 0.519 standard deviations is also significantly higher than the gap estimated using the GPA achievement measures. Other studies, specifically Grodsky, Warren, and Felts (2008), have shown that the standardized test itself may in fact hinder black performance.

This may be due to differences in how blacks respond to testing environments, or the ability of blacks to purchase preparatory materials for study. This theory lends itself well to our results. For instance, the achievement gap estimated by the ACT is larger than that estimated using the CTBS Total Battery scale score. Students, moreover, have more incentive to study for the ACT in advance because it is used in the college application process, whereas the CTBS is not. This incentive may give an advantage to those who are able to purchase study materials and tutors. Studying in advance for a test is costly, both in terms of the study materials themselves and, more importantly, in terms of time. The time used studying represents an opportunity cost in the form of forgone wages or leisure time. Thus, studying for the ACT may be economically costly, especially for a student in an economically disadvantaged family. This effect means that the achievement gap should theoretically be larger for the ACT than the CTBS, because students have an incentive to study for the test and because whites are usually in a better economic position than blacks to incur the losses associated with studying. In fact, this theory holds up well for the empirical evidence, showing that part of the achievement gap may be explained by the cost of studying for a test, which could be a higher proportion of income for blacks than for whites.

The evidence that the achievement test itself is biased so that whites will do better than blacks, however, can only explain part of the achievement gap. Even when using GPA, the measure that should be least affected by this standardized test bias, the achievement gap is still statistically significant. In fact, Levitt and Fryer (2004) show that the standardized testing bias may in fact not exist. They showed that using teacher assessments instead of standardized tests gave achievement gaps of similar magnitudes. In fact, the standardized test bias may not be limited to solely standardized tests, if it exists at all. It may actually be an artifact of higher

costs of education for blacks vis-a-vis whites. Thus, the bias may be simply one case of the difference in costs, or the $\Delta \ln(t)$ term in the augmented Neal model. Applied more broadly, blacks may face higher opportunity costs in a number of areas, not just studying. For instance, the higher opportunity costs of education for blacks may induce a lack of investment in human capital in general, not just in studying for standardized tests.

To better understand other forces that work to create an achievement gap, we turn to graduation year as a measure of school structure. Table (3) shows a multivariate regression on a number of achievement measures using school graduation binomial covariates. The odd columns display raw estimations while the even columns include controls. The $schk(n)$ covariates denote whether a student graduated from elementary school in year n. First, the striking trend across the estimations is the statistical significance of $schk6$, or in other words, the strongly negative effects on achievement of going to a kindergarten through 6th grade school. Kindergarten through 5th grade schools have much more ambiguous results, with ACT scores showing a positive and statistically significant coefficient and GPA showing a negative and statistically significant coefficient. It is difficult to interpret a clear trend for fifth grade since different achievement measures yield different results. However, it seems that elementary school graduation in fourth grade has a negative correlation on average, with seven out of eight coefficients negative. Although only 50% of the coefficients are statistically significant at least to the 0.05 level, there is some weak evidence to show that fourth grade graduation may hinder academic performance on the average. Finally, third grade graduation is also ambiguous, since it has statistical significance for positive and negative coefficients, depending upon the achievement measure used. Thus, the only strong trend is the negative performance of students who graduate from kindergarten to 6th grade schools. It also seems that students graduating from kindergarten to 4th grade schools also perform worse than the average student in the sample.

A number of explanations can account for the poor performance from those graduating in sixth grade from elementary school. Students in K-6 elementary schools usually go on to complete middle school (7th and 8th grades) then high school (9th to 12th grades). This particular progression of school transitions seems to be particularly harmful to academic performance, as documented by a number of studies. Simmons and Blythe (1987) argue that the transition to middle school is accompanied by a decline in motivation and self-esteem.

This theory could account for the poor performance by those who graduate in 6th grade because of peer pressure, especially from older children. The theory that

young students are exposed to older and possibly more rebellious children in middle school, however, does not hold up well under scrutiny of our data. The problem is that achievement is ambiguously affected by 5th grade graduation. Thus, if it were true that younger students were exposed to older, more disobedient, and belligerent students, we should see stronger negative performance in 5th grade. There seems to be little evidence that the interaction with older students produces lower academic achievement in younger students. Moreover, there should be even stronger negative interactions for 4th grade graduation, but the magnitude of the coefficients on schk4 is smaller both in terms of statistical significance and in terms of absolute value. Thus, another explanation of lower performance due to the transition to middle school is needed.

Bedard and Do (2005) emphasize that middle schools are larger, and consequently, less personal in terms of teacher-student interactions. Middle schools also tend to have more competitive environments than elementary schools. This, in turn, could link back to the size of the middle school. With more students, it is more difficult to be one of the best, and smart students must work harder in order to sustain the relative performance differential they enjoyed in elementary school. Moreover, the difficulty of excelling can discourage those who never were at the front end of the achievement spectrum in the first place, making education seem like a fruitless endeavor. Although the STAR project does not provide data on school size, it does provide extensive measurements of class size. The differences between K-6 and K-5 schools in class size are not statistically significant, with a p-value of 0.09 for a two sample t-test. However, class size is not the best indicator of school size. The assumption that larger schools have larger classes is not well founded in theory, as larger schools may have more resources than smaller schools or vice versa. The dataset does not allow us to distinguish the two hypotheses from reality. Neither does it let us examine the size theory-that middle schools hinder academic performance because of the number of students in the school.

Looking at more closely at the differential achievement between blacks and whites due to differences in graduation years may shed some light upon this theory. Table (4) displays binomial variables that include graduation year multiplied by race, allowing us to examine the difference between blacks and whites for each graduation year. As noted in the results section, two major trends seem apparent. The $schk5black$ and $schk4$ variables are always negative and statistically significant across all specifications. Also, the black coefficient is always negative and statistically significant. Recall that we dropped the 6th grade graduation year groups in these regressions, meaning that the coefficient on black actually gives an estimate of $schk6black$. Thus,

at least from using the CTBS Total Battery scaled score measure, we can see that black students do much worse relative to whites when graduating from elementary school in 5th and 6th grades. The multiplicative term *schk*5*black* allow us to isolate interaction effects that occur because of two variables occurring simultaneously. Thus, it seems that the argument that middle school hinders performance holds up, at least for the CTBS Total Battery achievement measure.

If we examine other achievement measures, such as CTBS standardized test measures of math and reading schools in tables (5) and (6) respectively, the middle school penalty resurfaces. Results for both the CTBS math and reading show that *schk*5*black* and *black* are negative and statistically significant for all specifications. In fact, looking at tables (7) through (12), the trend is stark and unambiguously clear - *schk*5*black* and *black* have negative and usually statistically significant coefficients. Undoubtedly, the robustness of this trend across 9 different achievement measures and 54 different specifications gives some weight to its authenticity.

It is true that there could be bias across the entire dataset. If more black children attended school systems that included middle school, the entire estimation may be thrown off and the trend in the interaction terms could simply be due to larger black populations in those schools. This possibility of bias is indeed worrisome, since project STAR did not account for population demographics in its randomization study. The STAR coordinators only randomized students within each school by class size. Thus, the conclusions that follow are tentative and cannot be interpreted as having definite causal links. It is quite possible that more blacks attend K-6 or K-5 elementary schools, which could bias our results significantly.

However, with such precautions, we can come to some conclusions about middle school and its effect upon the black-white achievement gap. The robustness of the negativity of the interaction terms for K-5 and K-6 elementary schools show that blacks who go on to middle school (classified here as school serving either 6th to 8th grade or 7th to 8th grade) are hurt significantly more than their white counterparts. These results, and the fact that the 4th grade graduation year interaction terms are either more ambiguous or statistically insignificant across the achievement measures, support the hypothesis that middle schools are detrimental for learning, especially for black students vis-a-vis white students.

Unfortunately, the estimation results do not allow us to distinguish between the different theories of why middle schools are disadvantageous. The results do tell us, however, that not only are middle schools detrimental on average, but they are more detrimental for black students than for whites. Thus, graduating from an elementary school and then transitioning to a middle school affects blacks more

than whites. Theoretically, it is possible that students move into an environment with older children again, and that this older environment affects blacks more than whites. However, we have shown that this hypothesis has little support for the average student, making it probable that it also has little support for explaining the differential achievement between blacks and whites. The same argument can be applied as before. Most of the achievement measures show that *schk4black* is insignificant. For those coefficients that are significant, it is difficult to make robust conclusions as some achievement measures have conflicting signs (for instance CTBS Vocabulary and CTBS Math). Thus, if interactions with older students affected the achievement gap more for blacks than for whites, then the *schk4black* variables should be even more statistically significant and negative than the variables for *schk5black* or *schk6black*. Moreover, the coefficients on *schk5black* should be more statistically significant and negative than those on *schk6black*. Neither of these are true, and so our results provide little evidence for this theory.

Although we cannot provide evidence confirming or contradicting the middle school size theory, we can provide tentative evidence that class size may have a potential effect on the gap. Across all achievement measures, the 2nd grade class size turned out to be statistically significant in 72% of the specifications. Most of the coefficients that were statistically significant to the 0.05 level were positive, although 3 were negative. The coefficients, however, tell us much less about how class size affects the achievement gap, because of its lack of an interaction term. Thus, we are only sure that class size has an effect upon the gap, and cannot point to the direction in which correlation runs. This is because the dependent variable is the achievement measure, not the achievement gap itself. Thus, we cannot identify whether class size increases or decreases the size of the achievement gap, only whether it increases or decreases test scores for the average student in the sample.

Other important and statistically significant covariates were gender, school urbanity, and free lunch eligibility status. Free lunch eligibility had particularly strong effects, where moving out of free lunch eligibility improved test scores by more than any other covariate. The next strongest covariate was school urbanity, which also had a large magnitude relative to the other covariates. The magnitude of the effects of these two controls is not surprising, as they are both proxies for socio-economic status. The school urbanity variable was coded to include rural, suburban, urban, and inner-city (which was defined as more than half of the school being eligible for free lunch). The overlap between the free lunch and school urbanity variables predicates that the two variables should be of similar magnitudes. The variables, moreover, identify how well off a student is, and whether he goes to a school with

a large amount of poverty. Thus, like Levitt and Fryer (2004), a large part of the achievement gap can be explained by socio-economic status, or at least proxies for socio-economic status.

The 3rd and 8th grade multiplicative interaction terms seem to remain statistically insignificant throughout various specifications and achievement measures. The general trend is for both the *schk*3*black* and *schk*8*black* terms to have either no statistical significance or statistical significance to the 0.05 level with relatively small magnitudes. Thus, it seems that graduation from elementary school in 3rd or 8th grade does not produce an achievement bias between races. This result shows that middle school tends to exacerbate the black-white achievement gap. Although we are not able to measure explicitly what school students transition into after elementary school graduation, we can be relatively confident that K-8 graduates go on to high school. However, K-3 graduates are more difficult to classify, because it is possible that they attend 4th through 8th grade schools or go on to an intermediate school and then a middle school consisting of either 6th through 8th or 7th through 8th grades. Both structures, however, are noticeably different than the traditional middle school transition.

These conclusions lend themselves to an immediate policy recommendation, that is, the elimination of middle schools altogether. However, this policy recommendation should only be considered if middle school graduation is actually the causal factor in producing an enlarged gap for those graduating in 5th and 6th grades. If the real reason why middle schools enlarged the black-white achievement gap was inherently because of size, an elimination of middle schools would do nothing to improve the gap. If middle schools confer resources differently, or more plausibly, if blacks attend middle schools that on average are larger and have less resources, eliminating middle schools would only shift the educational burden to either elementary or high schools. However, if middle schools enlarge the black-white achievement gap because of some interaction between students in the upper and lower grades of the school, or because adolescence development interacts in some way with the middle school environment, it may be advantageous to eliminate middle schools. The difficulty of identifying causality in our observational study hinders our ability to provide an adequate policy recommendation. However, we can conclude, with some reservation due to the possibility of self-selection bias, that graduating from 5th and 6th grades tends to hurt black academic achievement relatively more than white academic achievement. Whether this is due to the size of middle schools or the social interactions within them is open for debate.

5 Discussion

Many studies have suggested that the middle-school model currently in place in most schools is actually detrimental to discipline, GPA, and on time graduation rates. Our work similarly found that placing 6th grade into middle school academically hurt students, especially black students. Also notable is the prominent role that school effort and study skills play in black achievement. We will now examine our findings in context of successful school models and recommend a theoretically successful school model.

Knowledge is Power Program (KIPP) schools have gained prominence for their success in raising black students' test scores to levels higher than national standards. KIPP schools are commonly located in urban areas and specifically target lower income students: the average racial composition of KIPP schools is 62.5% black, in comparison to the national 16.9% (Educational Policy Institute 2005). Nevertheless, 5th grade cohorts gained between 9 to 17 points for all the various tests of the Stanford Achievement Test, a standardized achievement test for grades from kindergarten to high school (Educational Policy Institute 2005). Some KIPP schools have increased scores by half to one full standard deviation (Educational Policy Institute 2005). KIPP schools follow a rigorous curriculum stemming from a philosophy based on the five pillars of high expectations, choice and commitment, more time, power to lead, and focus on results (Educational Policy Institute 2005). Attending students are in class for 60% more time than students in other public schools (Educational Policy Institute 2005).

KIPP schools primarily focus on creating work ethic. Within our research, the variable school effort encompasses survey questions such as how much time a student spends working on homework or studying for a test - quite simply, it is the amount of effort, based on time, that a student puts into school. Our findings show that GPA is significantly associated with school effort, and, especially importantly, blacks report lower school effort. KIPP schools ensure that students are unable to not work. In this regard, work ethic, and school effort, can be created through significant time commitment and work.

Another successful case is Alexander Graham Bell School, which has had the greatest gain in achievement in any middle school in its district, despite having 99% of its students in its free lunch program. It strives to maintain an elementary school learning atmosphere in middle school. For example, students stay within same small building for the entire day. While students do not stay within a single classroom with the same teacher, their teachers have been with them since they started elementary

school -teachers continue to teach the same class as they progress through the grades (Fisher and Frey 2007). Similarly, they stay with the same group of students within each class. Classes are based around reciprocal teaching, in which students discuss their thoughts and teach what they learned to other students (Fisher and Frey 2007). Furthermore, every class employs similar content literacy strategies (Fisher and Frey 2007). The procedures, formats, and strategies are the same across classes, from math to English.

Unlike KIPP schools, which specifically target school effort, Alexander Graham Bell School is unique in its approach to study skills. Within our research, study skills are defined as the ability to carry out independent study using information-processing skills that are applied across subject areas. Bell School eliminates the necessity for developing different study skills. There is a universal study skill set that is applied across subjects. This allows the focus of the education to be on the content, rather than the structure. Furthermore, Bell School preserves the intimacy of elementary school. The small class and building size eliminate the anonymity of middle schools and largely eliminate interaction between classes. The same teachers, along with minimizing transition problems, create an atmosphere of familiarity. The reciprocal learning style encourages collaboration.

Shelby Steele, a prominent African-American professor, believes that there must be a fundamental shift in our approach to the black white achievement gap. He states that when currently addressing the gap, "excellence is relative" is across races (2000). If black students struggle in the school system while other students excel, then expectations for blacks will be lowered (2000). Black students are not held to the same standards as other students and are given boosts when comparing them. Steele offers what he calls the Moral-Power Model, in which blacks derive benefits from their victimization, to explain why the government and educational system allow black students to fall behind (2000).

Thus, we propose to combine all of the successful aspects elucidated above into a personal, isolated middle school environment defined by hard work, high expectations, and similar class structures.

6 Tables and Figures

Figure 1: Descriptive Statistics of Achievement Measures and Significant Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
g8tbatts	14568	779.034	37.09141	626	902
	8th Grade CTBS Total Battery Score				
g8tmathss	15768	794.8564	44.38465	572	920
	8th Grade CTBS Math Score				
g8treadss	15848	767.686	40.37561	588	892
	8th Grade CTBS Reading Score				
g8sciencess	15856	773.5439	41.41866	627	912
	8th Grade CTBS Science Score				
g8socialscs	15856	772.2114	42.40523	625	898
	8th Grade CTBS Social Science Score				
g8spells	14640	786.1809	42.18921	571	898
	8th Grade CTBS Spelling Score				
g8vocabs	14640	766.429	47.90956	595	908
	8th Grade CTBS Vocabulary Score				
hsactcomp	11296	19.41926	4.328912	10	34
	High School ACT Composite Score				
hsgpamath	15496	80.12567	8.635874	40	100
	High School Math GPA				
hsgpascience	13568	82.07179	8.900598	40	99.5
	High School Science GPA				
grdrange	20176	5.680412	1.336167	3	8
	Grade Range of School				

Note: Grdrange is coded 3 for Kindergarten through 3rd grade, 4 for Kindergarten through 4th grade, etc. The CTBS is the Comprehensive Test for Basic Skills administered in the 8th grade, and is a standardized test designed to evaluate a student's ability to learn.

Figure 2: Estimation of the Black White Achievement Gap

	(1) bat8	(2) g8math	(3) g8read	(4) g8science	(5) g8vocab	(6) g8spelling	(7) ACT	(8) GPA
Raw Gap: Without Controls								
Black	-0.577***	-0.553***	-0.588***	-0.673***	-0.547***	-0.178***	-0.761***	-0.268***
	(-37.55)	(-32.25)	(-38.83)	(-44.54)	(-35.55)	(-11.27)	(-41.35)	(-14.23)
Constant	0.439***	0.140***	0.386***	0.366***	0.369***	0.257***	0.258***	0.161***
	(55.42)	(16.09)	(50.34)	(47.69)	(46.39)	(31.46)	(27.22)	(18.60)
N	15312	16744	16824	16832	15384	15384	12120	16152
Controlled Gap: With Controls								
Black	-0.473***	-0.481***	-0.537***	-0.492***	-0.457***	-0.0972***	-0.689***	-0.201***
	(-17.56)	(-15.50)	(-19.18)	(-17.89)	(-16.29)	(-3.40)	(-20.06)	(-6.02)
Constant	-1.881***	-2.601***	-0.409	-0.0446	-0.0393	-1.815***	-0.368	-2.631***
	(-9.23)	(-11.19)	(-1.95)	(-0.22)	(-0.19)	(-8.41)	(-1.36)	(-10.29)
N	9784	10120	10136	10136	9816	9824	7400	9168

Note: The top panel includes regressions for the raw gap without a parsimonious set of controls, while the bottom panel includes a parsimonious set of controls. These controls are the same as the baseline specification used in the materials and methods section. t statistics in parentheses, * p < 0.05, ** p < 0.01, *** p < 0.001

Figure 3: Estimation of the Achievement Gap with Binomial Graduation Year Covariates

	(1) g8math	(2) g8math	(3) g8read	(4) g8read	(5) ACT	(6) ACT	(7) GPA	(8) GPA
schk3	0.101**	0.0806*	-0.0794**	-0.0463	0.0113	0.0109	-0.232***	-0.0643
	(3.00)	(2.14)	(-2.64)	(-1.37)	(0.28)	(0.24)	(-7.29)	(-1.68)
schk4	0.00156	-0.155***	-0.0240	-0.195***	0.0396	-0.0893*	-0.213***	-0.0631
	(0.06)	(-4.71)	(-0.96)	(-6.59)	(1.24)	(-2.29)	(-7.73)	(-1.79)
schk5	0.0279	-0.00393	0.0372	0.0161	0.120***	-0.0134	-0.457***	-0.417***
	(1.07)	(-0.13)	(1.60)	(0.57)	(4.09)	(-0.38)	(-18.07)	(-12.63)
schk6	-0.167***	-0.108***	-0.225***	-0.142***	-0.314***	-0.265***	-0.160***	0.0177
	(-8.25)	(-4.31)	(-12.49)	(-6.26)	(-13.86)	(-9.32)	(-7.93)	(0.69)
yearssmall		0.0284*		-0.0120		-0.0359**		0.0134
		(2.55)		(-1.19)		(-2.85)		(1.14)
gender		0.0729***		0.0255		-0.0476*		0.454***
		(3.89)		(1.51)		(-2.21)		(22.82)
cmpstype		0.0551*		-0.0339		-0.0671**		0.0220
		(2.49)		(-1.69)		(-2.70)		(0.95)
g3freelunch		0.453***		0.455***		0.467***		0.429***
		(22.06)		(24.49)		(18.27)		(19.30)
g3surban		0.113***		0.0953***		0.119***		0.0458**
		(8.09)		(7.55)		(7.66)		(3.02)
g3thighdegree		0.0785***		0.0439**		0.0495**		0.0869***
		(5.22)		(3.21)		(2.96)		(5.27)
g3tyears		0.00491***		0.00222*		0.00304*		0.00305**
		(4.59)		(2.29)		(2.50)		(2.70)
g3present		0.00869***		0.000967		0.000187		0.00670***
		(7.75)		(0.95)		(0.14)		(5.49)
g3motivraw		-0.00104		-0.00562*		-0.00129		0.000383
		(-0.43)		(-2.55)		(-0.47)		(0.15)
Constant	0.0649***	-2.767***	0.343***	-0.642**	0.187***	-0.790**	0.291***	-2.702***
	(3.88)	(-11.77)	(22.92)	(-3.02)	(9.82)	(-2.86)	(17.73)	(-10.69)
N	16800	10152	16880	10168	12152	7416	16192	9200

Figure 4: Estimation of the Effect of Elementary School Graduation on the CTBS Total Battery Score

	(1) totbatt	(2) totbatt	(3) totbatt	(4) totbatt	(5) totbatt	(6) totbatt
black	-0.663***	-0.624***	-0.441***	-0.382***	-0.211***	-0.188***
	(-29.37)	(-25.95)	(-12.32)	(-9.26)	(-10.06)	(-7.29)
schk3	-0.0819*	-0.0505	0.0522	-0.0500	0.122***	0.0824***
	(-2.42)	(-1.44)	(1.48)	(-1.06)	(5.11)	(3.43)
schk4	-0.0783**	-0.120***	-0.0864**	-0.127***	-0.0904***	-0.104***
	(-2.79)	(-4.11)	(-2.88)	(-3.88)	(-5.52)	(-5.42)
schk5	0.0364	0.0781**	0.0697*	0.0701*	0.123***	0.121***
	(1.39)	(2.90)	(2.41)	(2.11)	(7.41)	(6.02)
schk8	-0.0417	-0.0167	0.115***	0.0617*	0.0205	-0.00276
	(-1.65)	(-0.64)	(4.26)	(2.02)	(1.34)	(-0.16)
schk3_black	0.456**	0.473**	0.203	0.164	0.0492	0.0900
	(3.20)	(3.08)	(1.49)	(0.52)	(0.31)	(1.12)
schk4_black	0.0390	0.132	0.0206	0.0821	0.189***	0.0939
	(0.44)	(1.43)	(0.19)	(0.73)	(3.34)	(1.39)
schk5_black	-0.557***	-0.543***	-0.458***	-0.461***	-0.298***	-0.200***
	(-7.76)	(-7.10)	(-5.55)	(-5.16)	(-6.61)	(-3.69)
schk8_black	-0.0520	-0.107	0.0258	0.00207	0.142	0.0701
	(-0.37)	(-0.77)	(0.18)	(0.01)	(1.92)	(0.81)
Control Set	1	2	3	4	5	6
_cons	0.198***	-0.249***	-2.635***	-2.725***	-16.02***	-15.93***
	(12.74)	(-4.50)	(-12.58)	(-8.21)	(-83.88)	(-102.57)
N	14568	13016	10680	8480	8456	6544

Note: The Control Set denotes a set of parsimonious controls that are included in the appendix. Each control set has a different set of covariates. Schkn denotes the whether a student has graduated from elementary school in year n, while black is a binomial variable coded 1 for being black and 0 for being white. t statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 5: Estimation of the Effect of Elementary School Graduation on the CTBS Math Score

	(1) g8math	(2) g8math	(3) g8math	(4) g8math	(5) g8math	(6) g8math
black	-0.601***	-0.571***	-0.426***	-0.398***	-0.213***	-0.151***
	(-26.82)	(-23.73)	(-11.69)	(-9.39)	(-6.51)	(-3.72)
schk3	0.00669	-0.0146	0.124***	-0.0176	0.0933*	0.0802*
	(0.20)	(-0.42)	(3.48)	(-0.37)	(2.49)	(2.19)
schk4	-0.0856**	-0.151***	-0.0562	-0.113***	-0.0250	-0.00660
	(-3.10)	(-5.24)	(-1.84)	(-3.42)	(-0.98)	(-0.22)
schk5	0.00566	0.00244	0.110***	0.0745*	0.0693**	0.0819**
	(0.22)	(0.09)	(3.71)	(2.17)	(2.66)	(2.74)
schk8	-0.132***	-0.128***	0.0215	-0.0375	0.00544	0.0529*
	(-5.35)	(-5.00)	(0.79)	(-1.21)	(0.23)	(1.96)
schk3_black	0.228	0.246	0.0372	-0.346	-0.531*	0.140
	(1.68)	(1.69)	(0.28)	(-1.06)	(-2.18)	(1.21)
schk4_black	0.265**	0.370***	0.376***	0.514***	0.510***	0.491***
	(3.03)	(4.01)	(3.39)	(4.41)	(5.86)	(4.39)
schk5_black	-0.533***	-0.532***	-0.621***	-0.579***	-0.441***	-0.239**
	(-7.39)	(-6.91)	(-7.18)	(-6.16)	(-6.22)	(-2.94)
schk8_black	0.230	0.205	0.288	0.295	0.272*	0.256
	(1.59)	(1.43)	(1.89)	(1.94)	(2.39)	(1.79)
Control Set	1	2	3	4	5	6
_cons	0.177***	-0.199***	-2.698***	-2.644***	-14.19***	-15.76***
	(11.60)	(-3.70)	(-12.72)	(-7.78)	(-47.42)	(-47.94)
N	15768	14088	11088	8792	8352	5840

Note: The Control Set denotes a set of parsimonious controls that are included in the appendix. Each control set has a different set of covariates. Schkn denotes the whether a student has graduated from elementary school in year n, while black is a binomial variable coded 1 for being black and 0 for being white. t statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 6: Estimation of the Effect of Elementary School Graduation on the CTBS Reading Score

	(1) g8read	(2) g8read	(3) g8read	(4) g8read	(5) g8read	(6) g8read
black	-0.619***	-0.598***	-0.436***	-0.386***	-0.230***	-0.201***
	(-28.45)	(-25.30)	(-12.21)	(-9.49)	(-7.70)	(-5.01)
schk3	-0.0996**	-0.0546	0.0253	-0.0176	0.150***	0.168***
	(-3.07)	(-1.59)	(0.73)	(-0.38)	(4.38)	(4.62)
schk4	-0.000882	-0.0179	-0.0733*	-0.106***	-0.0706**	-0.119***
	(-0.03)	(-0.63)	(-2.45)	(-3.31)	(-3.03)	(-4.04)
schk5	0.108***	0.141***	0.145***	0.204***	0.227***	0.211***
	(4.32)	(5.4)	(4.99)	(6.16)	(9.48)	(7.15)
schk8	0.0115	0.0245	0.0956***	0.0593*	0.0888***	0.0824**
	(0.48)	(0.97)	(3.58)	(1.98)	(4.07)	(3.09)
schk3_black	-0.1	-0.137	-0.246	0.854**	0.717**	-0.0723
	(-0.76)	(-0.95)	(-1.90)	(2.7)	(3.19)	(-0.63)
schk4_black	-0.244**	-0.193*	-0.389***	-0.359**	-0.268***	-0.221*
	(-2.86)	(-2.12)	(-3.59)	(-3.18)	(-3.34)	(-2.00)
schk5_black	-0.599***	-0.569***	-0.568***	-0.629***	-0.439***	-0.287***
	(-8.53)	(-7.49)	(-6.70)	(-6.91)	(-6.71)	(-3.57)
schk8_black	-0.166	-0.193	0.0346	-0.032	0.0226	0.488***
	(-1.18)	(-1.36)	(0.23)	(-0.22)	(0.21)	(3.45)
Control Set	1	2	3	4	5	6
_cons	0.158***	0.110*	-1.229***	-1.281***	-12.43***	-13.44***
	(10.68)	(2.09)	(-5.90)	(-3.91)	(-45.45)	(-41.58)
N	15848	14168	11104	8792	8352	5840

Note: The Control Set denotes a set of parsimonious controls that are included in the appendix. Each control set has a different set of covariates. Schkn denotes the whether a student has graduated from elementary school in year n, while black is a binomial variable coded 1 for being black and 0 for being white. t statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 7: Estimation of the Effect of Elementary School Graduation on the CTBS Science Score

	(1) science	(2) science	(3) science	(4) science	(5) science	(6) science
black	-0.674***	-0.624***	-0.462***	-0.458***	-0.354***	-0.435***
	(-34.20)	(-29.96)	(-14.16)	(-12.32)	(-11.49)	(-12.11)
schk3	-0.0380	-0.0641*	0.0727*	0.108*	0.210***	-0.0130
	(-1.28)	(-2.10)	(2.27)	(2.55)	(5.89)	(-0.38)
schk4	0.0274	-0.0140	-0.0258	-0.0242	0.0176	-0.0634*
	(1.12)	(-0.56)	(-0.95)	(-0.83)	(0.73)	(-2.37)
schk5	0.0194	0.0231	-0.0366	-0.0244	-0.00267	-0.0102
	(0.85)	(1.00)	(-1.38)	(-0.81)	(-0.11)	(-0.36)
schk8	0.0235	0.0220	0.135***	0.137***	0.152***	0.0449
	(1.07)	(0.99)	(5.52)	(5.00)	(6.75)	(1.82)
schk3_black	0.314**	0.247	0.141	0.524	0.450	0.548***
	(2.61)	(1.94)	(1.19)	(1.81)	(1.93)	(4.90)
schk4_black	-0.00763	0.0510	-0.134	-0.178	-0.0879	0.316***
	(-0.10)	(0.63)	(-1.35)	(-1.73)	(-1.06)	(3.36)
schk5_black	-0.433***	-0.215**	-0.262***	-0.275***	-0.130	-0.0538
	(-6.78)	(-3.20)	(-3.39)	(-3.31)	(-1.93)	(-0.71)
schk8_black	0.199	0.185	0.235	0.234	0.280**	0.423***
	(1.55)	(1.48)	(1.73)	(1.74)	(2.58)	(3.50)
Control Set	1	2	3	4	5	6
_cons	0.360***	0.616***	-0.187	0.399	-8.714***	-10.20***
	(26.81)	(13.19)	(-0.99)	(1.34)	(-31.10)	(-46.60)
N	15856	14168	11104	8792	8384	6496

Note: The Control Set denotes a set of parsimonious controls that are included in the appendix. Each control set has a different set of covariates. Schkn denotes the whether a student has graduated from elementary school in year n, while black is a binomial variable coded 1 for being black and 0 for being white. t statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 8: Estimation of the Effect of Elementary School Graduation on the CTBS Social Science Score

	(1) socialsci	(2) socialsci	(3) socialsci	(4) socialsci	(5) socialsci	(6) socialsci
black	-0.623***	-0.460***	-0.460***	-0.468***	-0.332***	-0.195***
	(-30.81)	(-13.55)	(-13.55)	(-11.81)	(-10.81)	(-5.44)
schk3	0.0271	0.177***	0.177***	-0.00391	0.157***	0.331***
	(0.89)	(5.33)	(5.33)	(-0.09)	(4.46)	(9.83)
schk4	-0.0268	-0.0614*	-0.0614*	-0.0738*	-0.0524*	-0.101***
	(-1.07)	(-2.16)	(-2.16)	(-2.36)	(-2.18)	(-3.80)
schk5	-0.0386	-0.0698*	-0.0698*	-0.0773*	-0.0624*	-0.0239
	(-1.66)	(-2.53)	(-2.53)	(-2.40)	(-2.54)	(-0.85)
schk8	-0.0262	0.0426	0.0426	0.0216	0.0329	-0.0253
	(-1.16)	(1.68)	(1.68)	(0.74)	(1.47)	(-1.03)
schk3_black	0.221	-0.00222	-0.00222	0.587	0.373	-0.0360
	(1.79)	(-0.02)	(-0.02)	(1.90)	(1.61)	(-0.32)
schk4_black	-0.140	-0.0802	-0.0802	-0.0115	0.117	-0.0180
	(-1.76)	(-0.78)	(-0.78)	(-0.10)	(1.42)	(-0.19)
schk5_black	-0.235***	-0.211**	-0.211**	-0.195*	-0.0430	-0.0435
	(-3.60)	(-2.62)	(-2.62)	(-2.20)	(-0.64)	(-0.58)
schk8_black	0.530***	0.715***	0.715***	0.709***	0.738***	0.613***
	(4.04)	(5.05)	(5.05)	(4.94)	(6.82)	(5.10)
Control Set	1	2	3	4	5	6
_cons	0.380***	-0.780***	-0.780***	-0.915**	-11.76***	-11.95***
	(27.56)	(-3.95)	(-3.95)	(-2.88)	(-42.08)	(-54.78)
N	15856	14168	11104	8792	8384	6496

Note: The Control Set denotes a set of parsimonious controls that are included in the appendix. Each control set has a different set of covariates. Schkn denotes the whether a student has graduated from elementary school in year n, while black is a binomial variable coded 1 for being black and 0 for being white. t statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 9: Estimation of the Effect of Elementary School Graduation on the CTBS Spelling Score

	(1) spelling	(2) spelling	(3) spelling	(4) spelling	(5) spelling	(6) spelling
black	-0.150***	-0.0195	-0.0195	0.0207	0.121***	0.153***
	(-7.33)	(-0.59)	(-0.59)	(0.53)	(3.62)	(3.92)
schk3	-0.0819**	0.0297	0.0297	-0.117**	-0.0142	0.0731*
	(-2.65)	(0.90)	(0.90)	(-2.61)	(-0.37)	(2.02)
schk4	0.0132	-0.0146	-0.0146	-0.0380	-0.0185	-0.0547
	(0.52)	(-0.53)	(-0.53)	(-1.23)	(-0.71)	(-1.89)
schk5	0.125***	0.175***	0.175***	0.186***	0.214***	0.222***
	(5.22)	(6.54)	(6.54)	(5.95)	(8.09)	(7.31)
schk8	0.0515*	0.145***	0.145***	0.181***	0.150***	0.00621
	(2.23)	(5.78)	(5.78)	(6.28)	(6.17)	(0.23)
schk3_black	0.316*	0.118	0.118	0.544	0.466	-0.225
	(2.43)	(0.93)	(0.93)	(1.82)	(1.85)	(-1.86)
schk4_black	-0.265***	-0.145	-0.145	-0.110	-0.0434	-0.414***
	(-3.31)	(-1.46)	(-1.46)	(-1.03)	(-0.48)	(-4.06)
schk5_black	-0.385***	-0.328***	-0.328***	-0.321***	-0.220**	-0.453***
	(-5.88)	(-4.28)	(-4.28)	(-3.80)	(-3.07)	(-5.56)
schk8_black	0.141	0.177	0.177	0.114	0.197	0.418**
	(1.09)	(1.30)	(1.30)	(0.81)	(1.67)	(3.19)
Control Set	1	2	3	4	5	6
_cons	0.228***	-1.509***	-1.509***	-2.172***	-10.15***	-9.178***
	(16.12)	(-7.76)	(-7.76)	(-6.93)	(-33.45)	(-39.13)
N	14640	10720	10720	8512	8480	6552

Note: The Control Set denotes a set of parsimonious controls that are included in the appendix. Each control set has a different set of covariates. Schkn denotes the whether a student has graduated from elementary school in year n, while black is a binomial variable coded 1 for being black and 0 for being white. t statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 10: Estimation of the Effect of Elementary School Graduation on the CTBS Vocabulary Score

	(1) vocab	(2) vocab	(3) vocab	(4) vocab	(5) vocab	(6) vocab
black	-0.524***	-0.401***	-0.401***	-0.310***	-0.190***	-0.259***
	(-26.35)	(-12.27)	(-12.27)	(-8.40)	(-6.52)	(-7.30)
schk3	-0.103***	0.0131	0.0131	-0.0482	0.0811*	0.0383
	(-3.45)	(0.41)	(0.41)	(-1.14)	(2.45)	(1.16)
schk4	-0.0306	-0.0646*	-0.0646*	-0.0683*	-0.0274	-0.117***
	(-1.24)	(-2.36)	(-2.36)	(-2.34)	(-1.21)	(-4.43)
schk5	0.108***	0.100***	0.100***	0.162***	0.198***	0.103***
	(4.63)	(3.80)	(3.80)	(5.46)	(8.59)	(3.75)
schk8	-0.0419	0.0502*	0.0502*	0.0392	0.0228	-0.0940***
	(-1.87)	(2.04)	(2.04)	(1.43)	(1.07)	(-3.86)
schk3_black	0.391**	0.309*	0.309*	1.063***	0.907***	0.248*
	(3.09)	(2.48)	(2.48)	(3.75)	(4.12)	(2.25)
schk4_black	-0.259***	-0.433***	-0.433***	-0.475***	-0.404***	-0.259**
	(-3.33)	(-4.44)	(-4.44)	(-4.70)	(-5.15)	(-2.79)
schk5_black	-0.487***	-0.293***	-0.293***	-0.366***	-0.294***	-0.308***
	(-7.66)	(-3.90)	(-3.90)	(-4.58)	(-4.69)	(-4.15)
schk8_black	-0.0877	0.165	0.165	0.0883	0.132	0.212
	(-0.70)	(1.23)	(1.23)	(0.67)	(1.28)	(1.78)
Control Set	1	2	3	4	5	6
_cons	0.373***	-0.404*	-0.404*	-1.067***	-10.39***	-10.77***
	(27.17)	(-2.12)	(-2.12)	(-3.59)	(-39.18)	(-50.39)
N	15856	14168	11104	8792	8384	6496

Note: The Control Set denotes a set of parsimonious controls that are included in the appendix. Each control set has a different set of covariates. Schkn denotes the whether a student has graduated from elementary school in year n, while black is a binomial variable coded 1 for being black and 0 for being white. t statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 11: Estimation of the Effect of Elementary School Graduation on the Composite ACT Score

	(1) ACT	(2) ACT	(3) ACT	(4) ACT	(5) ACT	(6) ACT
black	-0.716***	-0.729***	-0.557***	-0.503***	-0.236***	-0.333***
	(-30.74)	(-28.82)	(-14.50)	(-11.20)	(-6.84)	(-8.04)
schk3	0.00118	-0.00475	0.170***	0.112*	0.164***	0.0401
	(0.03)	(-0.12)	(4.12)	(2.05)	(3.89)	(0.95)
schk4	0.101***	0.0773*	0.103**	0.155***	0.0913**	0.0366
	(3.37)	(2.44)	(3.02)	(4.16)	(3.27)	(1.14)
schk5	0.182***	0.198***	0.158***	0.180***	0.263***	0.293***
	(6.75)	(7.00)	(4.92)	(4.88)	(9.71)	(8.87)
schk8	0.114***	0.134***	0.172***	0.230***	0.154***	0.0709*
	(4.14)	(4.70)	(5.68)	(6.71)	(6.13)	(2.40)
schk3_black	0.151	0.201	0.0419	0.0148	0.0908	0.0536
	(0.66)	(0.88)	(0.19)	(0.05)	(0.41)	(0.32)
schk4_black	-0.163	-0.122	-0.122	-0.194	0.132	0.0249
	(-1.73)	(-1.24)	(-0.98)	(-1.45)	(1.38)	(0.23)
schk5_black	-0.378***	-0.272**	-0.233*	-0.245*	-0.288***	-0.192*
	(-4.43)	(-2.99)	(-2.30)	(-2.25)	(-3.63)	(-2.04)
schk8_black	-0.0734	-0.0853	0.262	0.219	0.196	0.214
	(-0.51)	(-0.59)	(1.64)	(1.37)	(1.71)	(1.55)
Control Set	1	2	3	4	5	6
_cons	0.200***	0.456***	-0.728**	-0.0704	-13.49***	-13.28***
	(12.72)	(7.70)	(-2.89)	(-0.19)	(-40.89)	(-49.74)
N	11296	10088	8088	6464	5984	4616

Note: The Control Set denotes a set of parsimonious controls that are included in the appendix. Each control set has a different set of covariates. Schkn denotes the whether a student has graduated from elementary school in year n, while black is a binomial variable coded 1 for being black and 0 for being white. t statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 12: Estimation of the Effect of Elementary School Graduation on High School GPA

	(1) GPA	(2) GPA	(3) GPA	(4) GPA	(5) GPA	(6) GPA
black	-0.312***	-0.384***	-0.162***	-0.128**	0.0275	0.101*
	(-13.11)	(-15.28)	(-4.30)	(-2.92)	(0.65)	(2.12)
schk3	-0.177***	-0.193***	-0.120***	0.0994*	0.113*	-0.0750
	(-5.66)	(-6.00)	(-3.43)	(2.10)	(2.48)	(-1.86)
schk4	-0.163***	-0.204***	-0.0937**	-0.115***	-0.130***	0.0381
	(-6.11)	(-7.44)	(-2.98)	(-3.34)	(-4.13)	(1.16)
schk5	-0.336***	-0.301***	-0.469***	-0.495***	-0.461***	-0.323***
	(-13.35)	(-11.80)	(-15.07)	(-13.72)	(-14.11)	(-8.80)
schk8	0.107***	0.0839***	0.0979***	0.120***	0.116***	0.332***
	(4.37)	(3.40)	(3.52)	(3.75)	(4.01)	(10.92)
schk3_black	-0.329*	-0.193	-0.346*	-0.0924	-0.0828	-0.318
	(-2.30)	(-1.26)	(-2.28)	(-0.29)	(-0.30)	(-1.94)
schk4_black	0.0539	0.219	0.266	0.337*	0.380**	-0.125
	(0.46)	(1.79)	(1.77)	(2.02)	(2.63)	(-0.87)
schk5_black	-0.460***	-0.361***	-0.196*	-0.0643	-0.0975	-0.297**
	(-7.33)	(-5.45)	(-2.46)	(-0.74)	(-1.11)	(-3.24)
schk8_black	0.0769	0.170	0.109	-0.0158	-0.0529	-0.255
	(0.62)	(1.40)	(0.72)	(-0.10)	(-0.40)	(-1.79)
Control Set	1	2	3	4	5	6
_cons	0.250***	-0.851***	-2.311***	-2.641***	-10.81***	-6.386***
	(17.03)	(-16.95)	(-10.37)	(-7.25)	(-28.39)	(-23.68)
N	15120	13696	9904	7896	7016	5664

Note: The Control Set denotes a set of parsimonious controls that are included in the appendix. Each control set has a different set of covariates. Schkn denotes the whether a student has graduated from elementary school in year n, while black is a binomial variable coded 1 for being black and 0 for being white. t statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

7 Appendix

The following table gives a complete set of the covariates used for each regression. At the bottom of tables 4 through 12, a control set number was used. The tables below correspond to each control set.

Figure 13: Control Set Variables Used for Baseline Regressions

Variable	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6
Black	x	x	x	x	x	x
Schk(n)	x	x	x	x	x	x
Schk(n)black	x	x	x	x	x	x
Years in a Small Class		x	x	x	x	x
Gender		x	x	x	x	x
Class Room Type		x				
1st Grade Free Lunch Eligibility				x	x	
1st Grade School Urbanity				x	x	
1st Grade Teacher Degree				x	x	
1st Grade Teacher Experience				x	x	
1st Grade Attendance				x	x	
1st Grade Motivation Score				x	x	
2nd Grade Free Lunch Eligibility				x	x	
2nd Grade School Urbanity				x	x	
2nd Grade Teacher Degree				x	x	
2nd Grade Teacher Experience				x	x	
2nd Grade Attendance				x	x	
2nd Grade Self Confidence Score				x	x	
2nd Grade Motivation Score				x	x	
2nd Grade Class Size				x	x	
3rd Grade Free Lunch Eligibility			x	x	x	
3rd Grade School Urbanity			x	x	x	
3rd Grade Teacher Degree			x	x	x	
3rd Grade Teacher Experience			x	x	x	
3rd Grade Attendance			x	x	x	
3rd Grade Motivation Score			x	x	x	
3rd Grade Class Size						x
8th Grade School Urbanity					x	x
8th Grade Language Expression Score					x	x
8th Grade Study Skills Score					x	x
8th Grade Identification Score						x
8th Grade Participation Score						x

Note: An x denotes whether the control set contained the specified variable. Each control set had a different set of covariates.

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