Preliminary draft
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Early Human Capital Skills and Labor Market Entry

Wim P. M. Vijverberg

School of Social Sciences
University of Texas at Dallas
P.O. Box 830688
Richardson, TX 75083-0688

Prepared for presentation at the
Third IZA/SOLE Transatlantic Meeting of Labor Economists
Buch am Ammersee, Germany
3-6 June 2004

Keywords: Education production, Cognitive skills, Labor market entry

J.E.L. Codes: I2: Education; J24, Human capital; J22, Labor supply

Abstract: This paper examines the build-up of human capital skills among a cohort of 1991 third grade students in Texas public schools, tracking them through high school and into institutions of higher education or into the workforce. Results indicate high rates of persistence of skill gaps at third grade, leading to differential patterns of labor market entry of these students as young adults.

Acknowledgements: I appreciate the help, comments, and suggestions provided by Daniel O'Brien, Greg Branch, Brian Bucks, and Nidhi Mehrotra. Needless to say, they have no responsibility for any errors.

1. Introduction

One of the most important investments in any society is education. In the U.S., average per student expenditures in public elementary or secondary education in 2000/2001 was $7376. In total, combining public and private funds, educational expenditures amounted to an estimated $852 billion in 2003, not far behind the roughly $1.1 trillion spent on private fixed nonresidential investment.[1] With it, society equips its next generation with skills and invests in human capital that in due time will yield abundant rewards, both personally and publicly. Or so we expect. Indeed, one of the most consistent findings in economics is the relationship between a person's educational attainment and his earnings, both among employees (Ashenfelter, Harmon and Oosterbeek, 1999) and among the self-employed (Van der Sluis, Van Praag and Vijverberg, 2003ab). Macroeconomic growth depends on human capital investments (Barro 1991, 2001; Hanushek and Kimko 2000), though growth might also lead to schooling investments (Bills and Klenow 2000).

But few are thrilled with the quality of education output. The U.S. ranks relatively low on internationally comparable cognitive achievement scores (e.g., Hanushek and Kimko 2000:1188). Just about every presidential and gubernatorial election campaign brings new discussions about new education initiatives. Soon after his inauguration, President Bush signed the *No Child Left Behind Act of 2001*, which aims to help students and schools that are not measuring up to specified improvement standards. Students are tested annually, and schools are held accountable for educational failure, be it students failing to pass these tests or students dropping out of school prematurely. Federal educational spending rose from $38.4 billion in 2000 to $63.2 billion in 2004 (U.S. Department of Education 2004), and still there is a clamoring for more funds.

This paper studies a cohort of students that grew up under just this kind of public accountability education regime. We follow them from third grade, when they are tested for the first time, until past high school when they either find jobs in the labor market or enter college and choose advanced fields of specialization. We track their build-up of cognitive skills and relate it to labor market entry: with the availability of test scores in consecutive years, it becomes possible to examine the impact of educational investments in programs such as special education

[1] Sources: U.S. Department of Education (2003, 2004); Economic Report to the President (2004).

or of such policies as teacher certification requirements and class size reduction on student scores, chances of graduation, and eventual performance in the labor market. In doing so, we evaluate the consequences of early human capital deficits for lifecycle levels of well-being.

There exists of course a substantial amount of literature on this topic already. Examples of econometrically oriented models include those studied by Willis and Rosen (1979), Hartog, Ridder and Pfann (1989), Kain and O'Brien (2000). More recently, a number of studies have taken a more structural approach, such as Keane and Wolpin (1997), Eckstein and Wolpin (1999), Ermisch and Francesconi (2000), Belzil and Hansen (2002), and Ahituv and Tienda (2004). Where this study differs is that it uses fairly long panel data of a large number of students, namely the Texas Schools Microdata Panel that covers all students in public schools from 1989 to 2002. This database is linked with campus and school district data, higher education data, and labor market information, and therefore is uniquely suited for this project. The database does have its drawbacks, in particular the scarcity of household information, but this should be weighed against the many other pieces of information that a survey of individuals or households will never capture.[2]

Section 2 describes the data in greater detail, in particular the way the high stakes test scores will be used in our analysis. Section 3 describes and analyzes the human capital investment process of a 1991 cohort of third grade students. Section 4 studies the graduation and dropout process. Related to this choice is the labor market participation of these teenagers while in high school. Section 5 considers the options of this cohort once it is past high school age: find employment, attend a community college, enroll at a four-year university, or study at the flagship public universities in Texas. If they pursue a higher education, we study the determinant of their field of specialization. Section 6 brings all of the results together. We examine patterns of ethnic differences, the consequences of growing up in a low-income family, and the impact of school expenditures and teacher experience.

[2] For example, the National Longitudinal Survey of Youth (NLSY79) contains data on individuals who were between 16 and 23 years of age in 1979. The sample is representative of the U.S. population of that age and contains extensive parental household information and subsequent labor market information but only a single snapshot of the school that the subjects attended and no cognitive skills pertaining to early childhood.

2. Data

The data come from the Texas Schools Microdata Panel, collected as part of the Texas Schools Project.[3] The database contains annual criterion-reference test scores for all Texas public school students from 1989-90 through 2001-02, higher education information for students enrolled over the same period in a Texas public university or college, and quarterly earnings data of all employees covered by unemployment insurance. We study students who were in third grade in 1991, following them into college and, for many, into the workforce.

Using Administrative Data

The TSP database is constructed from administrative data. Students are typically assigned a student id number that stays with them throughout their stay in Texas schools, but under certain circumstances (e.g., when a student walks in on the first day of class) a temporary id is assigned when the permanent id cannot be located. When enrolling in the next year, some students retain their temporary ids, others receive new temporary ids in the next year, others receive their permanent ids, and a few who have permanent ids in the past are enrolled with temporary ids. Occasionally, students in different school districts receive the same temporary id by chance. Just as well, it happens that temporary id numbers used in the past are reused for new students. The student's social security number is also recorded,[4] but many students do not yet have a social security number when they enroll, in part because they are so young and in part because they are children of illegal immigrants. Sometimes, they are assigned temporary social security numbers that are then replaced later on in the database with permanent ones that are usable for linkage with SAT and workforce data. By the time students graduate they almost all have a valid social security number, but it is preferable to link student records across years by student id. When a student id disappears or multiple records with the same student id appear, a linkage is established through a comparison of social security numbers if they exist, and otherwise of gender, birth date, and campus of enrollment: in this way, many students starting

[3] A description of the Texas Schools Project, the Texas Schools Microdata Panel (TSMP) and working papers based on the data is available at http://www.utdallas.edu/research/tsp/index.htm This project is one of many research topics being investigated using the TSMP. Its goal is to increase the awareness of researchers concerned with educational issues and to provide tools to develop improved measures of student ability beyond raw test scores, strengthening results of policy-oriented educational production function analyses.

[4] It should be noted that both the student id and the social security number are encrypted to prevent privacy issues. Temporary id numbers are flagged to facilitate the analysis of these panel data, as will become clear in a moment.

out with temporary ids and no social security number eventually receive a permanent student id and an official social security number. After all records are linked across years, the student's gender and birth date (day, month, year) as recorded each year are compared as well; if gender and two of the three part of the birth date match, a valid linkage is assumed.

Test Scores

The test scores represent measures of cognitive skills. Texas was one of the first states to mandate statewide assessment of public school students (Kain and O'Brien 1999). The Texas program was recently rated second only to the North Carolina program (Princeton Review, 2002). With the President and several Department of Education bureaucrats all hailing from Texas, it formed the model for the *No Child Left Behind Act of 2001* (NCLB) that directs states to develop challenging standards, administer high stakes accountability tests in grades 3-8, define adequate yearly progress (AYP) objectives, report on progress at the state, district and campus levels, and concentrate improvement efforts on remediation for campuses and students that do not meet AYP objectives (NCLB 2002). States are free to develop their own test instruments.[5] Thus, it is likely that similar data will soon become available in other states as well.

Since 1980, various programs have been used in Texas to test students in several grades. For this paper, the Texas Assessment of Academic Skills (TAAS) test scores are used. TAAS was administered from 1991 to 2002.[6] Starting with the 2002/2003 academic year, the TAAS test has been replaced by a new test instrument, the Texas Assessment of Knowledge and Skills (TAKS), which has been under preparation since 1999 and is broader and, according to preliminary analyses, more challenging (TEA, 2002b). Moreover, as required by NCLB, tests are administered in more grades and in more subjects.

Beginning in 1994, TAAS has been administered in the spring semester to students in grades 3 through 8, focusing in most grades on language and mathematics skills. Students were

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[5] Each state must also participate in the biannual National Assessment of Educational Progress (NAEP) administered in math and reading in the 4th and 8th grades. NAEP results will be used to confirm that the progress measured by each state's tests is consistent with NAEP results.

[6] By mandate of the state board of education and based on an extensive test development process by the Texas Education Agency (TEA), the test measures a student's skill level consistently from one year to the next, so that individual student progress and comparable improvement could be tracked from year to year, and the test is of approximately equal difficulty from one administration to the next, covers specified objectives, is free of cultural and linguistic biases, and is able to discriminate between high and low student understanding of the particular skill being measured using item response theory (TEA 1997; Hulin et al. 1983).

also required to pass an exit-level test, first administered during January of grade 10.[7] Testing in consecutive elementary and junior high grades allows year-to-year analysis of student academic progress. Prior to 1994, the TAAS test was given to students in third grade as early as 1991. For each test, a passing score is determined. Except for the exit level test, passing the test has not been a criterion for student promotion at the end of the year, but, in Texas, passing rates are used as the primary basis for assigning an accountability rating to each campus and district (TEA, 2002a), which is widely publicized and politicized.

Before delving into the analysis, it is important to clearly understand what the test scores are saying about student skills. Commonly, in using test scores as simple skill measures, one implicitly assumes that the link between skill and score is linear: a one-unit increment in the score represents an equivalent rise in ability, regardless of the position in the overall distribution of scores. A simple frequency distribution calls this assumption into question. Figure 1 shows the distribution of TAAS test scores in reading, writing and math for all students of the 1991 third grade cohort. The *x*-axis measures the number of correct answers (raw score), and at the top of the diagram a box plot highlights important percentile values of the distribution of the test scores. The *y*-axis measures the frequency distribution. Clearly the test score distribution is far from normal, with a much longer tail to the left and a wave of students pushing against the highest score. Several Texas education researchers have recognized this ceiling effect (Clopton 2002; Just for the Kids 2001). Note also that this ceiling effect does not represent a simple case of censoring, because censoring would yield a clustering of individuals, a spike in the histogram, at the boundary value of the top score. Figure 1 does not exhibit censoring spikes. Rather, while most questions are simply not difficult enough for many students, a few harder questions create the distinction among the more able students, such that only relatively few obtain the top score. This is what may be referred to as hidden censoring (Vijverberg and O'Brien, 2004).

A comparison over time also indicates that the compression at the top of the distribution is tightening. Table 1 highlights this shift through quartile values for sixth and eighth grade scores in various subjects. It is possible that students are indeed getting smarter. It could also be that in order to maximize the passing rate, teachers focus more of their attention on students who are likely to test near the passing score, at the cost of the worst and the best students. Teachers

[7] In addition, in order to receive a high school diploma, students failing the exam had six more chances to pass the test prior to the student's normal graduation date.

may also prefer to focus on subjects covered on the annual test, ignoring other topics that are also educationally productive. The data are supportive of the notion of such "teaching to the test" behavior (Koretz 2002; Stecher 2002). Just as well, the number of test waivers has also increased at least in part of a growing participation in special education programs. This probably empties the bottom of the distribution (see below).

These are relevant facts. In this paper, we follow the 1991 third grade cohort into college and, for a large number of them, into the workplace. The cohort's progress is assessed with TAAS scores in third, sixth, and eighth grade, and we will also look at the exit test.[8] Students arrive in sixth grade, and even more so in eighth and tenth grade, in different years. Standardization takes care of the shift in the distribution over time but is still subject to a worsening hidden censoring. Vijverberg and O'Brien (2004) designed three econometric models that enable one to derive skill measures from test scores that are subject to this form of censoring. According to each model, the skill gain per point in the middle of the score range is substantially smaller than at the high end of the score range: on a 50-item test, it is much easier to gain five points from a base of 35 than from a base of 45 points. Two of the three models have data requirements that exceed what is available for our analysis. The third model is in principle implementable, but for reasons to be explained later we take a simpler approach that yields a similar score-ability relationship: we normalize the test score. Thus, let S denote the test score, with S = 1, …, $S_{\max}$ and a distribution function $F(s) = \Pr[S \le s]$.[9] Define z_s as the equivalent percentile value: $z_s = \Phi^{-1}(F(s))$. A student's level of ability A falls in the range $(z_{s-1}, z_s]$ when her score equals $S = s$, where $z_0 = -\infty$ and $z_{S_{\max}} = \infty$. We therefore assign the average value of A over this range to this student:

$$A = E[Z \mid z_{s-1} < Z < z_s] = \frac{f(z_{s-1}) - f(z_s)}{\Phi(z_s) - \Phi(z_{s-1})} \quad \text{iff} \quad S = s \tag{1}$$

[8] In 1991, the TAAS test was implemented for the first time, and in third grade only. In 1992 and 1993, this cohort was not tested with the TAAS test; thus, 1994 is the first year we find these students in the database again. In addition, we are not so much interested in the year-to-year transitions as we are in the bigger picture. The eighth grade score, rather than a later score, is selected for reasons explained below.

[9] In the database, a value of S = 0 could technically indicate a score of 0 but, due to administrative reasons, mostly denotes students with invalid entries, possibly due to absenteeism, waivers, etc. Since the left tail is sparse anyway and a score of 0 would be rare indeed, nothing is lost by dropping the value of 0 from the range of feasible scores.

The relationship between S and A is illustrated for reading and math tests in Figure 2, for third, sixth and eighth grade tests taken in the 1991, 1994 and 1996 when most of this cohort took these tests. The nonlinearity highlights the deviation of F from normality, and in every case the curve becomes steeper near the upper end of the score range. The steeper slope at the lower end of the range is practically irrelevant, given the concentration of students at the right hand side of the range; see Table 1. Throughout this study, we will work with the normalized rather than the standardized test scores.

As is evident in Table 1, different subjects are tested in different grades. In 1991, third graders were tested on reading, math and writing; sixth graders fill out reading and math tests; and eighth graders are tested in reading, math, writing, science, and social studies. The exit test contains reading and math. On the one hand, one might wish to collapse these tests into a single human capital variable. Indeed, factor analysis points out one dominant factor at each grade level. Factor loadings, presented in Table 2, do show some variation in the importance of the test subjects, but it would not be invalid to condense the analysis around these factors. On the other hand, such a strategy would hide much heterogeneity among students that ultimately may become important in their labor market choices. Therefore, we shall pursue both tracks.

Other Information in the TSP Database

The TSP database contains a limited number of personal characteristics: gender, ethnicity, age, an indicator whether the student has limited English proficiency, participation in special education, and information whether the student qualifies for the free or reduced lunch program (as a crude measure of household income). Because the student's campus is known, peer/neighborhood effects can be computed as the average among students at the given grade level or on the campus overall. In addition, from TEA data files, we gather campus measures such as teacher experience, budgetary variables, the degree of student mobility, and an indicator whether sixth grade is part of an elementary or a middle school.

For all students living in Texas the TSP database contains information on the SAT and ACT tests, as well as a number of variables describing student enrollment and performance in public institutions of higher education within Texas. At the moment, students attending private institutions as well as those pursuing higher education outside of Texas are not yet part of the database. Information on the degree of self-selection in this regard is hard to come by. Kain and

O'Brien (2000:24) report that, in 1997, approximately 81 percent of high school students going on to college enrolled as freshmen in a public two-year or four-year university within Texas. For community colleges, the selectivity was much less at 95 percent, but of those who attend a four-year college or university, 66 percent attended a Texas public institution; 19 percent went to a private school in Texas; and 15 percent went out of state. The degree of selectivity may have been inflated some, as 1997 was the first year after the Hopwood decision. Moreover, significant numbers (as least one in ten) of out-of-state and private school students transferred to complete their study at a public Texas university.

Finally, the TSP database also contains quarterly earnings, collected by the Texas Workforce Commission, for every job in Texas that job is covered by unemployment insurance. This amounts to more than 98 percent of wage and salary employment, but it omits the self-employed, employees of religious organizations, railroads, and small farms (King and Schexnayder 1998). Unfortunately, hours of work are not part of the information, but the information can be linked to student records through the (encrypted) social security number and therefore provides a unique source of information. Obviously, the value of this information grows as the students age and enter onto their career paths.

3. Building Human Capital

Schooling Careers of the 1991 Third Grade Cohort

As a precursor to the econometric analysis, let us consider the flow of the 1991 third grade cohort through the school system. First, we define the cohort not only by their grade but also by their age. A student is allowed to enter first grade if he/she is six years of age by September 1, though waivers can be requested. Thus, most third graders will be eight years old. We admit into the cohort also those students who are one year older and were detained or held back by one year, as well as those students who are in third grade but are one year younger and had skipped a grade. Table 3 follows the cohort over time. In 1992, 90.95 percent has been promoted to fourth grade; 1.50 percent was retained; 0.17 percent skipped to fifth grade.[10] For

[10] A small number of students (48 of 269,475) enrolled in second grade in 1992 after having enrolled in third grade in 1991. This kind of seemingly erratic behavior occurs in later years as well, most likely referring to students with handicaps of various kinds. Seven students actually enrolled in sixth grade in 1992.

1.33 percent of the cohort, there is an identification problem in that while student id numbers matched, gender and/or birth date information was inconsistent. These are pulled out from the grade enrollment tabulation into a separate category. Attrition occurs: 3.03 percent is no longer enrolled and never enters the database again, and 3.00 percent did not enroll in 1992 but does return in some later year. We return to this below.

Over time, the third grade cohort disperses. Seventy-eight percent reaches eighth grade at the normal tempo, five years later. Retention causes 6.60 percent to arrive in eighth grade after six years, 0.50 percent is in eighth grade seven years later, and 0.45 percent arrives one year earlier.[11] Moreover, 4.40 percent of the cohort is not enrolled in 1996 but will still enroll again between 1997 and 2002, and 10.50 percent has permanently vanished. By 2001, 58.66 percent of the cohort graduates from a Texas public school.

The attrition is a potential cause for worry. Table 4 describes the subsamples of leavers and stayers in each year. We consider a number of factors. First of them are gender and ethnicity.[12] As household conditions change, economic status obviously changes. Moreover, the number of special education students trends upward in part because of policy and also because learning deficiencies become apparent over time. For these reasons, we also describe income status and learning status information for stayers. Finally, we include the human capital factor score in third, sixth and eighth grades, including the percentage of students for whom TAAS scores were missing. As we will see later, this latter group includes a substantial number of low performing students. For reference, the 1991 column describes the overall cohort as of that moment.

In the initial years, the sample of leavers included greater percentages of Anglos and Asians who had higher household incomes. They were less likely involved in special education and had fewer language problems. They scored above average on the third grade TAAS test. It is probably fair to say that these students may have transferred to private schools or are being homeschooled. An equally plausible assumption is that these children grow up in households

[11] Corman (2003) cites government statistics suggesting that retention rates in the U.S. are higher (at 15 to 29 percent by age 15) than those evident in Table 3. However, the statistics here document retention from grade 3 onward, and sample leavers may be re-enrolling at the same grade elsewhere. Unlike Corman's study, we do not examine reasons for grade repetition. Recorded sixth and eighth grade test scores pertain to the last TAAS tests taken. The exit test score is the first one taken, to avoid the statistical problems inherent in repeated tests.

[12] Ethnic association may change over time, in part because mixed designations are not coded but also sometimes for strategic reasons (Berg, Kain and Pai 2002).

that migrate more frequently, which is arguably unrelated to the education process studied in this paper.

In addition and especially so in 1992, some attrition is simply due to the fact that the student was enrolled with a temporary student id and at some point vanished in the crowd with another temporary or permanent number; note that the student population is dynamic: over time in the same grades as the 1991 cohort, we find students who are retained from higher grades or skip grades from lower grades, or who transfer in from other states or from private or home schools. It is debatable whether this administrative kind of attrition biases the analysis.

In the middle to high school years, the tide turns. Boys are more likely to leave. Household income of school leavers is lower, the percentage of Hispanics rises sharply, leavers have lower English skills and are more often in special education, and they scored lower (or did not participate) on TAAS tests. This is true especially in 1998 and 1999, when students normally would enter tenth or eleventh grade. Since schooling is mandatory until age 16, which students in our selected cohort reach between the school years of 1996 to 1999, it should be concluded that the school leavers trend represents conscious educational decisions. For this reason, we will examine the schooling process until eighth grade (normally, 1996) and investigate the determinants of dropout and graduation from there. In addition, the eighth grade test contains a broad range of subjects and is therefore of greater interest.

The graduating class of 2000 leaves the sample in 2001 and represents a clear break from the trend in the previous few years. Students still in school in 2001 and 2002 come from lower-income households and are themselves slower learners.

While Table 4 focuses on years of schooling and thus illustrates the human capital build-up in a traditional sense, shifts in the location of students within the distribution of human capital present another facet of the dynamics of the cohort. Table 5 presents transition matrices, distinguishing students by quartile and missing score status in consecutive testing rounds. There is a high degree of stability in the distribution. For example, 52.1 percent of the top quartile math third grade students score in the top quartile on the sixth grade test; 45.1 percent of the bottom quartile students repeat this performance—and these percentages would be even higher if those missing tests are dropped. Note also that there is slightly greater stability in math than in reading skills. Transition in the factor scores fall between the math and reading range, with the exception of the performance on the exit test where stability is substantially more pronounced. In other words, the eighth grade test score is a strong predictor of the performance on the TAAS exit exam.

So where do third grade students end up? Table 6 illustrates the destination of top and bottom quartile third grade students on their sixth grade, eighth grade and exit exams. In math, there is an immediate reshuffling up to sixth grade, then stability to eighth grade and a further spreading, especially because of students leaving school, on the exit exam. In reading, there is a slightly more pronounced regression towards the mean. However, top students rarely drop to the bottom, and bottom students rarely rise to the top: in either direction, only one in 40 to 50 students makes that transition. The human capital factor scores show more pronounced stability.

Multivariate Analysis

Of course, many factors influence these dynamics. We therefore continue with an econometric analysis of the build-up of human capital, based on the so-called value added approach (e.g., Todd and Wolpin 2003). Denote the grade level with *g*. A vector of determinants X_g relates to various measures at the current grade level. In addition, skill exhibited in the prior grade is an input in the production process:

$$A_{gi} = X_{gi} b_g + d A_{g-1,i} + u_{gi} \quad (2)$$

A_{g-1} represents all past inputs, which therefore do not have an independent influence of a student's performance in grade *g*. Since our analysis skips grades between tests, we use repeated substitution of (2) to arrive at the regression model. For example, if there are *h* years between the tests, we have:

$$A_{gi} = \Sigma_{j=0}^{h-1} \left(\Pi_{l=0}^{j} d_{g-l}\right) X_{g-j,i} b_{g-j} + \left(\Pi_{j=0}^{h-1} d_{g-j}\right) A_{g-h,i} + \Sigma_{j=0}^{h-1} \left(\Pi_{l=0}^{j} d_{g-l}\right) u_{g-j,i} \quad (3)$$

This is greatly simplified if one assumes $b_{g-j} = b_g$ and $d_{g-j} = d_g$ for j = 0, …, *h*. This still leaves a regression model that is nonlinear in d, which is impractical in the light of issues yet to be discussed. Thus, we define $\bar{X}_{gi}$ as the average of X for student *i* between grades *g* and $g-h$ and collapse the multiplicative terms in simple parameters:

$$A_{gi} = \bar{X}_{gi} \tilde{b}_g + \tilde{d} A_{g-h,i} + \tilde{u}_{gi} \quad (4)$$

where therefore $\tilde{b}_g \approx hb_g$ and $\tilde{d}_g = \left(d_g\right)^h$.

Tracking multiple (say, m) skill dimensions requires us to rewrite equation (2). Specifically, redefine A_{gi} to be a $(1 \times m)$ row vector capturing the m skills of student i. Then:

$$A_{gi} = X_{gi}\mathrm{B}_g + A_{g-1,i}\Delta_g + U_{gi} \tag{5}$$

where B_g is a matrix with m columns and Δ_g is a square $(m \times m)$ matrix. Repeated substitutions and subsequent simplifications yield a regression model similar to (4), but it becomes clear that the precise structure imposed in equation (5) (as in (3) for the univariate model) is not recoverable unless one actually estimates (5) on grade-by-grade school data. The alternative is to simply apply (5) to the data, defining the time periods from third to sixth and sixth to eighth grade to be the time units of essence. This is the approach taken in this paper. Moreover, we add flexibility in the dynamic structure of the model by allowing for a direct impact of third grade skills on measured eighth grade skills. Thus, the model of education production is given by:[13]

$$\begin{aligned} A_{3i} &= X_{3i}b_3 + u_{3i} \\ A_{6i} &= \overline{X}_{6i}\tilde{b}_6 + \tilde{d}_6 A_{3i} + \tilde{u}_{6i} \\ A_{8i} &= \overline{X}_{8i}\tilde{b}_8 + \tilde{d}_{8,6}A_{6i} + \tilde{d}_{8,3}A_{3i} + \tilde{u}_{8i} \end{aligned} \tag{6}$$

As Todd and Wolpin (2003) point out, value added models are subject to threats of simultaneity bias. To illustrate, focus on the first two equations in (6). Since the set of explanatory variables is likely incomplete, it does not capture an underlying inherent skill factor I that raises scores throughout the schooling career. However, in the Texas context, there is more. The politicized nature of the test puts pressure on teachers to provide more help to marginal students, and since the main emphasis is on passing anyway, the parents of these students may well pay more attention to their performance than those of students who perform well. Students far below and above the threshold are, relatively speaking, neglected. Conceptually, this may be incorporated through a compensatory factor C_6, which is thus argued

[13] One of the models in Vijverberg and O'Brien (2004) estimates a two-grade education production model in conjunction with a relationship between S and A, using a modified bivariate ordered probit approach. This becomes harder to implement with a three-equation model as in (6), as it would require evaluation of trivariate normal probabilities.

to be an inverse-U shaped function of A_{3i} and a host of other factors *Z*, some of which may already be in the regression equation (e.g., perhaps and then unfortunately so, ethnicity of the student) and other that are unobservable (e.g., ethnicity of the teacher relative to that of the student, personality of the student). These factors are made explicit as follows:

$$\begin{aligned} A_{3i} &= X_{3i}b_3 + a_3 I_i + v_{3i} \\ A_{6i} &= \bar{X}_{6i}\tilde{b}_6 + \tilde{d}_6 A_{3i} + a_6 I_i + q_6 C_6\left(A_{3i}, Z\right) + v_{6i} \end{aligned} \tag{7}$$

where the parameters a_3, a_6, and q_6 are positive. The presence of *I* biases the OLS estimator of $\tilde{d}_6$ upward, and an instrumental variable estimator is needed to correct for this bias. The compensatory factor generates a bias in an unknown direction but more likely downward, given that the majority of the cohort passes the test with relative ease. The only way to control for this bias is to find proxies for compensatory actions. Instruments are correlated with A_3 and therefore by definition with C_6 but they may well be orthogonal to *Z*. Thus, an instrumental variable estimator does not resolve the bias completely. But how harmful is this? Compensatory behavior is an embedded part of the educational production process in an environment where high stakes testing provides the measuring stick of cognitive skills. We fail to estimate the intertemporal transition parameter $\tilde{d}_6$ that applies to environments where cognitive skills tests are scientific and unpoliticized, but we are able to estimate the nature of the value added process that applies in the educational environment created by the *No Child Left Behind Act of 2001*. In sum, therefore, an IV estimator removes the upward bias caused by *I* and a portion of the negative bias caused by C_6; the relative magnitude of the IV and OLS estimators is an empirical matter.

Then, what instruments are suitable? Equation (7) suggests a natural IV estimator: instrument A_3 with X_3, and similarly instrument A_6 with $\left(X_3, \bar{X}_6\right)$. This choice has chronological justification and is dubbed IV-CHR. Note that, in concept, the variables included in X_3 and $\bar{X}_6$ overlap virtually entirely: these vectors contain student characteristics, school inputs, and peer characteristics (reflecting neighborhood or peer effects). Differences arise when students move between campuses, change into or out of special education, acquire English proficiency, or change ethnic association. Moreover, in some school districts, sixth grade is part of the middle school; in others, it belongs to elementary school. This also causes variation between X_3 and $\overline{X}_6$.

On the other hand, it is undeniably true that, with respect to A_3, $\overline{X}_6$ is exogenous and potentially informative, such that instrumentation of A_3 with $\left(X_3, \overline{X}_6\right)$, and similarly A_6 with $\left(X_3, \overline{X}_6, \overline{X}_8\right)$, may be advisable because it could lead to better predictions of the endogenous variable and therefore a more efficient IV estimator. This will be referred to as IV-2SLS. The OLS, IV-2SLS and IV-CHR estimators are compared in Table 7, reporting only the estimates of d but including various lagged cognitive skill combinations. First, consider the first line of the regressions of A_6 and A_8 where only the same skill is lagged: with the exception of the effect of Factor 3, the IV estimates are always *larger* than the OLS estimates. This corresponds with results in Vijverberg and O'Brien (2004) who examined fourth and fifth grade math scores of the 1998 third grade cohort: the bias induced by compensatory behavior is stronger than that resulting from unobserved inherent ability. Second, when multiple skills are included in the sixth grade equation, the IV estimates struggle with multicollinearity problems. Dropping Writing 3 changes the IV-2SLS estimates of the effects of third grade reading and math to more plausible values: 0.555 and 0.124 in the Reading 6 equation and 0.048 and 0.626 in the Math 6 equation. Third, in the eighth grade equations, the instrument set is richer, adding $\overline{X}_8$ in the case of IV-2SLS and $\overline{X}_6$ when using IV-CHR. The difference between OLS and IV-2SLS results is large but robust: adding combinations of cognitive skills does not yield wild fluctuations. IV-CHR is impacted more by variations in specification. On the basis of these considerations, we adopt the IV-2SLS method as the preferred estimation procedure, despite misgivings about the use of future *X*-variables as instruments.[14]

[14] A related consideration might be the quality of the first-stage regressions (Bound, Jaeger, and Baker 1995; Staiger and Stock 1997). Third grade cognitive skills regressions on X_3 yield R^2 values of 0.147 to 0.176 with *F*-statistics of 1521 and upward, much greater than what Staiger and Stock warn to be a danger threshold (a value of 10). Adding $\overline{X}_6$ raises the R^2 to 0.212 to 0.251. Under IV-CHR, the first stage sixth grade cognitive skills regressions generate R^2 values of 0.236 and 0.237. Under IV-2SLS, these rise to 0.260 and 0.263. For each endogenous variable separately, the instrument set is not weak even under IV-CHR, but, as mentioned, multicollinearity among the predictions is substantial.

Let us turn then to the full set of IV-2SLS estimates in Table 8. Panel A contains the so-called level regressions for third grade scores and the value added regressions for sixth graders; the appropriate chronological timing of the explanatory variables is implied. Panel B examines the eighth grade scores.[15] To avoid interpretation problems associated with multicollinearity, Writing 3 is omitted from the sixth grade equations. Though not complex, Table 8 is large because we follow the build-up of many skills through a process that involves many determinants. Interdependencies among the determinants further obscure the interpretation of the estimation results.

Being level regression models, the third grade results reflect the gaps between students, be it along ethnic or income lines or programs like special education or supplementary English. Boys are behind in reading and writing but slightly ahead in math. Campus/neighborhood characteristics also determine at what level children are.[16] Low-income neighborhoods hinder child development; special education programs and help for children with limited English proficiency help students campus wide. Surprisingly, mobility among the student population is associated with higher test scores, and campus expenditure and teacher experience lower scores.

The sixth grade scores indicate strong persistence in skills over time, at a rate of close to 70 percent; the factor score correlation is somewhat lower. Parameter estimates in this equation measure education production between third and sixth grade. Asian American students achieve greater gains than Anglos; African American and Hispanic students lag behind, as do those from low income households, with limited English proficiency, and in special education programs. Residing in low-income neighborhoods further lowers scores. Student mobility and campus size are detrimental; campus expenditures and teacher experience are beneficial. Finally, whether grade 6 is part of a middle school or belongs to an elementary school matter only slightly for math scores.

In Panel B, we observe that skill persistence between sixth and eighth grade is extremely strong. The parameter estimates linking eighth grade scores to sixth and third grade scores is

[15] The sample on which these models are estimated contains all students from the 1991 third grade cohort who were still in the database in sixth or eighth grade, who did not fall more than two years behind before finishing sixth grade and did not fall more than one extra year behind before finishing eighth grade.

[16] Hanushek et al. (2003) take a more structural approach to peer effects, incorporating the average achievement of the student's peers on the same campus as an explanatory variable. The model examined in this paper might be viewed as a reduced form of that structural model.

around 1, implying that as a rule there is hardly any regression to the mean. Boys gain on girls in their factor score; they lag in reading and writing but obtain higher scores in science and social studies. In reading, science and social studies, African American and Hispanic lag behind Anglos; Asian American students make substantial gains in math and writing. Native Americans do more poorly on science and social studies tests, but there is little difference with Anglos in other dimensions. Low income hurts slightly, but limited English proficiency does not appear to be disadvantageous any longer. Again, note that these students are in public schools since third grade and are therefore not recent immigrants. The impact of special education is mixed, but a student who moved between campuses lags behind in every subject. Compared with the third and sixth grade results, neighborhood effects are mixed: large campuses with more mobility and more experienced teachers achieve lower scores; campus expenditures also tend to be associated with lower scores. But when more of the student population comes from low-income households or is African American or Hispanic, a student's score is higher, and when the sixth grade is already integrated in middle school, students gain between 1.5 and 3.0 percent of a standard deviation (3.9 percent if we focus on the Factor 8).

4. Towards Graduation

In Section 3, it was clear that the selection process of dropping out vs. graduation starts soon after eighth grade. An analysis of cognitive skills as measured by test scores is therefore fraught with selectivity bias. Moreover, the TAAS exit test administered in tenth grade (and repeatable many times if failed) examines material that is already covered in previous grades and thus does not offer a particularly suitable measure of additional investments in cognitive skills. For these reasons, we examine the link between eighth grade cognitive skills and graduation directly.

The administrative records contain information about students who graduate and about some students who leave school for various reasons. However, of the 63,649 students who make it to eighth grade and do not graduate, the database contains reasons for leaving only for 15,742 students. Since dropouts reflect negatively on the school administrators in the context of public accountability ratings, it is likely that these records only pertain to students leaving during the year, and that students who simply do not enroll in the fall are benevolently assumed to have transferred. But as Table 1 showed an increased rate of students leaving school just during those high school years, it is plausible that many of the 47,907 vanishing students have indeed dropped out. Even so, not graduating does not necessarily mean being a dropout.

In order to support our analysis of the factors that stimulate graduation, we also examine who works during the school year. In this, we focus on the receipt of earnings during the fourth and first quarters of the calendar year, since the summer vacation frees students up to work without harming their human capital investments. Because schooling is mandatory until age 16, we consider students who are "at risk" (i.e., at least 16 years of age when the respective quarter ends) until May of 2000 when they are normally graduating. Under this definition, work is an indicator of dropping out from school, albeit imperfect as students in school may also work a part-time job.

Table 9 shows the bivariate probit estimates of these presumably correlated choices. The explanatory variables pertain to personal and campus conditions in eighth grade, as indicators of school inputs, neighborhood conditions and personal environment. Uniformly, higher test scores in eighth grade, especially in math, are associated with a greater likelihood of graduation and a lower chance of working during the school year. Male students are less likely to graduate, as are Anglos. Students from low-income households more likely drop out of school and seek work. An interesting result is found with respect to limited proficiency in English and special education programs: these students are more likely to graduate and less likely to receive earnings. It is not clear whether this is a reflection of the success of programs to help these students or of a lack of their employability—but since the regression model controls for skill, program success may be well implied.

Campus/neighborhood effects matter. To highlight a few, a student on a large campus with greater numbers of Asian and Native American, mobile, special education, and reduced-lunch students is less likely to graduate and more likely to work. Ceteris paribus, campus expenditures are associated with lower graduation rates but also fewer working students.

The correlation between the disturbances of the two equations is substantially negative. Someone more likely to seek work during the school year is less likely to graduate, holding all observables constant.[17]

5. After High School

Seeking Access to Higher Education

As the last step of our endeavor, we examine the choices of the 1991 third grade cohort after it leaves high school. First of all, consider the option of higher education. It needs to be noted that Texas residents are able to freely enroll in community colleges once they have a high school or GED diploma. Furthermore, since 1997, students in the top ten percent of their high school class are automatically admitted to any public university in Texas.[18] Other than that, to be admitted to more prestigious institutions of higher education, taking the SAT or ACT exam—and performing well—is a must. Bucks (2003) illustrates the strong correlation, up to an SAT score of 1400 or so, between SAT performance and enrollment into the two premier public universities in Texas, namely University of Texas at Austin and Texas A&M University.

Table 10 reports the estimated relationship between cognitive skills measured in eighth grade and the SAT scores on the math and verbal sections.[19] Since students take the test in eleventh or twelfth grade, they cannot be dropping out earlier; moreover, taking an SAT test when planning not to graduate is pointless, since graduation is necessary for successful college application. Thus, suitable explanatory variables describe conditions from ninth to eleventh grade. Nevertheless, not all eighth grade students end up taking the SAT exam: in fact, the selectivity among SAT takers is more severe than among those who graduate. It is therefore mandatory to apply a correction for self-selection; given the analysis of graduation in Section 5,

[17] This is consistent with research on work during college education by Stinebricker and Stinebricker (2003).
[18] The Top 10 Percent Law was signed in 1997 in response to the Supreme Court's 1996 decision to let the Fifth Circuit's decision on *Hopwood v. Texas* stand, prohibiting affirmative action admission policies. For more information, see Kain and O'Brien (2003).
[19] These scores range from a minimum of 200 to a maximum of 800. The combined score averages about 970. ACT scores on the English and Reading sections are converted into an SAT verbal equivalent through a polynomial regression analysis on about 22000 students in this cohort taking both the SAT and ACT test. Similarly the math ACT math score is translated into an equivalent SAT math score. The R^2-values of these regressions are 0.71 and 0.77 respectively.

the selection equation is specified in the same way as the graduation equation, but results are not reported in Table 10.

Ceteris paribus, a one standard deviation gain in human capital yields 100 points on the math test and 104 on the verbal section. This roughly corresponds to the gain if each cognitive skill component rises simultaneously by one standard deviation: the gain would be 114 in math and 117 in verbal. Hispanics score lower and Asians score higher than Anglo students; African American students are 8 to 10 points behind on math and little on verbal. Students from lower income households score 20 to 25 points less in total. Limited English proficiency appears to present no barrier, but note that this indicator may have lost its meaning as these students have been in the school since third grade. Campus ethnicity is a major correlate of SAT performance: students from schools that serve predominantly African American or Native American populations score substantially lower, and those from schools where the Asian population is larger do much better. This is after low-income status in the neighborhood is controlled for, which is a very important factor by itself. Teacher experience and school budget matters little, but students from larger schools where fewer students are in special education programs perform better. Finally, there is a strong positive self-selection in each equation. The implied correlation coefficient equals 0.61 for the math component and 0.67 for the verbal section.

Taking the SAT test does not necessarily imply enrollment at a college or university; because of the Top 10 Percent Law and open enrollment policies, not taking the SAT test does not always prevent one from pursuing a higher education. To understand the process of college enrollment better, we estimate a multinomial logit model where the options are (*i*) enrollment at a community college (a system of junior colleges that is widespread in Texas and guarantees automatic subsequent admission into universities), (*ii*) enrollment at one of the traditional flagship universities of UT-Austin and Texas A&M University, (*iii*) enrollment at any one of the remaining public four-year colleges or universities in the state, and (*iv*) not enrolling at any of these institutions. The latter is the base case in Table 11 and includes those who do not pursue a higher education anymore, those who attend private colleges or universities within the state, and those who seek postsecondary education out of state. Unfortunately, the data do not allow us to decompose this group. In response, the specification of the index functions underlying the multinomial logit model incorporate nonlinear effects of measured skills.

These skills are measured by SAT scores, if available, and the factor score that summarizes eighth grade cognitive skills, in recognition of the top ten percent rule as well as the fact that admission is based on more than SAT scores alone—and because of this we estimate conditional models separately for TAS test takers and non-takers. As Bucks (2003) demonstrated in a nonparametric regression analysis, the nonlinearity of the effect of SAT scores is marked. Panel C evaluates an average high school student who took the SAT test (and had a factor score of 0.54): both the least and the most skilled students choose not to enroll at a public institution of education. Cognitive skills add additional nonlinearity to this. Among students who did not take the SAT test, the average factor score is –0.36. Only about one in five of these seek a postsecondary education, and there is a mostly monotonic relationship in evidence here. The rightmost column of Panel D indicates that some students indeed rely on the Top 10 Percent Law to get them into college. In Panel A, note, furthermore, that the SAT math score drives the enrollment classification more than the score on the verbal test.

Once enrolled, the existing mix of human capital skills as measured by eighth grade TAAS scores is highly instrumental in the choice of major (Table 12). Note that these are the majors students enroll with, not fields they graduate from with a bachelor's degree. In interpreting the parameter estimates, also note that arts and humanities constitute the comparison group. This latter field as well as social sciences attracts students with superior reading skills; these same students avoid business administration, engineering and computer science, health, and semi-academic fields.[20] Students with math skills seek out natural sciences, business administration, and computer science and engineering. Students with writing skills are drawn to arts and humanities, though the differentiation is not nearly as sharp as is the case with reading and math. High test scores in science lead to enrollment in natural sciences and engineering and computer science, and those who did well on the social studies TAAS test tend to register under a social science major.

Skill sets are not the only determinant. By choice, male students seek out engineering and computer science more frequently, and female students are found more often in health-related majors. According to the main ethnic differentiations, ceteris paribus, Anglo students enroll in arts and humanities; Asian American students are found in natural sciences, engineering

[20] The eight fields listed in Table 12 are an aggregation of 48 study areas. The group of "Semi-academic fields" contains areas like military, interpersonal skills, leisure and recreation activities, and various trades.

and computer science, and semi-academic fields; African American students are found relatively frequently in business administration, engineering and computer science, health, and other academic fields; and Hispanic students are relatively more frequently drawn to health fields.

Earnings

Finally, we examine the effect of cognitive skills on earnings. The earnings data come from the Texas Workforce Commission and, as mentioned before, consist of quarterly earnings on jobs covered by unemployment insurance. As hours of work are not recorded, we are unable to turn this information into hourly wages. The estimated effects thus measure the combined impact on hourly wages and working hours. This immediately suggests that those who are finished with their education should be separated from those who attend school and cannot work fulltime. Arguably, the decision to attend school is jointly determined with the choice to find employment, but this issue is left for future research.

Table 13 reports estimated earnings equations, estimated with a maximum likelihood correction for self-selection. The sample consists of person-quarters: each quarter in which a member of the 1991 third grade cohort is aged 18 or older is included, up to the second quarter of 2002. The standard errors are computed allowing for clustering effects by person. Human capital is again measured by means of eighth grade TAAS test scores. The regression equation also includes dummies for years of high school attended, though this pertains only to attendance of public schools in Texas. A dummy for graduation (from a public school) is also added. The grade dummy variables have a minimal impact, perhaps indicative that students have received their schooling elsewhere if the dummy variable contained a zero value or else that high school attendance really does not count for much in the labor market unless one actually graduates.

There is a marked distinction between higher education students and those who finished schooling in the effect of graduation and human capital. For those out of school, graduation pays off with a return of 13 percent, and a one-standard deviation gain in human capital raises earnings by 18 percent. Math, reading and social studies skills all contribute; writing and science skills are not rewarded. For higher education students, the dummies for eleventh and twelfth grade carry a negative parameter estimate. Given that these are students in college, this may well indicate that not attending these grades in public school means acquiring an education at a private school and subsequently receiving rewards for a better quality of education. The graduation dummy has an insignificant effect: non-graduates must have a GED in possession in order to enter college. Contrary to high school graduates, college students are not turning their cognitive skills into earnings in these college years. Those with better scores may be dedicating themselves to more demanding fields of study—or, if these skills run in the family, they have parents who help finance their education. Whatever the explanation, the distinction between college students and high school graduates and dropouts is important.[21]

The earnings regression results also indicate a strong age effect, substantial ethnic differences, quarterly variation in earnings, and a strong negative selectivity effect. Those who are more likely to work earn less; those who earn more are less likely to find employment. It should be noted in this regard that "non-employment" includes those in the cohort who study at private colleges or at out-of-state colleges. The negative selectivity effect is therefore not at all surprising.

6. Evaluation and Conclusions

Having examined every stage of the early lifecycle of the 1991 third grade cohort, we now examine how differences between students propagate themselves from childhood to young adulthood. Figure 3 considers two children who differ by one standard deviation in their overall cognitive skill package (bars) or in their math skills (solid circles) and who are identical in all other aspects. All effects are expressed in standard deviation magnitudes, including those related to probabilities; the difference between the bars and the circles is the effect approximately due to reading and writing skills.[22] As mentioned before, the degree of skill persistence is stronger after sixth grade than between third and sixth grade. SAT scores rise by almost a full standard deviation. The shock also has a large positive impact on graduation, the likelihood of taking the SAT test, and enrollment in a more challenging college and a more challenging study college major.

[21] In fact, if these samples are pooled, a healthy negative human capital effect results. College students work fewer hours, even as their cognitive skills may open up more rewarding jobs.
[22] The sixth grade value added models do contain third grade writing skills, unlike those reported in Table 8. Note also that in nonlinear models the impact of reading and writing skills may differ from the gap between the bars and the circles.

Figure 4 compares African-American against Anglo students while holding all other factors, including peer environment, constant. The bars demarcate the total predicted difference, whereas the solid circles highlight the impact of past difference on the present. Thus, the gap between the bars and the circle measures the contribution of ethnicity to current human capital investment. Thus, there is evidence of some degree of remediation after the third grade, but relative to the impact of past deficits the scope of remediation is limited. Even so, the probability of graduation and taking the SAT test are virtually the same as for Anglos, and the likelihood of enrollment at a 4-year college or university is higher—as is the chance that an African-American student does not pursue an education at one of the three alternatives.

Figure 5 makes the same sets of comparisons between Hispanic and Anglo students. Gaps are smaller, remediation at the sixth grade level is more pronounced, but the situation at the eighth grade and the SAT test is similar. The likelihood of graduation is slightly less than Anglos (and therefore also less than African Americans), and Hispanics are less inclined to pursue a higher education.

It should be noted that Figures 4 and 5 only modify the student's own ethnicity and that the school's ethnic composition is left unchanged. Thus, we are comparing two students attending the same average campus. An alternative extreme comparison contrasts an Anglo student at a 100-percent Anglo campus with an African-American (or Hispanic) student at a 100-percent African-American (or Hispanic) campus. Table 14 juxtaposes the two comparisons. In most cases, the statistics in the column that simultaneously changes peer characteristics are *smaller* than those where only personal ethnicity is modified.[23] One exception to this is the likelihood of working during high school years. Note as well that it is difficult to allow these comparisons to capture realistic variations among students: for example, household income and proficiency of the English language are correlated with ethnicity but are not allowed to vary here.

Finally, Figure 6 raises three school inputs by one standard deviation: total campus expenditures, teacher experience and the percentage of students participating in special education programs. As Todd and Wolpin (2003) pointed out, it is difficult to envision the correct

[23] The specification of the regression models does not permit one to interpret this as evidence against diversity or in favor of segregation. The estimates indicate that an African-American student migrating from an Anglo campus to an African-American or Hispanic campus performs better at school, *as does an Anglo or Asian-American student moving from an Anglo campus to an African-American or Hispanic campus.* The regression models do not incorporate a variable measuring the percentage of the student body that has the same ethnicity as a respondent.

interpretation of a change in only one of these at the time. The only negative bar in Figure 6 refers to the likelihood of not enrolling in one of the three public higher education institutions in Texas. Thus, school inputs have their intended effect: they help educate children and steer them towards more challenging majors when attending a college or university. But note the scale of the vertical axes: where ethnic differences generated impacts between –0.7 and 0.25 standard deviations, the influence of school inputs amounts to no more than –0.02 to 0.04 standard deviations, and the impact on choice of major is virtually invisible when put on the same scale. Thus, the school input effects are exceedingly small. This is so, despite the fact that the additions in inputs are by no means small: a one standard deviation change in expenditures per student amount to an increase of $752 on a base of $3536, or 21.3 percent. Twenty-eight percent more children are helped with special education programs, and teachers have two more years of experience (compared to an average of 11 years). Thus, it is appropriate to echo the conclusion reached on the basis of a sample of white males drawn from the NLSY79 data by Eckstein and Wolpin (1999:1335): "Policies that do not alter traits with which youths come to high school will have very limited success in improving school outcomes." In fact, critical traits appear to be in place already by third grade.

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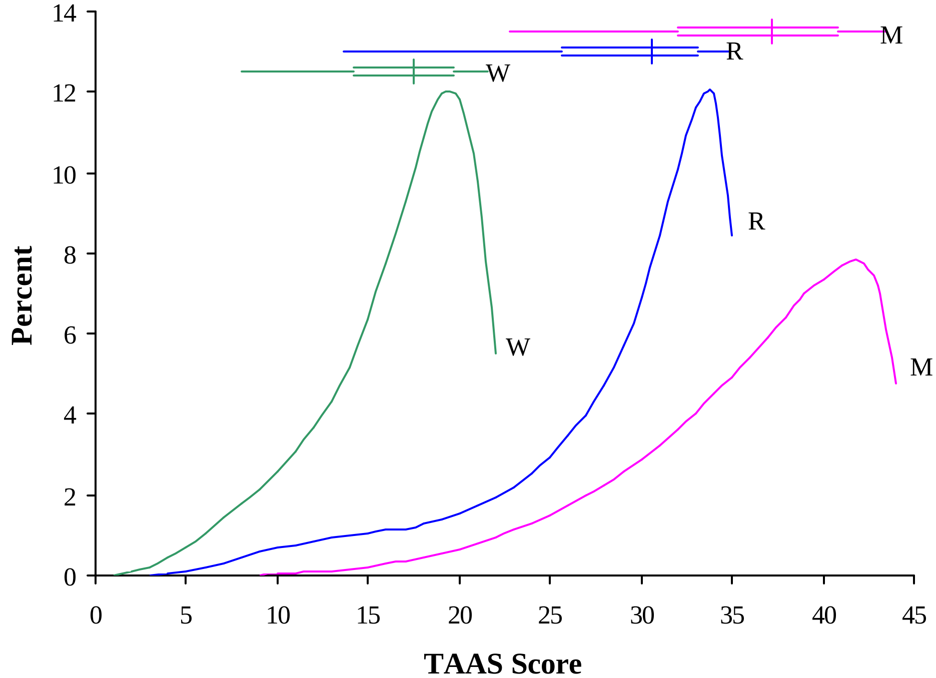
Figure 1: Distribution of TAAS Scores in Reading, Writing and Mathematics for the 1991 Third Grade Cohort



Note: boxplots indicate percentiles at the 5, 25, 50, 75 and 95 marks.

Figure 2: Normalization Transformation of the TAAS Test Scores

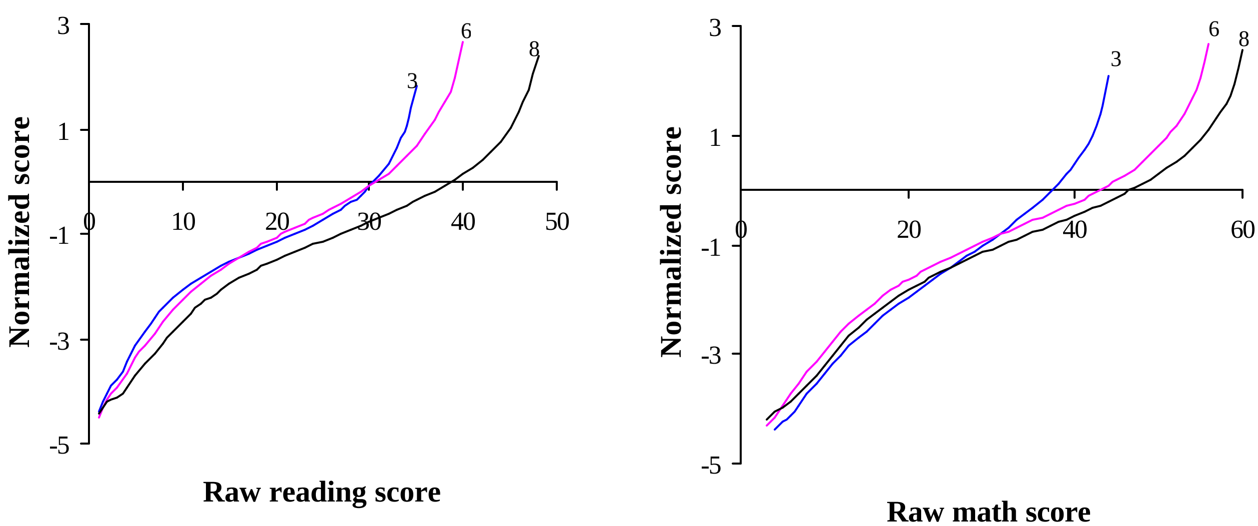
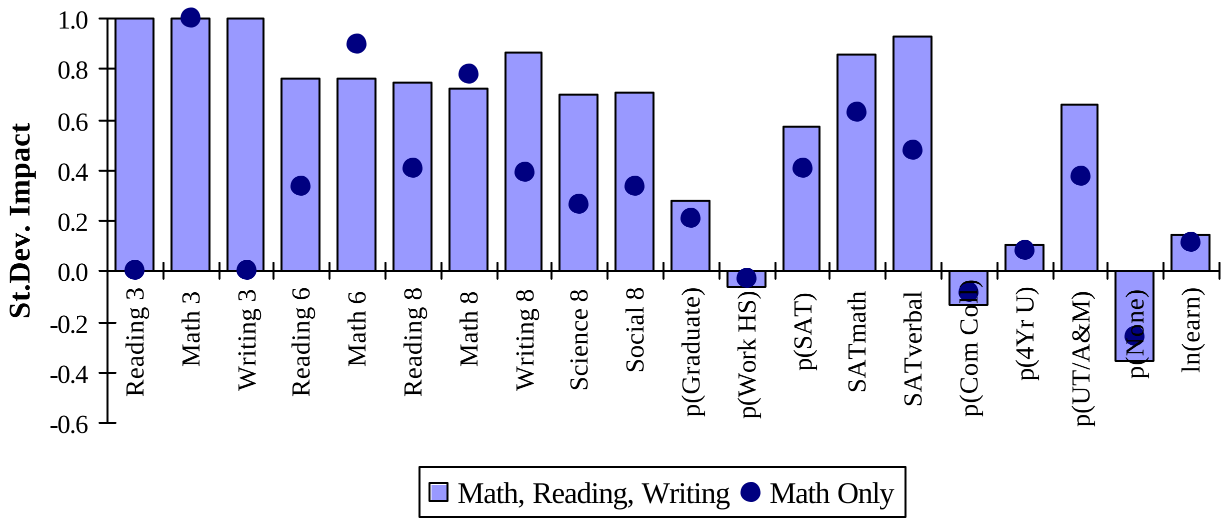


Figure 3: Impact of a One-Standard-Deviation Shock in Third Grade



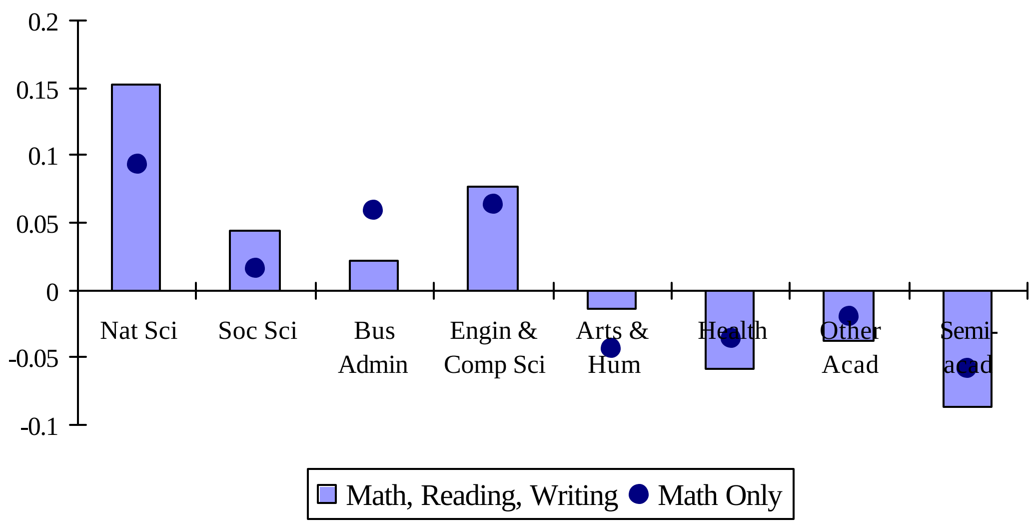


Figure 4: Ethnic Difference: African-American Compared With Anglo Students

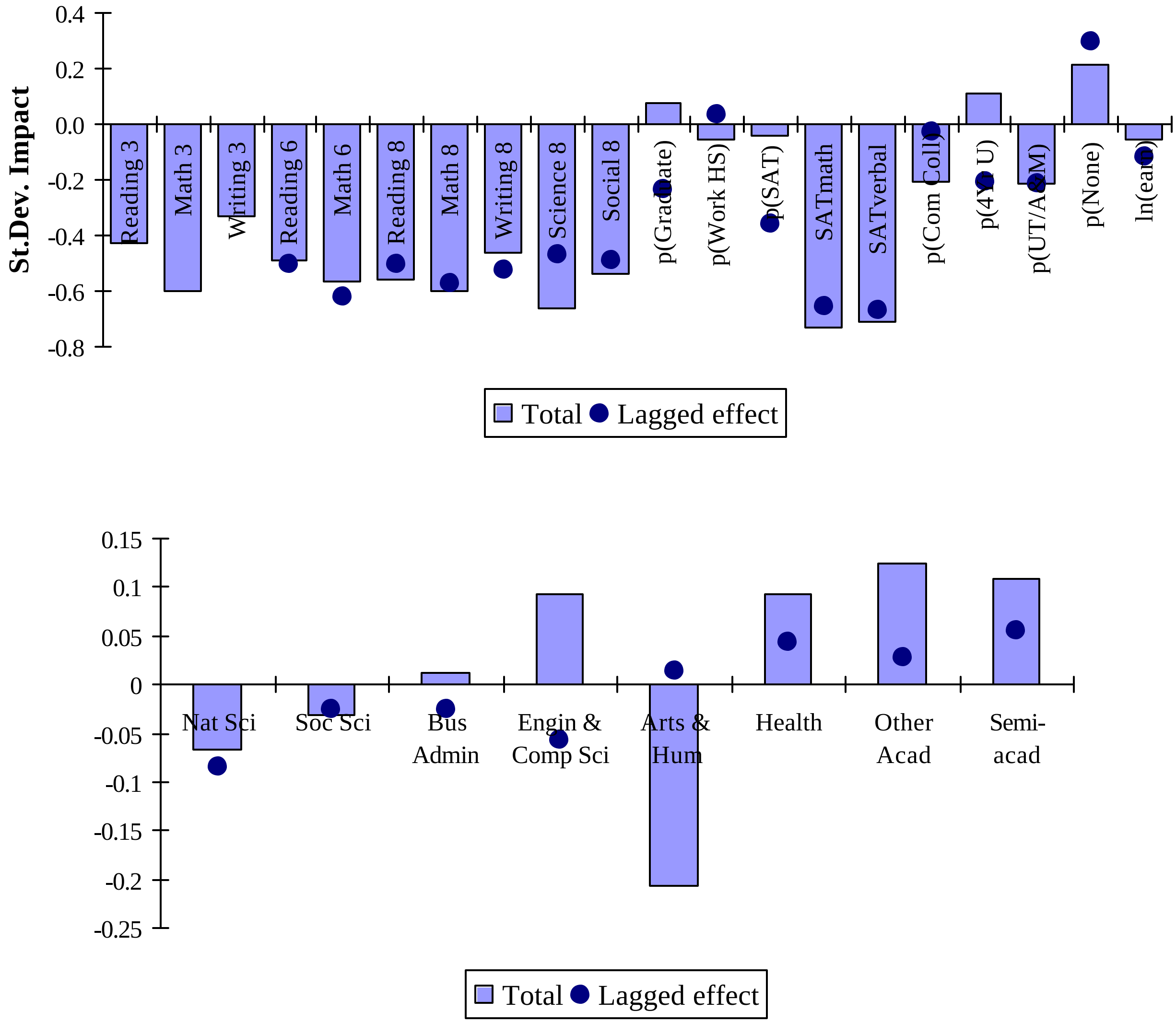
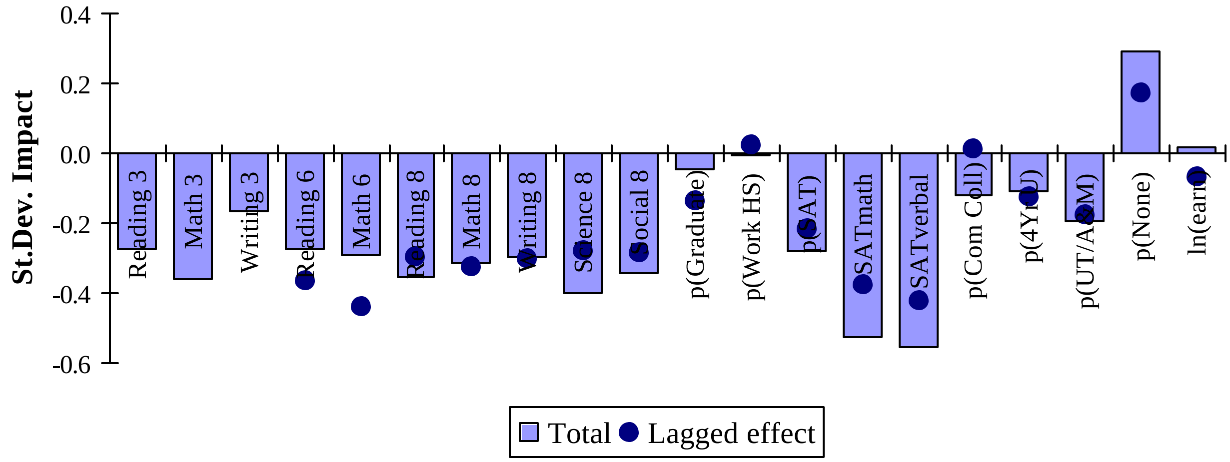


Figure 5: Ethnic Difference: Hispanic Compared With Anglo Students



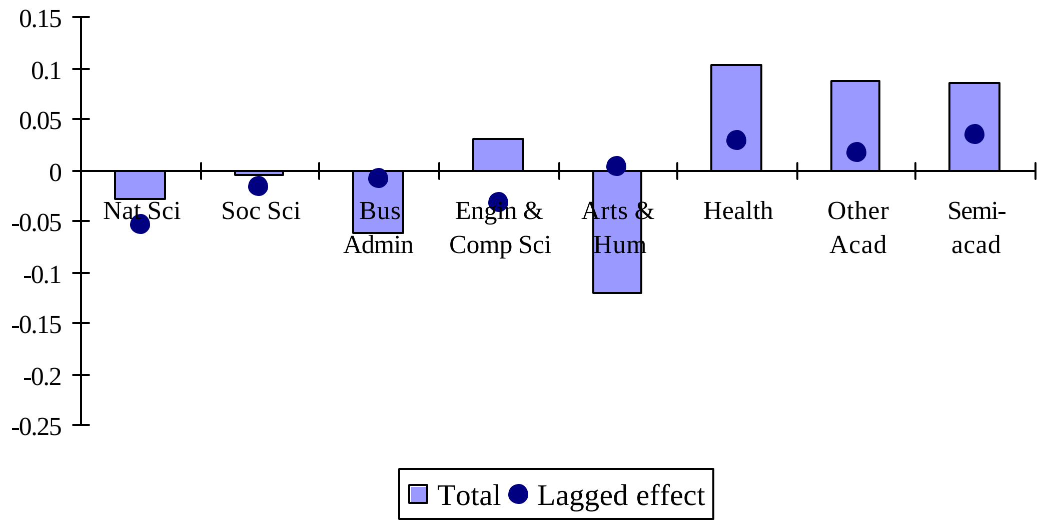


Figure 6: Impact of Schooling Inputs

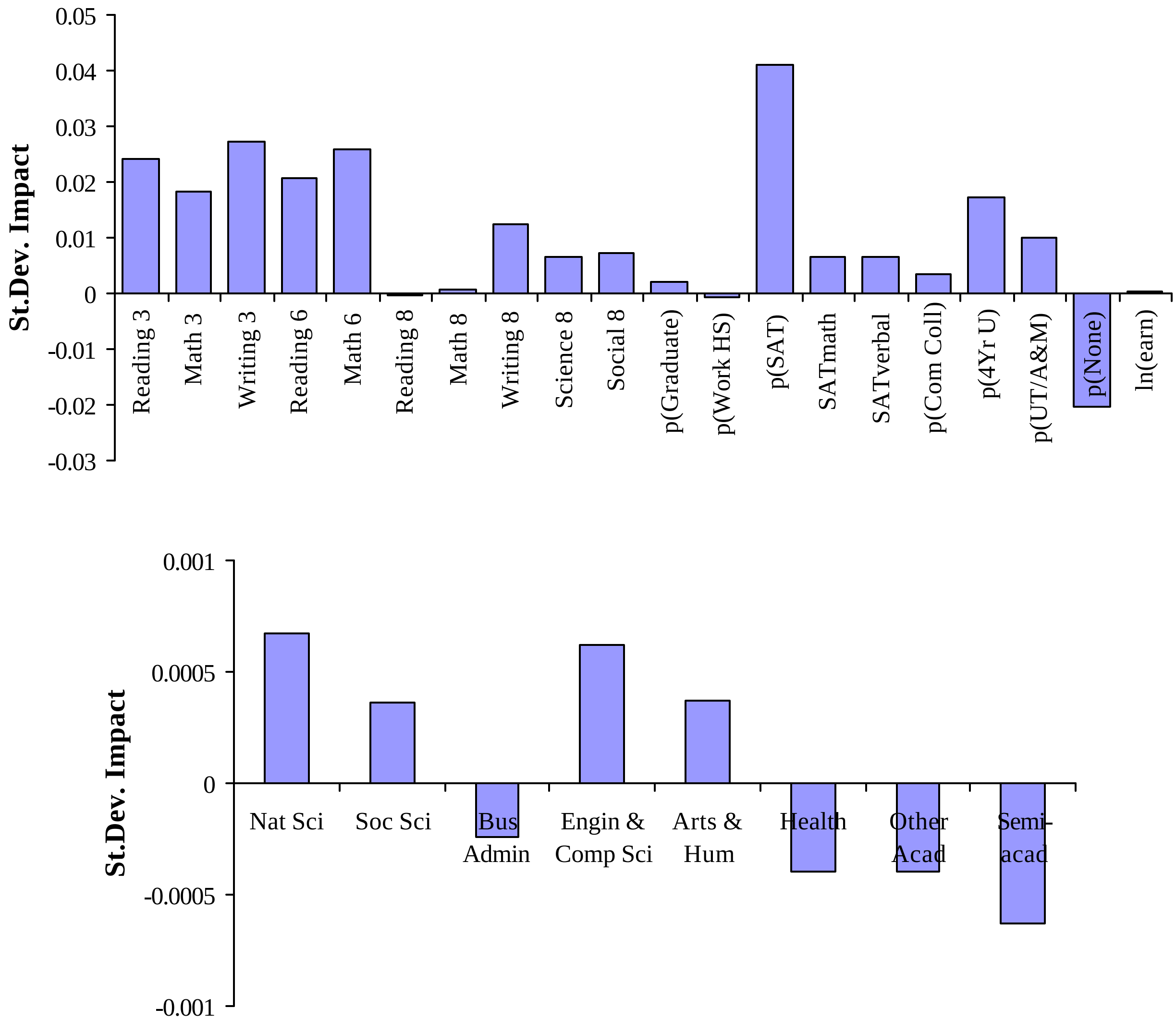


Table 1: Evolution of TAAS Scores over Time: Quartile Value as a Percentage of the Test's Maximum

	Reading			Math			Writing			Science			Social studies		
	25	50	75	25	50	75	25	50	75	25	50	75	25	50	75
Grade 3															
1991	73.1	87.3	94.6	72.7	84.6	92.8	64.4	79.5	89.4						
Grade 6															
1994	59.6	76.5	87.4	58.2	76.4	87.7									
1995	57.8	73.0	84.1	54.6	71.2	86.4									
1996	62.2	78.4	88.8	66.3	81.9	91.2									
1997	68.8	83.3	92.1	70.8	85.3	93.2									
1998	69.6	83.3	91.5	72.8	85.7	92.9									
1999	74.0	86.0	93.5	76.0	87.7	94.3									
Grade 8															
1995	63.7	79.2	89.3	50.2	67.4	82.9	60.9	74.3	85.1	65.0	77.4	86.4	56.3	72.7	85.4
1996	64.1	80.5	90.7	60.3	77.4	88.7	62.4	74.3	84.6	67.7	80.9	89.8	57.2	72.6	85.0
1997	67.5	81.7	90.8	64.5	81.4	91.5	67.6	79.4	88.8	70.1	80.6	88.3	55.9	71.4	83.7
1998	70.7	84.6	92.5	68.9	82.0	90.7	69.7	81.9	90.5	72.6	84.2	91.6	57.7	71.6	82.4
1999	77.0	87.8	94.1	74.5	86.0	93.2	73.5	84.4	91.1	76.4	86.0	92.8	67.4	80.5	89.4

Table 2: Condensing TAAS Test Scores into a Single Human Capital Factor: Factor Loadings

TAAS subject	Grade 3	Grade 6	Grade 8	Exit test
Reading	0.810	0.851	0.885	0.829
Math	0.727	0.851	0.855	0.814
Writing	0.811		0.809	0.811
Science			0.846	
Social Studies			0.891	

Table 3: Flow of 1991 Third Grade Cohort over Time

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Typical grade level	3	4	5	6	7	8	9	10	11	12		
Two years behind grade level		0.02	0.05	0.06	0.09	0.19	0.43	0.50	4.54	2.49	1.43	0.91
One year behind grade level		1.50	2.37	3.03	4.53	6.23	6.60	16.72	10.85	7.22	4.23	
At grade level	100.00	90.95	87.29	84.63	81.76	77.97	76.50	63.61	59.01	55.58		
One year ahead of grade level		0.17	0.26	0.36	0.45	0.64	0.42	0.41	1.05			
Two years ahead of grade level		0.00	0.01	0.00	0.01	0.01	0.01	0.05				
Enrolled, other		0.00	0.00	0.01	0.01	0.02	0.02	0.05	0.07	0.97	0.71	0.60
Graduated in earlier years								0.00	0.05	2.31	55.47	58.66
Identification problem		1.33	1.35	0.25	0.14	0.04	0.02	0.00	0.04	0.06	0.01	0.00
Temporarily not enrolled		3.00	3.54	4.32	4.06	4.40	3.32	2.62	1.92	0.78	0.41	
No longer enrolled		3.03	5.13	7.34	8.96	10.50	12.68	16.04	22.47	30.59	37.74	39.82

Note: N = 269,475

Table 4: Factors behind Sample Attrition

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	Total Sample	Sample leavers										
Male	51.2	51.5	50.9	50.5	51.7	51.3	50.7	51.0	53.7	52.2	49.3	63.9
Native American	0.2	0.5	0.3	0.2	0.2	0.5	0.3	0.4	0.3	0.4	0.2	0.2
Asian American	2.0	3.5	3.0	3.7	2.5	2.3	2.0	1.2	1.2	1.5	2.2	1.0
African American	14.3	14.9	14.0	11.1	11.7	11.3	11.1	13.2	15.4	15.0	13.6	21.9
Hispanic	33.5	26.0	21.3	22.1	25.9	28.2	34.7	41.4	40.6	39.5	31.2	48.7
Anglo	50.0	55.2	61.4	62.9	59.7	57.7	51.9	43.8	42.4	43.7	52.9	28.3
Eligible for free lunch	37.8	37.2	34.1	33.4	35.8	38.1	40.1	44.7	41.9	35.7	21.7	35.8
Eligible for reduced lunch	6.7	6.5	7.2	6.4	5.8	5.6	4.0	4.0	3.9	4.8	4.7	4.5
Limited English proficiency	10.1	10.7	7.6	7.1	7.8	7.4	7.8	8.4	6.2	4.3	1.6	3.8
Special education	11.1	10.2	11.9	11.6	14.2	15.3	16.2	18.9	17.8	16.2	9.6	18.9
Temporary student id	4.9	35.9	10.3	6.8	5.1	5.8	4.8	4.2	4.3	3.8	3.0	3.9
Factor 3	0	0.02	0.12	0.14	0.06	-0.03	-0.08	-0.32	-0.34	-0.24	0.14	-0.57
Factor 3 missing	22.3	29.6	23.1	22.4	25.3	26.8	27.3	29.2	27.2	25.7	18.9	27.6
Factor 6					0.16	-0.03	0.15	-0.38	-0.42	-0.30	0.16	-0.58
Factor 6 missing					45.6	27.5	57.6	33.0	28.3	25.4	14.1	25.4
Factor 8								-0.40	-0.48	-0.37	0.16	-0.62
Factor 8 missing								49.5	40.6	32.1	14.5	27.1
Number of observations	269475	10240	5362	4721	4044	4048	5869	9103	18644	28072	161328	14013
		Sample Stayers										
Eligible for free lunch		37.9	40.0	40.7	39.4	37.7	35.7	31.6	29.3	25.1	40.8	43.7
Eligible for reduced lunch		6.7	6.4	6.4	6.3	6.0	5.8	5.3	5.2	5.2	5.9	6.3
Limited English proficiency		10.0	9.0	8.6	7.8	6.6	5.4	4.6	3.5	2.7	6.2	6.4
Special education		11.1	11.8	12.3	12.1	12.2	12.3	12.0	11.7	11.0	24.3	44.9
Number of observations		259235	244256	237731	233308	229914	223270	217153	200479	174686	16010	2950

Table 5: Human Capital Transition Matrices, by Grade Level

	Math 3					
Math 6	M	1	2	3	4	Total
M	49.0	24.9	17.2	14.8	14.1	24.2
1	17.8	45.1	24.3	9.8	2.7	20.4
2	12.2	20.2	28.4	20.0	8.1	18.2
3	11.5	8.2	22.0	30.4	23.0	19.1
4	9.7	1.7	8.2	25.0	52.1	18.2
Total	100	100	100	100	100	100

	Read 3					
Read 6	M	1	2	3	4	Total
M	49.6	25.9	15.5	14.3	14.2	24.4
1	18.1	45.8	22.9	8.7	3.0	21.0
2	12.8	19.2	29.1	21.0	10.7	19.1
3	10.7	7.2	22.6	30.4	26.4	18.8
4	8.8	1.9	10.0	25.6	45.7	16.7
Total	100	100	100	100	100	100

	Factor 3					
Factor 6	M	1	2	3	4	Total
M	49.3	28.6	16.7	14.8	14.4	25.5
1	16.9	44.4	22.9	7.7	1.7	18.7
2	12.7	19.9	32.2	22.1	7.0	18.6
3	11.4	6.1	21.7	32.5	23.1	18.8
4	9.7	1.0	6.6	23.0	53.8	18.5
Total	100	100	100	100	100	100

	Math 6					
Math 8	M	1	2	3	4	Total
M	69.3	17.0	9.9	7.7	6.5	24.6
1	15.1	55.6	19.9	4.2	0.6	19.5
2	7.1	21.8	42.3	25.4	5.5	19.7
3	4.8	4.7	22.1	37.7	23.3	17.6
4	3.8	0.9	5.8	25.1	64.1	18.6
Total	100	100	100	100	100	100

	Read 6					
Read 8	M	1	2	3	4	Total
M	68.8	16.1	9.3	7.5	6.7	24.5
1	14.8	51.5	18.5	4.2	0.9	18.9
2	7.6	25.4	41.7	23.8	6.3	20.7
3	5.6	6.2	25.7	43.4	34.1	21.4
4	3.2	0.9	4.7	21.0	52.1	14.5
Total	100	100	100	100	100	100

	Factor 6					
Factor 8	M	1	2	3	4	Total
M	72.7	25.5	15.9	12.4	10.3	30.5
1	12.7	53.0	19.5	3.0	0.4	17.4
2	6.3	18.1	41.9	21.8	2.9	17.4
3	4.7	3.2	20.3	42.6	20.7	17.4
4	3.7	0.3	2.5	20.2	65.7	17.4
Total	100	100	100	100	100	100

	Math 8					
Math X	M	1	2	3	4	Total
M	91.9	35.1	18.1	11.5	7.6	36.5
1	4.6	47.8	22.9	4.6	0.5	15.9
2	1.8	13.6	38.7	28.8	6.5	17.0
3	1.2	3.1	17.8	39.7	30.4	17.1
4	0.5	0.4	2.5	15.4	54.9	13.6
Total	100	100	100	100	100	100

	Read 8					
Read X	M	1	2	3	4	Total
M	92.0	35.6	18.2	12.1	8.6	36.9
1	4.4	42.7	18.5	3.6	0.6	13.8
2	2.0	18.1	42.0	27.4	8.0	19.6
3	1.0	3.1	17.3	35.5	28.5	16.2
4	0.6	0.6	4.1	21.5	54.3	13.6
Total	100	100	100	100	100	100

	Factor 8					
Factor X	M	1	2	3	4	Total
M	73.9	35.0	17.8	11.5	8.0	35.0
1	10.4	50.1	21.9	3.2	0.2	16.2
2	6.2	12.6	41.6	25.3	3.1	16.2
3	5.2	2.0	16.8	42.9	22.7	16.3
4	4.5	0.3	2.0	17.2	66.1	16.2
Total	100	100	100	100	100	100

Notes: “M” denotes missing scores; 1, 2, 3, 4 refer to quartiles.

Table 6: Destination of Top and Bottom Third Grade Students

A: Students in the Top Quartile

Reading

	Grade 3	Grade 6	Grade 8	Exit
M		14.1	17.1	24.4
1		2.7	2.5	2.4
2		8.1	8.9	9.5
3		23.0	20.4	23.7
4	100	52.1	51.2	40.0
Total	100	100	100	100

Math

	Grade 3	Grade 6	Grade 8	Exit
M		14.2	16.7	24.5
1		3.0	2.3	2.1
2		10.7	10.1	12.3
3		26.4	30.0	24.6
4	100	45.7	40.8	36.5
Total	100	100	100	100

Factor

	Grade 3	Grade 6	Grade 8	Exit
M		14.4	20.4	21.9
1		1.7	1.6	1.7
2		7.0	6.5	7.7
3		23.1	20.3	21.3
4	100	53.8	51.3	47.4
Total	100	100	100	100

B: Students in the Bottom Quartile

Reading

	Grade 3	Grade 6	Grade 8	Exit
M		24.9	26.0	41.8
1	100	45.1	42.4	33.0
2		20.2	21.8	16.9
3		8.2	7.8	6.9
4		1.7	2.0	1.4
Total	100	100	100	100

Math

	Grade 3	Grade 6	Grade 8	Exit
M		25.9	26.6	43.4
1	100	45.8	40.4	28.5
2		19.2	22.5	19.5
3		7.2	8.8	6.6
4		1.9	1.7	2.1
Total	100	100	100	100

Factor

	Grade 3	Grade 6	Grade 8	Exit
M		28.6	35.5	44.7
1	100	44.4	39.9	34.1
2		19.9	18.2	15.0
3		6.1	5.6	5.1
4		1.0	0.8	1.0
Total	100	100	100	100

Note: "M" refers to missing scores; 1, 2, 3, 4 refer to quartiles.

Table 7: Sensitivity Checking on Value Added Models: Specification and Estimation Strategy

		Factor 6		Reading 6		Math 6		Factor 6		Reading 6		Math 6	
		Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t
OLS	Factor/Read/Math 3	0.645	335.6	0.537	260.3	0.564	293.2						
	Reading 3			0.366	145.1	0.164	67.1						
	Math 3			0.200	84.2	0.415	180.2						
	Write 3			0.119	47.6	0.137	56.6						
		IV-2SLS						IV-Chronological					
IV	Factor/Read/Math 3	0.525	18.5	0.647	18.7	0.667	17.7	0.617	11.6	0.823	11.6	0.775	11.5
	Reading 3			1.598	7.8	1.274	6.1			2.074	4.7	1.709	3.7
	Math 3			0.337	2.6	0.899	6.7			0.337	1.6	0.942	4.2
	Write 3			-1.173	-6.3	-1.407	-7.3			-1.299	-4.4	-1.595	-5.1

		Factor 8		Reading 8		Math 8		Factor 8		Reading 8		Math 8	
		Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t
OLS	Factor/Read/Math 6	0.814	518.5	0.647	370.4	0.714	445.4						
	Factor/Read/Math 6	0.658	315.6	0.531	248.1	0.593	292.0						
	Factor/Read/Math 3	0.248	117.9	0.222	103.3	0.204	103.2						
	Reading 6			0.486	221.2	0.148	71.8						
	Math 6			0.254	115.7	0.620	300.6						
	Reading 6			0.405	164.0	0.116	50.1						
	Math 6			0.182	71.4	0.519	216.4						
	Reading 3			0.159	66.5	0.001	0.6						
	Math 3			0.080	34.4	0.175	80.4						
	Writing 3			0.014	6.1	0.036	16.9						
		IV-2SLS						IV-Chronological					
IV	Factor/Read/Math 6	1.037	99.2	0.925	73.6	0.911	80.2	1.075	81.0	0.941	60.9	0.925	64.9
	Factor/Read/Math 6	0.999	47.0	0.946	32.7	0.913	38.7	0.624	6.4	0.040	0.1	0.725	8.4
	Factor/Read/Math 3	0.059	3.3	-0.009	-0.4	0.011	0.4	0.385	4.7	0.785	1.5	0.216	2.4
	Reading 6			1.079	19.1	0.432	9.2			1.054	15.5	0.395	7.0
	Math 6			-0.157	-2.8	0.489	10.4			-0.126	-1.8	0.519	8.9
	Reading 6			1.061	13.2	0.705	9.1			1.570	5.3	0.800	3.8
	Math 6			-0.165	-2.3	0.312	4.6			-0.188	-1.3	0.263	2.6
	Reading 3			0.029	0.4	-0.036	-0.5			-0.699	-1.3	-0.128	-0.3
	Math 3			0.195	2.6	0.259	3.5			-0.085	-0.3	0.302	1.4
	Writing 3			-0.156	-1.9	-0.274	-3.4			0.379	0.8	-0.263	-0.8

Table 8: Educational Production: Value Added Regression Results

Panel A	Reading 3		Math 3		Writing 3		Factor 6		Reading 6		Math 6	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t
Factor 3[a]							0.525	18.5				
Reading 3[a]									0.555	8.5	0.050	0.8
Math 3[a]									0.124	1.7	0.626	9.0
Individual characteristics												
Male	-0.164	-39.6	0.031	7.4	-0.260	-61.6	0.002	0.5	-0.006	-0.5	-0.087	-7.3
Native American	-0.224	-4.7	-0.258	-5.3	-0.135	-2.8	-0.064	-1.7	0.042	1.0	-0.074	-1.8
Asian	-0.022	-1.4	0.047	2.9	0.270	16.6	0.254	22.3	0.232	16.2	0.373	26.8
African American	-0.430	-52.6	-0.598	-72.4	-0.330	-39.6	-0.275	-20.4	-0.170	-7.0	-0.165	-6.9
Hispanic	-0.275	-40.7	-0.362	-53.0	-0.167	-24.2	-0.127	-14.6	-0.070	-4.8	-0.040	-2.8
Eligible for free lunch	-0.336	-58.9	-0.282	-49.0	-0.317	-54.5	-0.195	-17.6	-0.170	-12.7	-0.148	-11.2
Eligible for reduced lunch	-0.201	-22.8	-0.153	-17.2	-0.159	-17.7	-0.101	-10.7	-0.087	-7.8	-0.078	-7.1
Limited English proficiency	-0.498	-57.1	-0.396	-45.0	-0.557	-62.7	-0.222	-10.4	-0.233	-9.6	-0.132	-5.6
Special education	-0.520	-59.5	-0.469	-56.4	-0.503	-56.4	-0.321	-11.7	-0.158	-4.7	-0.340	-10.2
Number of campus moves							-0.061	-24.6	-0.048	-16.7	-0.064	-22.5
Campus characteristics												
Prop. Native American	-1.078	-2.4	0.068	0.2	-2.007	-4.3	0.029	0.1	-0.221	-0.5	-0.233	-0.5
Prop. Asian	0.432	6.7	0.999	15.4	0.794	12.2	0.229	4.2	0.279	3.5	-0.002	0.0
Prop. African American	0.221	12.2	0.432	23.5	0.475	25.6	-0.047	-2.5	-0.038	-1.5	-0.095	-3.9
Prop. Hispanic	0.200	11.5	0.254	14.4	0.350	19.7	0.038	2.3	0.022	1.2	0.041	2.2
Prop. free lunch	-0.428	-22.0	-0.493	-25.0	-0.452	-22.8	-0.341	-14.5	-0.286	-10.0	-0.270	-9.6
Prop. reduced lunch	-0.806	-14.5	-1.275	-22.7	-1.058	-18.6	-0.254	-3.9	-0.197	-1.9	0.070	0.7
Prop. limited English	0.236	10.0	0.397	16.5	0.261	10.8	0.273	12.2	0.225	7.5	0.192	6.6
Prop. special education	0.220	3.7	0.192	3.2	0.239	3.9	0.010	0.2	-0.004	-0.1	0.000	0.0
Prop. mobile	0.015	16.9	0.007	7.8	0.016	17.7	-0.004	-14.3	-0.003	-7.4	-0.006	-16.9
Number of students / 1000	-0.014	-1.4	-0.020	-1.9	-0.016	-1.5	-0.104	-12.2	-0.071	-7.2	-0.135	-14.1
Dollars per pupil ($000)	-0.019	-6.0	-0.004	-1.3	-0.018	-5.7	0.015	6.1	0.018	5.6	0.005	1.5
Teacher experience	-0.002	-6.4	-0.002	-4.9	-0.002	-6.7	0.008	9.2	0.004	4.1	0.012	11.4
Grade 6 in middle school							0.004	0.8	-0.007	-1.2	0.022	3.6
Intercept	0.475	26.6	0.412	22.8	0.388	21.4	0.378	18.6	0.268	10.5	0.378	15.1
R-squared	0.176		0.163		0.149		0.541		0.462		0.481	
N	186228		187950		185779		168837		172460		172947	

Note: [a] Treated as an endogenous variable through IV-2SLS.

Table 8, continued

Panel B	Factor 8		Reading 8		Math 8		Writing 8		Science 8		Social 8	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t
Factor 6[a]	0.999	47.0										
Factor 3[a]	0.059	3.3										
Reading 6[a]			1.061	13.2	0.705	9.1	0.808	9.9	1.220	12.4	1.188	13.3
Math 6[a]			-0.165	-2.3	0.312	4.6	0.035	0.5	-0.305	-3.5	-0.159	-2.0
Reading 3[a]			0.029	0.4	-0.036	-0.5	0.123	1.6	0.076	0.8	0.017	0.2
Math 3[a]			0.195	2.6	0.259	3.5	0.088	1.2	0.128	1.4	0.076	0.9
Writing 3[a]			-0.156	-1.9	-0.274	-3.4	0.014	0.2	-0.200	-2.0	-0.168	-1.8
Individual characteristics												
Male	0.049	16.2	-0.072	-3.9	-0.020	-1.1	-0.172	-9.3	0.157	6.9	0.087	4.3
Native American	-0.043	-1.3	-0.072	-1.5	0.018	0.4	-0.010	-0.2	-0.145	-2.4	-0.120	-2.3
Asian	-0.032	-2.9	0.006	0.2	0.236	7.2	0.194	5.4	0.058	1.4	0.066	1.8
African American	-0.085	-10.1	-0.055	-2.4	-0.030	-1.4	0.064	2.8	-0.191	-6.7	-0.050	-2.0
Hispanic	-0.091	-15.5	-0.059	-3.3	0.007	0.4	0.001	0.1	-0.116	-5.3	-0.058	-3.0
Eligible for free lunch	-0.047	-8.4	-0.034	-3.9	-0.003	-0.3	0.005	0.6	-0.005	-0.5	-0.016	-1.7
Eligible for reduced lunch	-0.016	-2.2	-0.002	-0.2	0.024	2.2	0.036	3.2	0.041	3.0	0.003	0.3
Limited English proficiency	0.053	4.2	0.112	4.9	0.137	6.2	0.155	6.7	0.170	6.1	0.173	6.8
Special education	0.056	4.2	-0.032	-1.6	-0.074	-3.9	0.047	2.3	0.026	1.1	0.028	1.3
Number of campus moves	-0.025	-8.3	-0.024	-5.6	-0.037	-8.9	-0.019	-4.5	-0.031	-5.9	-0.030	-6.4
Campus characteristics												
Prop. Native American	0.450	1.2	1.235	2.4	1.188	2.4	0.870	1.7	-0.130	-0.2	0.380	0.7
Prop. Asian	0.162	3.3	-0.110	-1.5	0.005	0.1	-0.090	-1.2	0.162	1.8	0.250	3.0
Prop. African American	0.105	7.6	0.177	8.5	0.113	5.7	0.114	5.5	0.112	4.5	0.115	5.1
Prop. Hispanic	0.067	5.2	0.112	5.9	0.044	2.4	0.070	3.6	0.106	4.6	0.100	4.8
Prop. free lunch	-0.038	-2.2	0.006	0.3	0.062	2.7	0.109	4.6	-0.033	-1.1	-0.118	-4.5
Prop. reduced lunch	0.639	11.1	0.395	4.3	0.337	3.9	0.447	4.9	0.673	6.1	0.563	5.7
Prop. limited English	0.071	3.0	0.099	2.9	0.051	1.6	0.012	0.4	0.004	0.1	0.130	3.5
Prop. special education	-0.242	-6.0	-0.308	-5.6	-0.250	-4.8	-0.189	-3.4	-0.053	-0.8	-0.247	-4.1
Prop. mobile	-0.002	-6.6	-0.003	-6.2	-0.004	-8.4	-0.005	-10.4	-0.004	-6.4	-0.002	-4.4
Number of students / 1000	-0.036	-6.6	-0.063	-7.6	-0.042	-5.3	-0.076	-9.0	-0.045	-4.4	-0.001	-0.2
Dollars per pupil ($000)	-0.004	-1.8	-0.005	-1.9	-0.002	-0.8	-0.012	-4.1	-0.005	-1.6	0.000	-0.1
Teacher experience	-0.003	-4.3	-0.001	-1.3	-0.004	-3.7	0.003	2.7	-0.002	-1.4	-0.001	-0.5
Grade 6 in middle school	0.039	16.9	0.015	4.3	0.023	6.8	0.030	8.2	0.023	5.4	0.027	7.0
Intercept	0.094	6.6	0.182	9.0	0.150	7.7	0.166	8.1	0.073	3.0	0.028	1.3
R-squared	0.699		0.419?		0.471?		0.418		0.169		0.320	
N	141945		151619		151302		150561		150230		151039	

Note: [a] Treated as an endogenous variable through IV-2SLS.

Table 9: Determinants of Graduation and Work[a] (Bivariate Probit[b]).

	Graduation		Working		Graduation		Working	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t
Factor 8	0.461	94.1	-0.147	-34.8				
Reading 8					0.029	3.9	-0.004	-0.6
Math 8					0.240	36.5	-0.014	-2.3
Writing 8					0.103	16.8	-0.054	-9.5
Science 8					0.028	4.2	-0.002	-0.3
Social Studies 8					0.116	15.6	-0.074	-10.6
Individual characteristics								
Male	-0.168	-22.1	0.042	6.2	-0.162	-20.7	0.036	5.1
Native American	-0.127	-1.4	-0.198	-2.4	-0.135	-1.5	-0.189	-2.3
Asian	0.223	7.3	-0.424	-18.1	0.198	6.5	-0.427	-18.2
African American	0.377	25.6	-0.205	-15.5	0.385	25.9	-0.186	-14.1
Hispanic	0.124	10.3	-0.072	-6.6	0.111	9.3	-0.060	-5.5
Eligible for free lunch	-0.348	-34.7	0.150	15.9	-0.354	-35.2	0.155	16.4
Eligible for reduced lunch	-0.103	-6.2	0.142	9.4	-0.112	-6.8	0.145	9.6
Limited English proficiency	0.261	17.0	-0.127	-8.5	0.327	21.0	-0.121	-8.1
Special education	0.056	2.9	-0.217	-11.4	0.088	4.4	-0.218	-11.5
Campus characteristics								
Prop. Native American	-1.721	-1.8	2.030	2.5	-2.173	-2.3	2.045	2.5
Prop. Asian	-0.347	-2.7	0.483	4.2	-0.296	-2.3	0.451	3.9
Prop. African American	-0.304	-8.6	-0.052	-1.6	-0.302	-8.5	-0.053	-1.7
Prop. Hispanic	0.114	3.4	-0.339	-11.4	0.128	3.8	-0.341	-11.5
Prop. free lunch	0.176	4.1	-0.479	-12.4	0.175	4.1	-0.483	-12.5
Prop. reduced lunch	0.004	0.0	1.202	9.4	-0.043	-0.3	1.230	9.7
Prop. limited English	-0.032	-0.5	-0.059	-1.1	-0.076	-1.3	-0.053	-1.0
Prop. special education	-0.197	-2.0	1.028	11.3	-0.210	-2.1	1.049	11.5
Prop. mobile	-0.014	-20.9	0.012	18.9	-0.013	-20.2	0.012	19.2
Number of students / 1000	-0.119	-8.5	0.186	14.9	-0.114	-8.1	0.185	14.9
Dollars per pupil ($000)	-0.019	-3.6	-0.049	-10.4	-0.019	-3.7	-0.050	-10.6
Teacher experience	0.002	0.9	0.005	3.1	0.002	1.0	0.005	3.1
Intercept	1.343	41.3	0.354	12.1	1.292	39.6	0.356	12.16
rho	-0.277	-56.4			-0.281	-57.3		
N	156377				156539			
lnL/N	-1.049				-1.047			

Note: [a] "Working" is a dichotomous variable equal to 1 if the individual received earnings during the fourth and first quarter in the years after (s)he turned 16 and before the second quarter of 2002.

[b] Explanatory variables describe conditions in the (last) year the student was in eighth grade.

Table 10: Performance on the SAT tests[a]

	SATmath		SATverbal		SATmath		SATverbal	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t
Factor 8	100.5	98.8	104.2	110.9				
Reading 8					5.9	12.8	29.0	65.2
Math 8					53.7	94.1	8.3	15.2
Writing 8					22.7	50.4	28.5	66.1
Science 8					15.8	37.2	16.7	41.3
Social Studies 8					16.4	32.4	34.4	70.8
Individual characteristics								
Male	15.4	26.6	-12.4	-23.0	16.8	30.4	-9.3	-17.7
Native American	-3.6	-0.6	-0.9	-0.2	-4.4	-0.8	-1.1	-0.2
Asian	44.5	28.9	11.4	7.9	33.2	22.9	13.3	9.5
African American	-10.0	-9.2	-1.1	-1.0	-7.9	-7.6	-3.5	-3.5
Hispanic	-13.9	-16.2	-12.5	-15.7	-14.8	-18.1	-12.6	-16.1
Eligible for free lunch	-9.0	-8.6	-14.9	-15.6	-10.0	-10.2	-13.5	-14.5
Eligible for reduced lunch	-6.8	-4.6	-12.9	-9.5	-7.5	-5.3	-12.2	-9.2
Limited English proficiency	12.9	4.3	0.5	0.2	10.9	3.8	2.5	1.0
Special education	-7.1	-4.1	-4.6	-2.9	-0.8	-0.5	-4.5	-2.9
Number of campus moves	0.8	1.4	1.4	2.7	0.7	1.3	1.4	2.7
Campus characteristics								
Prop. Native American	-354.7	-9.1	-223.7	-6.2	-349.2	-9.4	-204.1	-5.8
Prop. Asian	145.8	21.1	83.2	13.0	143.6	21.9	82.9	13.2
Prop. African American	-26.4	-11.3	-22.3	-10.4	-26.5	-11.9	-23.5	-11.1
Prop. Hispanic	0.6	0.2	2.1	1.0	0.8	0.3	0.9	0.4
Prop. free lunch	-20.8	-6.2	-19.2	-6.2	-22.0	-6.9	-18.0	-5.9
Prop. reduced lunch	-102.1	-8.9	-44.0	-4.2	-93.2	-8.6	-43.3	-4.2
Prop. limited English	17.2	3.1	11.2	2.2	14.1	2.7	11.2	2.2
Prop. special education	-43.0	-5.9	-41.9	-6.2	-42.7	-6.1	-43.9	-6.6
Prop. mobile	-0.7	-13.1	-0.3	-5.1	-0.7	-12.2	-0.2	-4.8
Number of students / 1000	6.7	17.6	3.2	9.1	6.7	18.7	0.4	9.8
Dollars per pupil ($000)	0.8	2.5	0.3	0.9	0.7	2.4	0.3	1.2
Teacher experience	0.6	4.8	0.7	5.8	0.5	4.4	0.6	5.3
Intercept	405.5	123.4	406.7	134.4	398.1	126.1	400.3	133.7
Lambda[c]	41.4	17.5	42.6	19.6	39.4	17.8	41.9	20.0
St.Dev. of Disturbance	68.0		64.1		64.7		62.8	
N	68956		68956		68959		68956	

Notes: [a] Explanatory variables describe the average over the years the student was in ninth, tenth and eleventh grade.

[b] ACT scores are transformed into SAT equivalent values.

[c] Heckman‘s selectivity correction, based on exogenous variables describing the student’s condition in eighth grade.

Table 11: Enrollment in community colleges, four-year universities, or at UT-Austin/Texas A&M [a]

	Community College		4-Year College or University		University of Texas at Austin or Texas A&M University	
	Coef.	z	Coef.	z	Coef.	z
A: Students Taking SAT test [b]						
SATmath	0.942	9.5	2.264	20.3	4.526	24.3
SATverbal	0.698	6.7	1.881	16.0	2.729	14.2
$SATmath^2$	-0.078	-4.4	-0.151	-8.2	-0.256	-10.6
SATmath x SATverbal	-0.070	-2.2	-0.134	-4.1	-0.177	-4.3
$SATverbal^2$	-0.057	-3.1	-0.127	-6.6	-0.164	-6.5
Factor 8	0.125	4.9	0.298	10.4	0.828	11.8
$(Factor\ 8)^2$	-0.003	-0.2	-0.081	-4.9	-0.193	-6.5
Male	-0.195	-8.5	-0.233	-9.9	-0.339	-11.1
Native American	-0.441	-1.7	-0.792	-2.7	-0.454	-1.3
Asian	-0.070	-0.9	0.569	7.5	0.934	12.1
African American	-0.674	-18.1	0.173	4.7	-0.505	-7.0
Hispanic	-0.351	-12.5	0.007	0.2	-0.297	-6.8
Intercept	-2.016	-6.8	-9.395	-26.9	-21.781	-33.4
B: Students not taking SAT test [c]						
Factor 8	0.353	33.1	1.005	38.9	2.530	13.7
$(Factor\ 8)^2$	-0.137	-15.9	-0.098	-4.6	-0.307	-3.5
Male	-0.234	-15.0	-0.214	-5.6	-0.522	-5.1
Native American	-0.659	-3.1	0.013	0.0	-26.835	0.0
Asian	0.206	3.0	0.955	8.0	1.609	9.1
African American	-0.425	-16.3	0.883	16.9	-0.722	-2.6
Hispanic	-0.223	-12.7	0.054	1.2	-0.895	-5.3
Intercept	-0.608	-41.4	-3.032	-78.7	-5.404	-44.9

Notes: [a] Multinomial logit model estimates. The base category consists of students not enrolling at any of these institutions, all of which refer to public colleges and universities within the state of Texas.

[b] Number of observations = 70706, lnL / N = -1.188.

[c] Number of observations = 94464, lnL / N = -0.679.

C: Probability of enrollment	Value of SATmath and SATverbal (estimates from panel A)				
Institution	400	500	600	700	800
Community college	0.495	0.341	0.229	0.163	0.087
4-year college or university	0.321	0.417	0.348	0.204	0.059
UT-Austin or Texas A&M	0.019	0.104	0.254	0.301	0.122
None of these	0.165	0.138	0.169	0.332	0.733

D: Probability of enrollment	Value of Factor 8 (estimates from panel B)				
Institution	-1	0	1	2	2.5
Community college	0.198	0.280	0.308	0.262	0.218
4-year college or university	0.013	0.035	0.076	0.140	0.177
UT-Austin or Texas A&M	0.000	0.001	0.011	0.051	0.086
None of these	0.789	0.684	0.605	0.546	0.519

Table 12: Fields of Study, Conditional on College Enrollment (Multinomial Logit)

	Coef.	t	Coef.	t	Coef.	t	Coef.	t
	Natural sciences		Social sciences		Business administration		Engineering and computer science	
Reading 8	-0.002	-0.1	0.080	2.2	-0.118	-5.5	-0.257	-9.8
Math 8	0.405	14.3	0.056	1.6	0.381	19.3	0.402	17.0
Writing 8	-0.032	-1.2	-0.003	-0.1	-0.076	-4.0	-0.041	-1.8
Science 8	0.303	10.8	-0.126	-3.6	-0.073	-3.6	0.254	10.8
Social studies 8	0.090	2.9	0.300	8.1	-0.002	-0.1	0.041	1.5
Male	-0.062	-1.8	0.011	0.3	0.306	13.2	1.483	47.1
Native American	0.036	0.1	0.196	0.4	0.094	0.3	-0.322	-0.7
Asian	0.981	12.6	0.235	1.9	0.528	8.0	0.919	13.1
African American	0.434	6.6	0.285	3.9	0.410	10.4	0.875	18.6
Hispanic	0.302	7.2	0.237	4.9	0.025	0.9	0.410	12.1
Intercept	-2.464	-74.1	-2.549	-69.9	-1.222	-59.0	-2.736	-84.8
	Arts and humanities[a]		Health		Other academic		Semi-academic	
Reading 8	0.000		-0.161	-5.7	-0.035	-1.2	-0.102	-5.5
Math 8	0.000		0.073	2.9	0.094	3.6	0.052	3.1
Writing 8	0.000		-0.105	-4.5	-0.093	-3.8	-0.139	-8.7
Science 8	0.000		0.015	0.6	-0.071	-2.7	0.026	1.5
Social studies 8	0.000		-0.121	-4.2	-0.057	-2.0	-0.028	-1.5
Male	0.000		-1.051	-30.7	-0.033	-1.1	0.242	12.2
Native American	0.000		-0.214	-0.5	-0.813	-1.4	0.201	0.8
Asian	0.000		0.049	0.5	0.010	0.1	0.614	10.3
African American	0.000		0.469	10.1	0.612	12.9	0.408	12.2
Hispanic	0.000		0.413	12.5	0.399	11.5	0.257	11.0
Intercept	0.000		-1.273	-55.1	-1.740	-67.0	-0.654	-38.1
N	85216							
lnL/N	-1.759							
Pseudo R2	0.032							

Note: [a] Arts and humanities constitutes the comparison group.

Table 13: Determinants of Quarterly Earnings

	Not enrolled in higher education				Enrolled in higher education			
	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Factor 8	0.181	34.6			0.007	1.8		
Reading 8			0.060	7.1			-0.017	-3.1
Math 8			0.093	11.9			0.020	4.0
Writing 8			-0.002	-0.3			-0.009	-1.9
Science 8			-0.016	-2.0			0.012	2.4
Social Studies 8			0.067	7.8			0.002	0.4
Grade 9	-0.038	-1.6	-0.038	-1.6	0.053	1.8	0.055	1.9
Grade 10	0.014	1.4	0.013	1.3	0.019	1.2	0.018	1.1
Grade 11	-0.012	-1.2	-0.013	-1.4	-0.064	-5.1	-0.065	-5.2
Grade 12	-0.009	-0.9	-0.010	-1.0	-0.090	-7.7	-0.092	-7.9
Graduated	0.131	13.2	0.129	13.1	0.021	1.5	0.020	1.4
Age	0.252	113.8	0.252	114.2	0.255	132.4	0.255	132.6
Male	0.119	13.8	0.119	13.4	0.147	25.8	0.141	23.9
Native American	0.121	0.9	0.118	0.8	0.098	1.1	0.097	1.1
Asian	0.605	10.5	0.590	10.2	0.203	9.8	0.198	9.6
African American	0.062	4.4	0.059	4.2	-0.014	-1.5	-0.010	-1.0
Hispanic	0.089	9.3	0.081	8.5	0.111	16.5	0.112	16.5
Quarter 2	-0.095	-21.2	-0.095	-21.2	-0.149	-38.2	-0.149	-38.2
Quarter 3	-0.086	-16.9	-0.086	-16.8	-0.041	-9.6	-0.041	-9.6
Quarter 4	0.050	11.0	0.050	11.0	0.087	22.5	0.087	22.5
Intercept	3.793	75.6	3.778	75.4	3.062	64.2	3.066	64.4
Lambda [a]	-1.679	-343.4	-1.677	-343.0	-1.383	-403.7	-1.383	-404.0
rho	-0.974		-0.974		-0.970		-0.970	
St.Dev. of Disturbance	1.723	395.6	1.721	395.3	1.427	461.2	1.426	461.2
N	430298		430298		564104		564104	
lnL / N	-1.384		-1.384		-1.526		-1.525	

Note: [a] The earnings equation is part of a model that includes a selection equation for labor force participation, estimated by means of maximum likelihood. The selection equation is not reported in this table.

Table 14: Ethnic Variations: Impact of Personal and Peer Characteristics

	African American		Hispanic	
	Personal	Personal + Peer	Personal	Personal + Peer
Reading 3	-0.430	-0.208	-0.275	-0.275
Math 3	-0.598	-0.166	-0.362	-0.362
Writing 3	-0.330	0.145	-0.167	-0.167
Reading 6	-0.489	-0.386	-0.276	-0.143
Math 6	-0.565	-0.419	-0.290	-0.118
Reading 8	-0.558	-0.279	-0.357	-0.131
Math 8	-0.600	-0.396	-0.316	-0.162
Writing 8	-0.461	-0.187	-0.300	-0.065
Science 8	-0.659	-0.488	-0.398	-0.204
Social 8	-0.539	-0.368	-0.344	-0.149
p(Graduate)	0.074	-0.077	-0.045	0.128
p(Work HS)	-0.055	-0.097	-0.005	-0.226
p(SAT)	-0.039	-0.106	-0.283	0.259
SATmath	-0.733	-0.754	-0.528	-0.308
SATverbal	-0.708	-0.678	-0.553	-0.287
p(Com Coll)	-0.210	-0.215	-0.118	-0.067
p(4Yr U)	0.113	0.062	-0.108	0.192
p(UT/A&M)	-0.211	-0.172	-0.195	-0.062
p(None)	0.213	0.225	0.292	-0.050
ln(earn)	-0.055	-0.011	0.014	0.052
Nat Sci	-0.067	-0.039	-0.028	0.002
Soc Sci	-0.031	-0.018	-0.005	0.008
Bus Admin	0.013	0.020	-0.061	-0.059
Engin & Comp Sci	0.092	0.111	0.030	0.046
Arts & Hum	-0.207	-0.203	-0.120	-0.115
Health	0.092	0.071	0.104	0.084
Other Acad	0.124	0.114	0.088	0.077
Semi-Acad	0.108	0.080	0.085	0.062

Note: All effects are expressed in standard deviation magnitudes.