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ABSTRACT

This paper is concerned with the statistical issues of state rankings based on the state average Scholastic Assessment Test I (SAT I) scores and other relevant demographic and policy-related variables that are to be controlled. The purposes of the study were threefold. One purpose was to investigate the optimal transformation of a particular predictor variable, the proportion of high school graduates taking the SAT I, in a regression equation. The second purpose was to apply the all-possible regressions procedure to select the best subset regression equation where the average SAT I scores are used as the predicted variable. The third purpose was to examine a way to combine both the SAT I and ACT Assessment scores for the state education performance indicator that can be used in the state ranking or other purpose. Two appendixes contain detailed descriptions of statistical procedures used in the analyses. (Contains 14 tables, 21 figures, and 53 references.) (Author/SLD)

An Investigation of State Rankings Based on SAT I Scores

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Abstract

This paper is concerned with the statistical issues of state rankings based on the state average Scholastic Assessment Test I (SAT I) scores and other relevant demographic and policy-related variables that are to be controlled. The purposes are of threefold. One purpose is to investigate the optimal transformation of a particular predictor variable, the proportion of high school graduates taking the SAT I, in a regression equation. The second purpose is to apply the all possible regressions procedure to select the best subset regression equation where the average SAT I scores are used as the predicted variable. The third purpose is to examine a way to combine both the SAT I and ACT scores for the state education performance indicator that can be used in the state ranking or other purpose.

Key Words: *ACT, all possible regressions, Box and Tidwell method, NAEP, SAT I, State Ranking.*

Introduction

George W. Bush got 1206 and Al Gore got 1335. These are not the results from the recounts of last year's presidential election in Palm Beach and Broward Counties by the canvassing boards scrutinizing the hanging, swinging, tri, and pregnant chads, and, of course, the infamous dimples. These are, as you might have inferred from the title of the current manuscript, how President and ex-Vice President did on their Scholastic Aptitude Tests (SATs) (Cloud, 2001). Note that its original name was changed to the Scholastic Assessment Test I: Reasoning Test (SAT I) in 1994 and that its recentered scale was introduced in April 1995. The President's and ex-Vice President's SAT scores might not be directly comparable with today's scores obtained from high school graduates taking the SAT I even if we consider the magnitude of the standard error of prediction (Lord & Novick, 1968, p. 68). Their scores on the SAT I would be much higher than the scores reported above.

The original SAT was a measurement of basic reasoning abilities in verbal and mathematical areas, and was developed to supplement the school record and other information about the student in assessing skills that were important to his or her academic success in college (Donlon & Angoff, 1971). The purpose of the SAT I seems to remain exactly the same as the original SAT. The SAT I may provide high school guidance counselors and college admission officers with a common standard against which college applicants can be compared because of the wide variation in high school course content and grading practices. SAT I scores are known to be very useful in making decisions about college-bound students. However, using SAT I scores in aggregate form as an indicator to rank colleges, school districts, or states is not valid because the SAT I was not developed for such a purpose and not all eligible students take the test.

Cautions on the use of the aggregate SAT I results to make comparisons other than those originally intended can be found in many original reports from the College Board and summary tables from the National Center for Education Statistics (e.g., College Entrance Examination Board, 1999; National Center for Education Statistics, 1988–1999). These cautions about the inappropriate use of the SAT I results are largely unread and/or ignored by the general public, politicians, college administrators, and even some faculty members in education. The reason why the inappropriate use prevails is not all clear. One of the reasons might be the extremely small font used to print the cautions on the bottom of tables that report the aggregate SAT I comparison results. Another reason might be that those people who use the SAT I to make such comparisons obtained the information from a secondary source and never had a chance to read the footnotes. Yet another reason might be that people knowingly and willingly misuse and misinterpret the results.

It was not difficult to find studies that used the (aggregate) SAT I or SAT results to make comparisons other than those originally intended (e.g., Bennett, 1995; Slater, 1999; Young & Fisler, 2000). Studies investigating state rankings based on SAT scores have been the source of many perplexing debates in the educational statistics and educational policy communities for many years (e.g., Behrendt, Eisenach, & Johnson, 1986; Dynarski, 1987; Dynarski & Gleason, 1993; Edwards & Cummings, 1990; Ginsburg, Noell, & Plisko, 1988; Gohmann, 1988; Graham & Husted, 1993; Holland & Wainer, 1990; Page & Feifs, 1985; Powell & Steelman, 1984, 1987, 1996; Rosenbaum & Rubin, 1985; Taube & Linden, 1989; Wainer, 1986a, 1986b; Wainer, Holland, Swinton, & Wang, 1985; Womer, 1983). In many studies state rankings were obtained from adjusted SAT scores from which the effects of the potential concomitant variables were removed using linear regression techniques.

One of the key predictors in the regression equations is the participation rate or the proportion of high school graduates taking the SAT, that exhibits a curvilinear relationship with the average SAT scores. The differences in the participation rate is due to the self-selection characteristic of the SAT (Wainer, 1986b). There seem to be three ways of solving this problem. One way is to ignore the problem (e.g., Page & Feifs, 1985; Slater, 1999). The second is transformation the data (or add additional terms to the regression equation) so as to change the curvilinear relationship to the linear one (Dynarski, 1987; Dynarski & Gleason, 1993; Edwards & Cummings, 1990; Graham & Husted, 1993; Powell & Steelman, 1984, 1996). The third is to apply bias correction techniques, those routinely used in econometric literature, to regression (e.g., Behrendt et al., 1986; Gohmann, 1988; Heckman, 1979; Taube & Linden, 1989). Note that the second and third solutions are not necessarily mutually exclusive.

The current study considers the variable transformation issue to correct the curvilinear pattern. If a straight line cannot be used in the regression model due to lack of fit or nonlinearity, then, based on the examination of residuals, one might consider transformation or adding additional terms (e.g., a squared predictor) to the regression equation so that the regression model can be extended to various polynomial models with various orders in the predictor variables. For example, Dynarski (1987) considered the logistic transformation of the participation rate, Graham and Husted (1993) used the logarithmic transformation, and Dynarski and Gleason (1993) added squared and cubed terms in their regression equations when they analyzed the state average SAT scores. There are some other studies in which combinations of the predictor transformation and the polynomial models have been applied, but the justifications of the selection of the predictor transformation or the use of particular polynomial models were not clearly presented.

In this regard, Box and Tidwell (1962) provided an optimal way to transform predictor variables (see also Box & Draper, 1987; Draper & Smith, 1981). One purpose of this paper is to apply the Box and Tidwell technique to the recent SAT I data to obtain an optimal transformation of a predictor variable.

The SAT I can be considered as an important indicator in education. More than two million students took the SAT I in 2000 (Cloud, 2001). Here we may define an educational indicator as a readily and repeatedly collectable statistic that reflects the performance of an education system (Richards, 1988). The reason we are interested in educational indicators is not to obtain rankings of states. The real purpose of obtaining state rankings based on the average SAT I scores is to identify major factors that contribute the differences in the SAT I scores. It is, hence, important to investigate the effects of other relevant variables on the state average SAT I scores by including them in the prediction equations. Such model selection results can be found in Behrendt et al. (1986), Dynarski (1987), Dynarski and Gleason (1993), Gohmann (1988), Graham and Husted (1993), Page and Feifs (1985), Powell and Steelman (1984, 1996), and Taube and Linden (1989).

During the model selection process in regression two opposed criteria are usually involved when selecting the useful linear equation (Draper & Smith, 1981). First, to make the equation useful for predictive purposes the model should include as many predictor variables as possible so that reliable fitted values can be obtained. Second, because of the costs involved in obtaining information on a large number of predictor variables and to avoid potential problems due to multicollinearity, the model should include as few predictor variables as possible. In this study the all possible regressions technique is applied to select the best subset regression equation. The Mallows (1973) C_p statistic is used in the selection of the best subset regression. Note that the variables in the prediction equations can be classified into two different categories: Variables that are related to educational policy in the states and variables that are related to demographic characteristics which cannot be manipulated with the implementation of states' educational policy.

SAT I scores of college-bound students can be treated as an indicator of performance quality, but pitfalls of using the aggregated or even adjusted SAT scores as indicators of student achievement have been repeated mentioned in literature on educational measurement (e.g., Holland & Wainer, 1990; Richards, 1988; Wainer, 1986b). To overcome the pitfalls we might consider including scores from another admission test results when comparing state performance. Because about 1.8 million students took the rival college-admission test ACT Assessment (Cloud, 2001), combining information from both tests would yield a better educational indicator. For this purpose, Wainer (1986b) and Lehnen (1992) suggested that the equating of the ACT and the SAT be performed to obtain a unified measure of state performance.

As Wainer (1986b) and Wainer et al. (1985) presented we may combine the information obtained from students taking the SAT I and the information obtained from students taking the ACT. Although there were several equations for equating the average ACT scores onto the scale of the SAT, we cannot use previous equations due to the use of the recentered scale for the SAT I which was introduced in 1995. Earlier studies that provide the information to equate the ACT scores with the SAT scores includes Astin (1971), Chase and Barritt (1966), Houston and Sawyer (1991), Marco and Abdel-Fattah (1991), and Pugh and Sassenrath (1985). Fortunately, Dorans (1999) and Dorans, Lyu, Pommerich, and Houston (1997) offered equating results that could be applied to the current situation for the SAT I and the ACT scores. In this paper, using the information from Dorans (1999) and Dorans et al. (1997), the state average ACT scores are expressed on the metric of the SAT I. The combined results are analyzed for the purpose of state rankings.

It should be noted that there are still better educational indicators we can use to make state comparisons. The National Assessment of Education Progress (NAEP) is an example. The NAEP is a survey of the educational achievement of students and changes in that achievement across time (Calderone, King, & Horkay, 1997). The NAEP can provide accurate and useful achievement information to educators and policy makers. In addition, the NAEP collects demographic, curricular, and instructional background information for students, teachers, and principals to provide a context for the achievement results.

Note that since 1990 state data from the Trial State Assessment NAEP and the State NAEP are available. For example, 47 jurisdictions (i.e., mostly states) participated in the

State NAEP which assessed science at grade 8 and mathematics at grades 4 and 8 in 1996 (see O'Sullivan, Reese, & Mazzeo, 1997; Shaughnessy, Nelson, & Norris, 1997). The 1998 State NAEP assessed writing at grade 8 and reading at grades 4 and 8. As early as 1985 Wainer et al. (1985) indicated that expanding the NAEP to allow state estimates might be the best solution when comparing states on the student performance because it could remove the self-selection problem and the bias from inconsistent aggregation.

In this study we use the NAEP results to crossvalidate the rankings based on the adjusted SAT I as did Powell and Steelman (1996) and Dynarski and Gleason (1993). Powell and Steelman (1996) reported that the correlation between the state average SAT that was adjusted for participation rate and the NAEP score was quite respective ($r = .693$). Dynarski and Gleason (1993) compared the adjusted SAT mathematics score with the state NAEP score from the 1990 NAEP mathematics examination in order to check the validity of the regression models analyzed in their study. The Spearman rank correlation between the unadjusted SAT mathematics and the NAEP score was .384. The Spearman rank correlations between results from various models that adjusted differential participation rates and the NAEP score ranged from .666 to .780.

Method

Data

We used data obtained mainly from the College Entrance Examination Board *1999 College-Bound Seniors* reports. These reports present profile data for 1999 high school graduates who participated in the SAT Program during their high school years. Test scores and other variables such as measures of academic background, parental education, and household income obtained from the Student Descriptive Questionnaire (SDQ) are summarized in the reports (see Baird, 1984 for a detailed analysis of SDQ). Table 1 displays the descriptions and the summary statistics of the key variables analyzed in this study with respective sources of the variables.

Table 2 contains the descriptions and the summary statistics of the additional variables used in this study. The original sources of the variables are also listed in Table 2. Some of the variables in Table 2 were transformed to yield the key variables in Table 1. For example, the monetary variables in Table 1 were adjusted for the cost of living (Leonard, Walder, & Acevedo, 1999).

Other variables (e.g., state SAT scores and proportion of students taking the SAT in the previous 12 years) were obtained mainly from the *Digest of Educational Statistics* by the National Center for Educational Statistics (1988–1999), and *State Rankings* by the Morgan Quitno Press (e.g., O'Leary Morgan & Morgan, 1999).

Analyses

The main variables of interest were the average SAT I scores of the 50 states and the District of Columbia in 1999 and the proportion of high school graduates taking the SAT I. Because the relationship between the average SAT I score and the proportion was known to be nonlinear (e.g., Powell & Steelman, 1984, 1996), we performed the lack of fit analyses (see Draper & Smith, 1981, pp. 33-42) and inspected the residual plots.

To obtain the optimal transformation of the predictor variable, the proportion of high school graduates taking the SAT I, the Box and Tidwell (1962) method was applied. The Box and Tidwell method is presented briefly in Appendix A. To check the consistency of the required transformation to achieve linearity of the predictor variable, the method was also applied to the SAT I (and SAT) data from the previous 12 years.

After obtaining the optimal transformation of the proportion of the high school graduates taking the SAT I, other variables were included in the regression equations to identify the best subset equation. The examples of the other variables are as follows: mean percentile rank, percent male, percent white, percent speaking English as the first language, percent U.S. citizen, median family income, percent bachelor's and graduate degree of parents, percent everyday calculator experience, pupil teacher ratio, average teacher salaries, and expenditure per pupil (see Table 1). State cost of living was to used to adjust for some monetary variables. Many of the variables were analyzed to find the best subset equations were from the *College-Bound Seniors* reports (CEEB, 1999). All possible regressions procedure was applied to select the best subset regression equation with Mallows C_p as a criterion (see Appendix B for a brief description of Mallows C_p).

Other variables considered in some portions of the analyses to obtain the best subset-equation were, for example, mean grade point average, highest level of parental education, per capita personal income, median income of households, public high school graduation rate, per capita state and local government expenditures for elementary and secondary education, percent of population graduated from college, percent of school age children living in poverty, and federal sources as percent of school revenues (see Table 2). Note that many of these variables were not obtained from the *College-Bound Seniors* reports.

Wainer (1986b) and Powell and Steelman (1996) recommended that class rank be used in lieu of proportion of high school graduates taking the SAT I. It is possible to assume that the proportion taking the SAT I is related to the state average SAT I scores because the proportion is a proxy variable for academic achievement. If this is the case, then the variable controlled should be class rank of the test-taking population instead of proportion. Therefore, similar analyses to obtain the best subset equation were performed using the mean percentile rank (i.e., class rank) of high school graduates taking the SAT I as one of the predictor variables.

Next we considered linking the ACT and SAT I. The equating of the ACT scores onto the scale of the SAT I was based on Dorans (1999) and Dorans et al. (1997). It should be noted that, instead of using the ACT Composite scores, the ACT Sum scores were used to obtain the conversion equation. It should also be noted that, instead of the entire range of the ACT Sum scores, the limited range (i.e., scores 74–91) was used that contained the state average ACT Sum scores converted from the ACT Composite scores.

Since the NAEP is a primary indicator of the level of students' academic achievement, we may compare the adjusted results to that of the NAEP. The score metric used in the NAEP ranges from 0 to 500. To give meaning to the results, student performance is characterized at various levels along the scale. For example, the National Assessment Governing Board (NAGB) adapted three achievement levels in mathematics; basic, proficient, and advanced. The basic level denotes partial mastery of fundamental knowledge and skills. The proficient level defines solid academic performance that demonstrates competency in challenging subject matter. The advanced level signifies superior performance (Shaughnessy, Nelson, & Morris, 1997). Four percentages of students by their achievement levels are reported in Shaughnessy et al.—below basic, at or above basic, at or above proficient, and advanced.

To validate the results from the combined information, results from the 1996 NAEP mathematics for grade 8 were compared to the results from the combined information of the SAT I and the ACT. The percent of the proficient level and above in 1996 NAEP mathematics for grade 8 was obtained for each of the available 40 states and the District of Columbia (Blank et al., 1997). The 8th-grade students performing at the proficient level should be able to apply mathematical concepts and procedures consistently to complex problems in the five NAEP content strands (Blank et al., 1997).

Results

Results from Adjusting Proportion

Figure 1 shows an inside-out plot of the proportion of student taking the SAT I for the 50 states and the District of Columbia in 1999. The 50 states and the District of Columbia were operationally split into 24 states in which the SAT I was the predominant test (i.e., SAT states) and 27 remaining states in which the ACT was the predominant test (i.e., ACT states). In Arizona more high school graduates took the SAT I than the ACT in 1999, but Arizona was classified as the ACT state because only 34 percent of high school graduates took the SAT I. In sum the SAT states are those where 40 percent or more of high school graduates took the SAT I in 1999 (cf. Creed, 1993). In the SAT states the proportion of high school graduates taking the SAT I ranged from .49 in California to .83 in Connecticut. In the ACT states the proportion of high school seniors taking the SAT I ranged from .04 in Mississippi to .34 in Nevada.

Table 3 presents that proportion of high school graduates taking the SAT I, the average SAT I scores, and the rankings of the states and the District of Columbia in 1999. The ranking of the District of Columbia was placed between rankings of the two adjacent states to make the range of the entire rankings from 1 to 50.

Figure 2 shows an inside-out plot of the SAT I scores for the 50 states and the District of Columbia in 1999. The two distributions of the average SAT I scores show only minimal overlapping in the opposite tails. The most noticeable feature of the plot is that the high school graduates in the ACT states who took the SAT I performed much better than those in the SAT states. We may infer that students in the ACT states who took the SAT I are better students and might not be representative samples of high school graduates in the respective states.

Figure 3 displays the scatterplot of the proportion of high school graduates taking the SAT I and the average SAT I score. There is a strong negative relationship between the proportion and the average SAT I score. The scatterplot also displays the nonlinear relationship between the two variables. A rapid decrease of the average SAT I score was observed for the lower proportion of high school graduates taking the SAT I. The rate of the change reduced for the higher proportion.

Figure 4 shows a set of 12 scatterplots of the proportion and the average SAT I score in 1987 through 1998. Each scatterplot displays a strong nonlinear negative relationship between the proportion of graduates taking the SAT I (or SAT) and the average SAT I (or SAT) score. Note that the effect of the recentered scale of 1995 can be found in the scatterplots of 1996 to 1998.

The Box and Tidwell method was applied to the 1991 SAT I data. First, let y be the SAT I score and x be the proportion of high school graduates taking the SAT I. The initial fitting model for the 1999 SAT I data in Table 3 was

$$\hat{y} = 1145.368 - 215.678x, \tag{1}$$

where $\hat{\beta}_1 = -215.678$. Using $d\hat{y}/dx = -215.678$ and $z = -215.678x \ln x$, the next fitting model based on the Taylor series was

$$\hat{y} = 1212.551 - 195.202x - 1.357z, \tag{2}$$

where $\hat{\gamma} = -1.357$. The first estimate of α was

$$\hat{\alpha}_{(1)} = -1.357 + 1 = -.357. \tag{3}$$

Note that the standard error of $\hat{\alpha}$ and, equivalently, the standard error of $\hat{\alpha} - 1$ was .256. We performed a subsequent iteration to obtain $\hat{\alpha}'_{(2)} = .290$. The second estimate of α was

$$\hat{\alpha}_{(2)} = \hat{\alpha}'_{(2)} \times \hat{\alpha}_{(1)} = .104. \tag{4}$$

The 5th estimate was .044 that was very close to 0, indicating the logarithmic transformation of the proportion is required to achieve linearity.

Table 4 shows the power transformation estimates for the proportion of high school graduates taking the SAT I (or SAT) from the 1987–1999 SAT data. All final estimates were very close to 0 and suggested the log transformation be performed on the proportion.

The scatterplot of the log proportion and the average SAT I score is presented in Figure 5. It clearly shows that a linear relationship was achieved by the log transformation of the proportion of high school graduates taking the SAT I. The 12 scatterplots in Figure 6 also seem to confirm that the log transformation yielded the sufficiently linear pattern for the two variables for the 1987–1998 SAT data.

The estimated SAT I scores using the log proportion as a predictor variable are listed in Table 3. The prediction equation was

$$\mathrm{SAT}' = 979.208 - 61.363 \ln P_{\mathrm{SAT}}, \tag{5}$$

where P_{SAT} is the proportion of high school graduates taking the SAT I (see also Table 7). The log proportion explained about 85 percent of the variation in the average SAT I scores. Although Powell and Steelman (1984, 1996) did not use the same transformation for the proportion, as was the case for Powell and Steelman (1984, 1996), the unadjusted rankings were very different from the rankings adjusted for the log proportion.

Results from Adjusting Percentile Ranks

Figure 7 shows an inside-out plot of the mean percentile ranks in class for those taking the SAT I in the SAT states and the ACT states. The mean percentile ranks of those who took the SAT I in the ACT states are much higher than those in the SAT states (see also Wainer et al., 1985). Figure 8 displays a scatterplot of the mean percentile rank of the students taking the SAT I and the average SAT I score. The two variables are linear in their relationship.

Table 5 presents the mean percentile ranks in class (i.e., class rank) and the estimated SAT I scores from the model with the class rank as a predictor variable. The prediction equation using only the class rank was

$$\text{SAT}' = 203.919 + 11.475\text{Class Rank}. \tag{6}$$

Table 5 also contains the residuals and the adjusted rankings of the 50 states and the District of Columbia. Note that class rank accounted for about 77 percent of the variation in the average SAT I scores. The estimated rankings in Table 5 were somewhat different from those in Table 3.

Results from Adjusting Both Proportion and Class Rank

It is possible to use both proportion and class rank as predictors in the model. The proportion of high school graduates taking the SAT I and the mean percentile rank in class was inversely related (see Figure 9). The pattern of the relationship was curvilinear. After the log transformation was performed on the proportion, the relationship became linear. The correlation after the transformation was $-.951$ (see Figure 10). Since there seems to be a rather strong relationship between the log proportion and the mean percentile rank, we could suspect that data might have a problem of multicollinearity.

The model that contained the two predictors was

$$\text{SAT}' = 994.375 - 62.434 \ln P_{\text{SAT}} - .221\text{Class Rank}, \tag{7}$$

and the respective standard errors were 161.503, 11.989, and 2.352. The corresponding t values were 6.157, -5.208, and $-.094$. The two variables as a set explained over 85 percent of the variation in the average SAT I score, but the regression weight for the class rank was not statistically significant.

Nevertheless the estimated SAT I scores using both log proportion and class rank as the predictor variables are reported in Table 6. Table 6 also contain the residuals and the adjusted rankings. The adjusted rankings in Table 6 and earlier Table 3 were very similar, partly due to the potential multicollinearity problem. The subsequent analyses considered only one of the two variables in the models.

The Best Regression Equation with Log Proportion

Table 7 contains the three regression models with the average SAT I score as the predicted variable and the log proportion as one of the predictor variables. Model II has two predictor variables, the log proportion and the pupil expenditure. It should be noted that all variables in Table 7 except the pupil expenditure were obtained from the *College-Bound Seniors* reports (CEEB, 1999).

The regression coefficient of the pupil expenditure was not statistically significant at the .05 alpha level. Adding the pupil expenditure to the model that already contained the log proportion increased R^2 and the adjusted R^2 negligibly.

Table 7 also presents the best regression equation using the Mallows C_p criterion. All variables in Table 1 except class rank, ACT, ACT proportion, and NAEP math, were used in the all possible regressions procedure. There was one predictor variable, the average SAT I score, and there were 11 predictor variables. All possible regressions were performed to obtain the best regression equation. The best regression equation contained four predictor variables—log proportion, race composition, parental degree, and calculator experience. All regression coefficients were significant at the nominal .05 alpha level. The best regression equation did not contain the pupil expenditure variable.

Table 8 presents best subset regression equations for each number of variables in the subset. Note that all equations contained the log proportion. The regression equation that contained four variables was the best based on the Mallows C_p criterion. The best regression equation also had a very high adjusted R^2 value.

The Best Regression Equation with Class Rank

Table 9 presents four regression models with the average SAT I score as the predicted variable and the class rank as one of the predictor variables. Model II contained two predictors but pupil expenditure was not statistically significant at the nominal .05 alpha level. Model I, containing only one predictor variable, had about the same R^2 and adjusted R^2 as Model II.

Model III, containing four predictors, was the best regression equation based on the Mallows C_p criterion. The regression coefficient of the race composition in model III was not statistically significant. Model IV was the second best regression equation using the C_P. Model IV seemed to be better than Model III because of the nonsignificance of the regression coefficient of the race composition and the values of the nearly identical adjusted R^2.

Table 10 presents 11 best subset regression equations, which reflected the number of variables in the subset, with the average SAT I score as the predicted variable and the class rank as one of the predictor variables.

Analyses of the ACT

Table 11 contains the average ACT composite scores and the proportion of high school graduates taking the ACT in 1999 as well as the rankings of the 50 states and the District of Columbia.

Figure 11 shows an inside-out plot of the proportion of the high school graduates taking the ACT for the 50 states and the District of Columbia in 1999. Note that the classification of the SAT stats and the ACT states was based on the earlier notion used in Figure 1. That is, when the proportion of the high school graduates taking the SAT I was greater than .40, the state was classified as the SAT state. Although in Arizona 28 percent of high school graduates took the ACT and 34 percent took the SAT I, Arizona was classified as the ACT state for the sake of simplicity. Except Arizona, more than 40 percent of the high school graduates took the ACT in the ACT states whereas less than 40 percent of the high school graduates took the ACT in the SAT states in 1999.

Figure 12 shows an inside-out plot of the average ACT scores for the 50 states and the District of Columbia in 1999. The most obvious difference between Figure 2 and Figure 12 is that the two distributions of the average ACT scores from the SAT states and the ACT states are essentially overlapping. The average ACT scores from the SAT states seem to be roughly uniform in shape. The average ACT scores in the ACT states formed two distinctive groups of states, those above 21 (which is roughly the mean of the ACT score) and those below 21.0.

The relationship between the proportion of the high school graduates taking the ACT and the average ACT score is presented in Figure 13. There seems to be a negative, but very weak, relationship between the two variables, indicating that the relationship is very different from that obtained for the SAT I data. The correlation between the proportion and the ACT score was −.153.

Figure 14 displays scatterplots of the proportion of high school graduates taking the ACT and the average ACT score in 1994 to 1998. All five scatterplots show essentially the same weak negative pattern.

Table 11 also presents the estimated ACT scores obtained from the regression equation of the average ACT score on the proportion, the resulting residuals, and the rankings of the 50 states and the District of Columbia. The proportion was used in fitting the regression equation without any transformation because there was no clear nonlinear pattern observed between the two variables. There were no dramatic changes in the original rankings of the states and the estimated rankings based on the residuals due to the weak relationship between the proportion and the average ACT score. Only Connecticut and Hawaii showed greater improvement in their rankings.

We may perform an analysis of the average ACT scores controlling the class rank variable. Figure 15, for example, which was adapted from Powell and Steelman (1996), presents the relationship between the percentage of the high school graduates taking the ACT who were within the top twenty-five percent in class and the average ACT score for the 50 states. Not surprisingly, there is a positive relationship between the two variables. Neither the percentage of the top twenty-five students nor the percentile rank of the high school graduates taking the ACT were reported in recent data. We cannot analyze the relationship between the class ranking and the average ACT score as we did for the SAT I.

Figure 16 displays the positive relationship between the average ACT score and the SAT I score for the 50 states and the District of Columbia. The same pattern of the positive relationship was observed between the average ACT score and the average SAT I score for data from 1994 to 1998 (see Figure 17).

Equating Results

As suggested in Wainer (1986) and Wainer et al. (1985), equating of the ACT and the SAT I was performed to obtain a unified measure of state performance. Figure 18 shows an inside-out plot of the estimated SAT I scores for the 50 states and the District of Columbia. Specifically, the estimated SAT I score was obtained using the equation,

$$(P_{\mathrm{SAT}}\mathrm{SAT} + P_{\mathrm{ACT}}\mathrm{SAT}')/(P_{\mathrm{SAT}} + P_{\mathrm{ACT}}), \tag{8}$$

where P_{SAT} is the proportion of high school graduates taking the SAT I, SAT is the average SAT I score, P_{ACT} is the proportion of high school graduates taking the ACT, and SAT' is the equated average ACT score on the scale of the SAT I. SAT' is defined as

$$\mathrm{SAT}' = 160 + 40\mathrm{ACT}. \tag{9}$$

Table 12 contains the equated scores of the ACT on the scale of the SAT I. Table 12 also shows the proportion of the high school graduates taking the ACT and the SAT I, respectively. The two variables are negatively related (see Figure 19). On the average about 78 percent of the high school graduates took either the SAT I or the ACT in 1999. Figure 20 displays the same consistent pattern of the negative relationship between the two proportion of students taking the ACT and the SAT I in years 1994 to 1998.

The estimated SAT I scores for the 50 states and the District of Columbia that were obtained by combining information from the SAT I and from the ACT are reported in Table 12. In order to obtain the estimated SAT I scores that reflected relative contributions of the students who took the ACT and the students who took the SAT I, two scores were combined using the weights that were functions of the two respective proportion. Wisconsin high school graduates performed the best whereas Mississippi high school graduates performed the worst based on the estimated SAT I scores. Note that not all high school graduates took the ACT or the SAT I.

Crossvalidation with the NAEP Result

Table 13 displays the NAEP performance and the state rankings (1–41). The NAEP mathematics results were not available for the following 10 states: Idaho, Illinois, Kansas, Nevada, New Hampshire, New Jersey, Ohio, Oklahoma, Pennsylvania, and South Dakota. Minnesota was the best and the District of Columbia was the worst according to the NAEP mathematics performance.

Figure 21 shows an inside-out plot of the NAEP mathematics performance for the 40 states and the District of Columbia based on the earlier SAT and ACT state dichotomy. Students in the SAT states seem to perform similarly to those students in the ACT states, although there are some variations in the NAEP mathematics performance among the SAT states and the ACT states.

If the adjustment performed to solve the self-selection problem in the SAT I and in the ACT worked, we may expect a close relationship between the respective results from the earlier analyses and the NAEP mathematics performance. Table 13 contains the unadjusted SAT I, the residuals from Table 3 in which the log proportion was adjusted for the SAT I, from Table 5 in which the class rank was adjusted for the SAT I, and from Table 6 in which the proportion was adjusted for the ACT, and the estimated SAT I from Table 12 that combined both the SAT I and the ACT scores via equating. These are expected to be comparable with the NAEP mathematics performance.

Table 14 presents correlations among the NAEP mathematics performance, the average SAT I, the residuals from Tables 3, 5, and 6, and the estimated SAT I from Table 12. The Spearman rank-order correlation between the NAEP mathematics performance and the unadjusted SAT I (which was based on only 41 cases) was very low, $r_S = .325$. The estimated SAT I has the highest rank-order correlation with the NAEP mathematics performance ($r_S = .838$), indicating the adjustment using both the SAT I and the ACT as well as the weighted proportion yielded better results. In fact, the pattern found in Figure 21 looks very similar to that in Figure 18.

Summary and Discussion

Based on the 1999 data, a natural logarithmic transformation of the proportion of high school graduates taking the SAT I should be used to fit linear regression with the state average SAT I scores as a predicted variable. The consistency of this transformation was evaluated using data from 1987 to 1998. The same transformation estimates of the Box and Tidwell method were obtained from the previous 12 years of data.

The best subset regression equation of the average SAT I score using the Mallows C_p criterion contained the log proportion and the three other predictor variables—race composition, parental degree, and calculator experience. Hence, the variation in the average SAT I scores could be attributed to the three demographic characteristics of the SAT I takers when the log proportion was controlled. None of the policy-related variables significantly improved the regression equation as long as the log proportion and the three demographic characteristics were already included in the model. It can be noted that the calculator experience variable might be a proxy that reflected the highest mathematics courses taken by the SAT I takers. A similar best subset regression equation was obtained when class rank was used in place of the log proportion. Note that when we perform regression analyses on unplanned data, such as the SAT I data and the ACT data used in this study, that are not from a designed experiment, we must keep in mind the possibility of jumping to erroneous conclusions because of the existence of potential lurking variables and the dependency among the predictor variables (Draper & Smith, 1981).

To obtain a combined indicator to make state comparisons, the average scores from the ACT were equated onto the metric of the SAT I. The rankings of the 50 states and the District of Columbia were obtained from the estimated SAT I scores which combined information from the ACT and from the SAT I. A crossvalidation of the rankings was performed using the results from the 1996 NAEP mathematics for grade 8.

This paper only considered the 1996 NAEP mathematics for grade 8 (i.e., the percent of the proficient level and above) because this particular grade level seemed to be the most closely related to the high school graduates taking the college admission tests in 1999. We may use different achievement-level results as well as other grade results of the 1996 NAEP mathematics. In addition we may use the results from the 1996 NAEP science for grade 8 (e.g., O' Sullivan et al., 1997). Combinations of the NAEP results may provide us a better criterion to crossvalidate the estimated SAT I scores although there remain a question of the motivation of students who took the NAEP assessment.

The NAEP and, especially, the State NAEP provide undeniably the best indicators to compare states because there are many known problems when using the aggregate SAT I scores as an educational indicator. Yet there have been many studies that used the aggregate state SAT scores to make state comparisons. According to Powell and Steelman (1996) and Dynarski and Gleason (1993), the reasons why researchers used the SAT data included: (1) Every state does not participate in the State NAEP. (2) The NAEP is not administered yearly. (3) The NAEP and its scale do not have the prominence of the SAT I. Wainer (1986b) also noted that many researchers were attracted to the aggregate SAT data partly because of its high quality (e.g., good predictive validity, careful scaling, existence of good ancillary information). In addition, the general public are always sensitive to the issues related to SAT I because of its high-stakeness (e.g., when compared with the NAEP) and the familiarity (i.e., many people took the SAT I, and many of us still remember the test results).

This study was designed to provide educational statisticians and educational policy makers with clear applications of the variable transformation technique and the selection of best subset regression. We tried to identify important demographic characteristics and policy related variables that influence average state SAT I scores. We also examined a way to combine the ACT and SAT I results to obtain a better indicator for the state comparison purpose. This study may provide some material for discussion in introductory statistics courses that deal with various regression techniques.

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Appendix A

While the Box and Tidwell (1962) procedure is applicable to the multiple regression situation, we present its description in the context of a simple linear regression model. Suppose that the response variable y is a function of a predictor variable in x and that it is desired to fit some graduating function f by least squares. Suppose further that the predictor variable may require a transformation to powers

$$\xi = x^{\alpha}. \tag{10}$$

The response variable y is related to a power of the predictor variable ξ as

$$E(y) = f(\xi, \beta_0, \beta_1) = \beta_0 + \beta_1 \xi, \tag{11}$$

where $\xi = x^{\alpha}$ for $\alpha \neq 0$ or $\xi = \ln x$ for $\alpha = 0$, and α, β_0, and β_1 are unknown parameters.

We can expand $E(y)$ in a Taylor series to first order about the initial value $\alpha_{(0)} = 1$ to give the approximation

$$E(y) = [f(\xi, \beta_0, \beta_1)]_{\alpha_{(0)}} + (\alpha - 1)\left[\frac{df(\xi, \beta_0, \beta_1)}{d\alpha}\right]_{\alpha_{(0)}} \tag{12}$$

and, consequently,

$$E(y) = \beta_0 + \beta_1 x + (\alpha - 1)\beta_1 x \ln x. \tag{13}$$

The $\beta_1 x \ln x$ in the last term could be treated as an additional predictor variable, say z, and it is possible to estimate parameters α, β_0, and β_1 by a method of least squares.

Let $\gamma = (\alpha - 1)$ and $\hat{y} = \hat{\beta}_0 + \hat{\beta}_1 x$ be the initial fitting model, then

$$\hat{y} = \hat{\beta}_0^* + \hat{\beta}_1^* x + \hat{\gamma} z \tag{14}$$

is the fitting model based on the Taylor series. The first estimate of α is

$$\hat{\alpha}_{(1)} = \hat{\gamma} + 1. \tag{15}$$

As a second phase the following steps are followed.

1. Use $x' = x^{\hat{\alpha}_{(1)}}$ and fit model

$$E(y) = \beta_0' + \beta_1' x' \tag{16}$$

and obtain $\hat{\beta}_0'$ and $\hat{\beta}_1'$.

2. Define $z' = \beta_1' x' \ln x'$.

3. Fit a regression of y on x' and z', and obtain new coefficient of $\hat{\beta}_0'^*$, $\hat{\beta}_1'^*$, and $\hat{\gamma}'$.

4. The estimate of α is

$$\hat{\alpha}'_{(2)} = \hat{\gamma}' + 1 \tag{17}$$

and it is based on $x' = x^{\hat{\alpha}_{(1)}}$. In terms of the original predictor x,

$$\hat{\alpha}_{(2)} = \hat{\alpha}'_{(2)} \hat{\alpha}_{(1)}. \tag{18}$$

If desired, we may repeat the steps to obtain the improved estimate of α. the convergence of α may occur fairly quickly in most cases.

Appendix B

The use of specific statistical procedures for selecting variables in regression should be considered when we investigate the relationship between the average state SAT I scores as a response variable and other demographic and policy-related variables as predictor variables. Although there is no unique statistical procedure for selecting best regression equation, the best subset regressions (that is based on in essence a fraction of all possible regression) with the C_p statistic as a criterion is preferred when exploration of equations is needed (Draper & Smith, 1981).

Mallows C_p has the form

$$C_p = \frac{\text{RSS}_p}{s^2} - (n - 2p), \tag{19}$$

where RSS_p is the residual sum of squares from a model, p is the number of all parameters in the model (i.e., $p - 1$ is the total number of predictors), and s^2 is the residual mean square from the most inclusive equation that contains all predictors.

If an equation with p parameters is adequate, then $E(\text{RSS}_p) = (n - p)\sigma^2$, $E(s^2) = \sigma^2$, and, consequently,

$$E(C_p) = p. \tag{20}$$

A regression with a smaller C_p value given p can be chosen as the best (Draper & Smith, 1981). Note that Mallows C_p cannot be expected to provide a single best equation when data are inadequate to support such inference (Mallows, 1973).

Table 1

Descriptions, Means, and Standard Deviations (SDs) of Key Variables

Variable	Description	Mean	SD
SAT I[a]	Average SAT I score in 1999	1065.35	67.64
Log Proportion	Log proportion of high school graduates taking the SAT I	−1.40	1.02
Class Rank[a]	Mean Percentile rank of high school graduates taking the SAT I	75.40	5.18
Sex Composition[a]	Percent of male high school graduates taking the SAT I	45.71	1.46
Race Composition[a]	Percent of white high school graduates taking the SAT I	75.94	15.88
First Language[a]	Percent of high school graduates learned English as the first language	89.29	6.17
Citizenship Composition[a]	Percent of U.S. Citizen or U.S. national high school graduates	96.49	2.12
Adjusted Income	Family income over cost of living in thousands	57.66	11.38
Parental Degree[a]	Percent of parents of high school graduates with bachelor's or graduate degrees	61,88	11.12
Calculator Experience[a]	Percent of high school graduates who use calculators almost every day	76.18	6.84
Pupil-Teacher Ratio[b]	Pupil-teacher ratio in public elementary and secondary schools in 1998	16.49	2.20
Adjusted Teacher Salary	Average salaries over cost of living in thousands	38.82	4.55
Adjusted Expenditure	Pupil expenditures over cost of living in thousands	6.07	.99
ACT[c]	Average ACT Composite score in 1999	21.08	.98
ACT Proportion[c]	Proportion of high school graduates taking the ACT	.41	.28
NAEP Math[d]	Percent of the proficient level and above in 1996 NAEP mathematics for grade 8	21.59	7.67

[a]College Entrance Examination Board (1999).
[b]O'Leary Morgan and Morgan (1999).
[c]ACT, Inc. (2000).
[d]Blank et al. (1997): The number of cases is 41.

Table 2

Descriptions, Means, and Standard Deviations (SDs) of Additional Variables

Variable	Description	Mean	SD
SAT I Verbal[a]	Average SAT I Verbal score	532.41	33.37
SAT I Math[a]	Average SAT I Math score	532.94	34.78
Proportion	Proportion of high school graduates taking the SAT I	.37	.28
SAT I Takers[a]	Number of high school graduates taking the SAT I	22962.59	33912.41
Total Graduates[b]	Total number of high school graduates	55062.53	57466.45
GPA[a]	Mean grade point average of high school graduates taking the SAT I	3.38	.23
Family Income[a]	Median family income of high school graduates taking the SAT I in thousands	56.57	9.46
Living Cost[c]	State cost of living in 1998	.99	.08
Parental Education[a]	Mean highest level of parental education in year	15.18	.61
Personal Income[d]	Per capita personal income in 1997 in thousands	24.34	3.98
Household Income[e]	Median income of households 1997–1998 in thousands	37.86	5.55
Teacher Salary[f]	Average salaries of public school teachers 1998–1999 in thousands	38.49	5.98
Graduation Ratio[d]	Public high school graduation rate in 1999	69.45	10.14
State Expenditure[d]	Per capita state and local government expenditures for education in 1995	1.01	.20
Pupil Expenditure[d]	Expenditures per pupil in elementary and secondary schools in 1998 in thousands	6.03	1.28
College Education[d]	Percent of population graduated from college as of 1998	24.02	4.67
Poverty Percent[d]	Percent of school age children living in poverty in 1997	18.71	5.73
Federal Source[g]	Federal sources as percent of school revenues	6.87	2.42

[a]College Entrance Examination Board (1999).
[b]Western Interstate Commission for Higher Education (1998).
[c]Leonard, Walder, and Acevedo (1999).
[d]O'Leary Morgan & Morgan (1999).
[e]U.S. Bureau of the Census (1999a).
[f]National Educational Association (2000)
[g]U.S. Bureau of the Census (1999b).

Table 3

Proportion of High School Graduates Taking the SAT I, Average SAT I Scores, Rankings, Estimated SAT I Scores Controlling for Log Proportion, Residuals, and Estimated Rankings of States

State	Proportion	Average SAT I	Ranking	Estimated SAT I	Residual	Estimated Ranking
Alabama	.09	1116	15	1127.073	−11.073	33
Alaska	.50	1030	30	1021.291	8.709	18
Arizona	.34	1049	27	1046.134	2.866	24
Arkansas	.06	1119	13.5	1157.002	−38.002	46
California	.49	1011	36	1023.435	−12.435	34
Colorado	.32	1076	23	1049.402	26.598	11
Connecticut	.83	1019	34	990.692	28.308	9
Delaware	.67	1000	41	1003.916	−3.916	29
Florida	.53	997	42.5	1018.155	−21.155	40
Georgia	.63	969	49	1007.671	−38.671	47
Hawaii	.52	995	44	1019.764	−24.764	43
Idaho	.16	1082	22	1091.260	−9.260	32
Illinois	.12	1152	7	1107.590	44.410	2
Indiana	.60	994	45	1010.906	−16.906	39
Iowa	.05	1192	2	1163.068	28.932	8
Kansas	.09	1154	6	1128.722	25.278	12
Kentucky	.12	1094	19	1109.053	−15.053	36
Louisiana	.08	1119	13.5	1133.678	−14.678	35
Maine	.68	1010	37	1002.496	7.504	23
Maryland	.65	1014	35	1005.545	8.455	19
Massachusetts	.78	1022	32	994.867	27.133	10
Michigan	.11	1122	12	1113.760	8.240	21
Minnesota	.09	1184	3	1126.822	57.178	1
Mississippi	.04	1111	17	1172.594	−61.594	50
Missouri	.08	1144	8	1131.951	12.049	16
Montana	.21	1091	20.5	1074.541	16.459	14
Nebraska	.08	1139	9	1130.835	8.165	22
Nevada	.34	1029	31	1045.719	−16.719	38
New Hampshire	.72	1038	29	999.071	38.929	3
New Jersey	.80	1008	38	993.214	14.786	15
New Maxico	.12	1091	20.5	1107.400	−16.400	37
New York	.76	997	42.5	996.150	.850	27
North Carolina	.61	986	48	1009.662	−23.662	42
North Dakota	.05	1199	1	1162.269	36.731	4
Ohio	.26	1072	24	1062.758	9.242	17
Oklahoma	.08	1127	11	1133.284	−6.284	30
Oregon	.53	1050	26	1017.956	32.044	6
Pennsylvania	.70	993	46.5	1000.718	−7.718	31
Rhode Island	.70	1003	40	1001.141	1.859	25
South Carolina	.61	954	50	1009.975	−55.975	49
South Dakota	.04	1173	5	1172.324	.676	28
Tennessee	.13	1112	16	1103.702	8.298	20
Texas	.50	993	46.5	1021.979	−28.979	45
Utah	.05	1138	10	1165.890	−27.890	44
Vermont	.70	1020	33	1001.274	18.726	13
Virginia	.65	1007	39	1005.522	1.478	26
Washington	.52	1051	25	1019.251	31.749	7
West Virginia	.18	1039	28	1082.980	−43.980	48
Wisconsin	.07	1179	4	1144.435	34.565	5
Wyoming	.10	1097	18	1119.152	−22.152	41
District of Columbia	.77	972	48–49	994.929	−22.929	41–42

Table 4

Power Transformation Estimates for Proportion from the SAT Data in 1987–1999

Year	Iteration				
	1st	2nd	3rd	4th	5th
1999	−.357	.104	.032	.047	.044
1998	−.155	.223	.161	.174	.172
1997	−.371	.208	.093	.126	.118
1996	−.480	.124	.014	.043	.036
1995	−.432	.121	.037	.058	.053
1994	−.398	.186	.094	.119	.113
1993	−.546	.120	−.006	.030	.021
1992	−.483	.144	.037	.065	.058
1991	−.446	.167	.059	.088	.081
1990	−.346	.183	.110	.127	.124
1989	−.303	.185	.128	.140	.137
1988	−.435	.124	.123	.060	.072
1987	−.758	−.140	−.172	−.140	−.172

Table 5
Class Ranks of High School Graduates Taking the SAT I, Average SAT I Scores, Rankings, Estimated SAT I Scores Controlling for Class Rank, Residuals, and Estimated Rankings of States

State	Class Rank	Average SAT I	Ranking	Estimated SAT I	Residual	Estimated Ranking
Alabama	79.95	1116	15	1116.548	−.548	26
Alaska	75.65	1030	30	1067.464	−37.464	45
Arizona	74.60	1049	27	1055.478	−6.478	30
Arkansas	84.00	1119	13.5	1162.779	−43.779	46
California	72.50	1011	36	1031.507	−20.506	38
Colorado	75.10	1076	23	1061.186	14.815	17
Connecticut	67.65	1019	34	976.144	42.856	6
Delaware	69.05	1000	41	992.125	7.875	21
Florida	71.30	997	42.5	1017.809	−20.808	39
Georgia	68.85	969	49	989.842	−20.842	40
Hawaii	70.35	995	44	1006.964	−11.964	35
Idaho	78.70	1082	22	1102.280	−20.280	37
Illinois	75.75	1152	7	1068.605	83.395	1
Indiana	70.10	994	45	1004.111	−10.110	34
Iowa	84.10	1192	2	1163.921	28.080	11
Kansas	81.15	1154	6	1130.246	23.754	12
Kentucky	78.40	1094	19	1098.855	−4.855	29
Louisiana	78.40	1119	13.5	1098.855	20.145	14
Maine	69.80	1010	37	1000.686	9.314	19
Maryland	70.75	1014	35	1011.530	2.470	22
Massachusetts	68.90	1022	32	990.413	31.588	10
Michigan	78.50	1122	12	1099.997	22.004	13
Minnesota	79.65	1184	3	1113.124	70.876	2
Mississippi	83.70	1111	17	1159.355	−48.354	47
Missouri	77.45	1144	8	1088.011	55.989	3
Montana	78.40	1091	20.5	1098.855	−7.855	32
Nebraska	81.15	1139	9	1130.246	8.754	20
Nevada	76.90	1029	31	1081.733	−52.733	48
New Hampshire	69.15	1038	29	993.266	44.734	5
New Jersey	68.70	1008	38	988.130	19.871	15
New Maxico	80.85	1091	20.5	1126.822	−35.822	44
New York	69.70	997	42.5	999.545	−2.544	28
North Carolina	71.25	986	48	1017.238	−31.238	42
North Dakota	84.05	1199	1	1163.350	35.650	7
Ohio	73.25	1072	24	1040.068	31.932	9
Oklahoma	80.95	1127	11	1127.963	−.963	27
Oregon	74.75	1050	26	1057.190	−7.190	31
Pennsylvania	69.05	993	46.5	992.125	.875	24
Rhode Island	68.95	1003	40	990.983	12.017	18
South Carolina	71.05	954	50	1014.955	−60.955	49
South Dakota	83.45	1173	5	1156.501	16.499	16
Tennessee	76.45	1112	16	1076.596	35.404	8
Texas	72.35	993	46.5	1029.794	−36.794	44
Utah	82.65	1138	10	1147.369	−9.369	33
Vermont	71.45	1020	33	1019.521	.479	25
Virginia	70.20	1007	39	1005.252	1.748	23
Washington	75.90	1051	25	1070.318	−19.318	36
West Virginia	79.05	1039	28	1106.275	−67.275	50
Wisconsin	81.20	1179	4	1130.817	48.183	4
Wyoming	80.30	1097	18	1120.544	−23.544	41
District of Columbia	70.00	972	48–49	1002.969	−30.969	41–42

Table 6

Estimated State SAT I Ranking Results Controlling for Both Log Proportion and Class Rank

State	Proportion	Class Rank	Average SAT I	Ranking	Estimated SAT I	Residual	Estimated Ranking
Alabama	.09	79.95	1116	15	1127.148	−11.148	33
Alaska	.50	75.65	1030	30	1020.531	9.469	17
Arizona	.34	74.60	1049	27	1045.996	3.004	24
Arkansas	.06	84.00	1119	13.5	1156.727	−37.727	46
California	.49	72.50	1011	36	1023.362	−12.362	34
Colorado	.32	75.10	1076	23	1049.214	26.786	11
Connecticut	.83	67.65	1019	34	991.088	27.912	9
Delaware	.67	69.05	1000	41	1004.239	−4.239	29
Florida	.53	71.30	997	42.5	1018.244	−21.244	40
Georgia	.63	68.85	969	49	1008.096	−39.096	47
Hawaii	.52	70.35	995	44	1020.076	−25.076	43
Idaho	.16	78.70	1082	22	1091.010	−9.010	32
Illinois	.12	75.75	1152	7	1108.217	43.783	2
Indiana	.60	70.10	994	45	1011.125	−17.125	39
Iowa	.05	84.10	1192	2	1162.871	29.129	8
Kansas	.09	81.15	1154	6	1128.576	25.424	12
Kentucky	.12	78.40	1094	19	1109.155	−15.155	35
Louisiana	.08	78.40	1119	13.5	1134.182	−15.182	36
Maine	.68	69.80	1010	37	1002.640	7.360	23
Maryland	.65	70.75	1014	35	1005.542	8.458	19
Massachusetts	.78	68.90	1022	32	995.073	26.927	10
Michigan	.11	78.50	1122	12	1113.919	8.081	21
Minnesota	.09	79.65	1184	3	1126.955	57.045	1
Mississippi	.04	83.70	1111	17	1172.635	−61.635	50
Missouri	.08	77.45	1144	8	1132.623	11.377	16
Montana	.21	78.40	1091	20.5	1074.081	16.919	14
Nebraska	.08	81.15	1139	9	1130.723	8.277	20
Nevada	.34	76.90	1029	31	1045.099	−16.099	38
New Hampshire	.72	69.15	1038	29	999.294	38.706	3
New Jersey	.80	68.70	1008	38	993.434	14.566	15
New Maxico	.12	80.85	1091	20.5	1106.969	−15.969	37
New York	.76	69.70	997	42.5	996.212	0.788	27
North Carolina	.61	71.25	986	48	1009.623	−23.623	42
North Dakota	.05	84.05	1199	1	1162.070	36.930	4
Ohio	.26	73.25	1072	24	1063.171	8.829	18
Oklahoma	.08	80.95	1127	11	1133.254	−6.254	30
Oregon	.53	74.75	1050	26	1017.327	32.673	6
Pennsylvania	.70	69.05	993	46.5	1000.989	−7.989	31
Rhode Island	.70	68.95	1003	40	1001.439	1.561	25
South Carolina	.61	71.05	954	50	1009.982	−55.982	49
South Dakota	.04	83.45	1173	5	1172.413	0.587	28
Tennessee	.13	76.45	1112	16	1104.121	7.879	22
Texas	.50	72.35	993	46.5	1021.913	−28.913	45
Utah	.05	82.65	1138	10	1166.039	−28.039	44
Vermont	.70	71.45	1020	33	1001.057	18.943	13
Virginia	.65	70.20	1007	39	1005.633	1.367	26
Washington	.52	75.90	1051	25	1018.406	32.594	7
West Virginia	.18	79.05	1039	28	1082.522	−43.522	48
Wisconsin	.07	81.20	1179	4	1144.535	34.465	5
Wyoming	.10	80.30	1097	18	1119.026	−22.026	41
District of Columbia	.77	70.00	972	48–49	994.909	−22.909	41–42

Table 7

Regression Models of State SAT I Scores on Log Proportion and Other Key Variables

	Model I		Model II		Model III	
	b	t	b	t	b	t
Variable	(se)	(p)	(se)	(p)	(se)	(p)
Log Proportion	−61.363	−16.663	−65.097	−15.866	−21.690	−4.052
	(3.683)	(.000)	(4.103)	(.000)	(5.353)	(.000)
Race Composition					.381	2.161
					(.176)	(.036)
Parental Degree					2.792	4.651
					(.600)	(.000)
Calculator Experience					1.913	2.577
					(.742)	(.013)
Pupil Expenditure			7.915	1.881		
			(4.207)	(.066)		
Intercept	979.208	153.944	925.925	31.936	687.460	18.031
	(6.361)	(.000)	(28.993)	(.000)	(38.128)	(.000)
R^2	.850		.860		.946	
Adjusted R^2	.847		.854		.942	
C_p					2.41	

Table 8

Best Subsets from All Possible Subsets Regression Analysis of State SAT I Scores with Log Proportion

Variable	Number of Variables in the Subset										
	1[a]	2	3	4	5	6	7	8	9	10	11
Log Proportion	o[b]	o	o	o	o	o	o	o	o	o	o
Sex Composition										o	o
Race Composition			o	o	o	o	o	o	o	o	o
First Language					o	o	o	o	o	o	o
Citizenship Composition							o	o	o	o	o
Adjusted Income						o	o	o	o	o	o
Parental Degree		o	o	o	o	o	o	o	o	o	o
Calculator Experience				o	o	o	o	o	o	o	o
Pupil-Teacher Ratio									o	o	o
Adjusted Teacher Salary									o	o	o
Adjusted Expenditure								o			o
R^2	.849	.921	.941	.946	.949	.950	.951	.952	.952	.952	.952
Adjusted R^2	.847	.918	.937	.942	.943	.943	.943	.942	.941	.940	.938
C_p	74.63	19.00	4.82	2.41	2.55	3.60	4.66	6.17	8.06	10.03	12.00

[a]The model contains Parental Degree yields $R^2 = .898$, Adj. $R^2 = .896$, and $C_p = 35.63$.

[b]Variable included in the model.

Table 9
Regression Models of State SAT I Scores on Class Rank and Other Key Variables

	Model I		Model II		Model III		Model IV	
	b	*t*	*b*	*t*	*b*	*t*	*b*	*t*
Variable	(*se*)	(*p*)	(*se*)	(*p*)	(*se*)	(*p*)	(*se*)	(*p*)
Class Rank	11.425	12.640	11.887	11.565	3.669	4.533	3.942	4.937
	(.904)	(.000)	(1.028)	(.000)	(.809)	(.000)	(.798)	(.000)
Race Composition					.259	1.486		
					(.175)	(.144)		
Parental Degree					2.877	5.274	2.599	5.008
					(.546)	(.000)	(.519)	(.000)
Calculator Experience					2.554	3.486	3.106	4.860
					(.733)	(.001)	(.639)	(.000)
Pupil Expenditure			5.091	.948				
			(5.371)	(.348)				
Intercept	203.919	2.985	138.174	1.419	396.444	7.168	370.678	6.970
	(68.311)	(.004)	(97.406)	(.162)	(55.305)	(.000)	(53.184)	(.000)
R^2	.765		.770		.950		.947	
Adjusted R^2	.760		.760		.945		.944	
C_p					3.86		4.01	

Table 10

Best Subsets from All Possible Subsets Regression Analysis of State SAT I Scores with Class Rank

	Number of Variables in the Subset										
Variable	1[a]	2	3	4	5	6	7	8	9	10	11
Class Rank	o[b]	o	o	o	o	o	o	o	o	o	o
Sex Composition											o
Race Composition				o	o	o	o	o	o	o	o
First Language					o	o	o	o	o	o	o
Citizenship Composition							o	o	o	o	o
Adjusted Income										o	o
Parental Degree		o	o	o	o	o	o	o	o	o	o
Calculator Experience			o	o	o	o	o	o	o	o	o
Pupil-Teacher Ratio						o	o	o	o	o	o
Adjusted Teacher Salary									o	o	o
Adjusted Expenditure								o	o	o	o
R^2	.765	.921	.947	.950	.951	.953	.955	.955	.956	.956	.956
Adjusted R^2	.760	.918	.944	.945	.946	.947	.948	.947	.946	.945	.944
C_p	162.71	25.65	4.01	3.86	4.53	4.88	5.09	6.85	8.43	10.02	12.00

[a]The model contains Parental Degree yields $R^2 = .898$, Adj. $R^2 = .896$, and $C_p = 44.05$.

[b]Variable included in the model.

Table 11
Proportion of High School Gradiates Taking the ACT, Average ACT Scores, Rankings, Estimated ACT Scores Controlling for Proportion, Residuals, and Estimated Rankings of States

State	Proportion	Average ACT	Ranking	Estimated ACT	Residual	Estimated Ranking
Alabama	.65	20.2	41.5	20.950	−.750	39
Alaska	.35	21.1	32	21.109	−.009	32
Arizona	.28	21.4	23.5	21.146	.254	28
Arkansas	.69	20.3	39.5	20.929	−.629	37
California	.12	21.3	28.5	21.231	.069	30
Colorado	.62	21.5	18	20.966	.534	16
Connecticut	.03	21.6	15	21.278	.322	26
Delaware	.03	20.5	38	21.278	−.778	40
Florida	.39	20.6	36	21.088	−.488	35
Georgia	.16	20.0	45	21.209	−1.209	46
Hawaii	.18	21.6	15	21.199	.401	24
Idaho	.60	21.4	23.5	20.977	.423	21
Illinois	.67	21.4	23.5	20.940	.460	19
Indiana	.19	21.2	30.5	21.193	.007	31
Iowa	.66	22.0	9	20.945	1.055	6
Kansas	.75	21.5	18	20.897	.603	15
Kentucky	.68	20.1	43.5	20.934	−.834	43
Louisiana	.76	19.6	47	20.892	−1.292	47
Maine	.04	22.1	6.5	21.273	.827	8
Maryland	.10	20.9	33	21.241	−.341	34
Massachusetts	.06	22.0	9	21.262	.738	12
Michigan	.69	21.3	28.5	20.929	.371	25
Minnesota	.64	22.1	6.5	20.955	1.145	5
Mississippi	.82	18.7	50	20.860	−2.160	50
Missouri	.67	21.6	15	20.940	.660	13
Montana	.54	21.8	12	21.008	.792	10
Nebraska	.73	21.7	13	20.908	.792	9
Nevada	.41	21.5	18	21.077	.423	22
New Hampshire	.05	22.2	5	21.268	.932	7
New Jersey	.04	20.7	34	21.273	−.573	36
New Maxico	.64	20.1	43.5	20.955	−.855	44
New York	.14	22.0	9	21.220	.780	11
North Carolina	.12	19.4	48	21.231	−1.831	48
North Dakota	.79	21.4	23.5	20.876	.524	17
Ohio	.59	21.4	23.5	20.982	.418	23
Oklahoma	.69	20.6	36	20.929	−.329	33
Oregon	.11	22.6	2.5	21.236	1.364	3
Pennsylvania	.07	21.4	23.5	21.257	.143	29
Rhode Island	.03	22.7	1	21.278	1.422	1
South Carolina	.18	19.1	49	21.199	−2.099	49
South Dakota	.70	21.2	30.5	20.924	.276	27
Tennessee	.77	19.9	46	20.887	−.987	45
Texas	.31	20.3	39.5	21.130	−.830	42
Utah	.68	21.4	23.5	20.934	.466	18
Vermont	.09	21.9	11	21.246	.654	14
Virginia	.07	20.6	36	21.257	−.657	38
Washington	.18	22.6	2.5	21.199	1.401	2
West Virginia	.58	20.2	41.5	20.987	−.787	41
Wisconsin	.67	22.3	4	20.940	1.360	4
Wyoming	.66	21.4	23.5	20.945	.455	20
District of Columbia	.13	18.6	51	21.225	−2.625	51

Table 12

Proportion of High School Graduates Taking the ACT, Average ACT Scores, Equated ACT Scores onto SAT I, Proportion of High School Graduates Taking the SAT I, Average SAT I Scores, Estimated SAT I Scores, and Ranking of States

State	Prop. ACT	Average ACT	Equated Score	Prop. SAT I	Average SAT I	Estimated SAT I	Estimated Ranking
Alabama	.65	20.2	968	.09	1116	986.000	39
Alaska	.35	21.1	1004	.50	1030	1019.294	23
Arizona	.28	21.4	1016	.34	1049	1034.097	13
Arkansas	.69	20.3	972	.06	1119	983.760	43
California	.12	21.3	1012	.49	1011	1011.197	28
Colorado	.62	21.5	1020	.32	1076	1039.064	7
Connecticut	.03	21.6	1024	.83	1019	1019.174	24
Delaware	.03	20.5	980	.67	1000	999.143	34
Florida	.39	20.6	984	.53	997	991.489	38
Georgia	.16	20.0	960	.63	969	967.177	47
Hawaii	.18	21.6	1024	.52	995	1002.457	33
Idaho	.60	21.4	1016	.16	1082	1029.895	15
Illinois	.67	21.4	1016	.12	1152	1036.658	11
Indiana	.19	21.2	1008	.60	994	997.367	36
Iowa	.66	22.0	1040	.05	1192	1050.704	5
Kansas	.75	21.5	1020	.09	1154	1034.357	12
Kentucky	.68	20.1	964	.12	1094	983.500	44
Louisiana	.76	19.6	944	.08	1119	960.667	48
Maine	.04	22.1	1044	.68	1010	1011.889	26
Maryland	.10	20.9	996	.65	1014	1011.600	27
Massachusetts	.06	22.0	1040	.78	1022	1023.286	21
Michigan	.69	21.3	1012	.11	1122	1027.125	16
Minnesota	.64	22.1	1044	.09	1184	1061.260	2
Mississippi	.82	18.7	908	.04	1111	917.442	50
Missouri	.67	21.6	1024	.08	1144	1036.800	10
Montana	.54	21.8	1032	.21	1091	1048.520	6
Nebraska	.73	21.7	1028	.08	1139	1038.963	8
Nevada	.41	21.5	1020	.34	1029	1024.080	20
New Hampshire	.05	22.2	1048	.72	1038	1038.649	9
New Jersey	.04	20.7	988	.80	1008	1007.048	29
New Maxico	.64	20.1	964	.12	1091	984.053	42
New York	.14	22.0	1040	.76	997	1003.689	32
North Carolina	.12	19.4	936	.61	986	977.781	46
North Dakota	.79	21.4	1016	.05	1199	1026.893	17
Ohio	.59	21.4	1016	.26	1072	1033.129	14
Oklahoma	.69	20.6	984	.08	1127	998.857	35
Oregon	.11	22.6	1064	.53	1050	1052.406	4
Pennsylvania	.07	21.4	1016	.70	993	995.091	37
Rhode Island	.03	22.7	1068	.70	1003	1005.671	30
South Carolina	.18	19.1	924	.61	954	947.165	49
South Dakota	.70	21.2	1008	.04	1173	1016.919	25
Tennessee	.77	19.9	956	.13	1112	978.533	45
Texas	.31	20.3	972	.50	993	984.963	40
Utah	.68	21.4	1016	.05	1138	1024.356	19
Vermont	.09	21.9	1036	.70	1020	1021.823	22
Virginia	.07	20.6	984	.65	1007	1004.764	31
Washington	.18	22.6	1064	.52	1051	1054.343	3
West Virginia	.58	20.2	968	.18	1039	984.816	41
Wisconsin	.67	22.3	1052	.07	1179	1064.014	1
Wyoming	.66	21.4	1016	.10	1097	1026.658	18
District of Columbia	.13	18.6	904	.77	972	962.178	47–48

Table 13

Average SAT I, Residuals from Tables 3–5, Estimated SAT I from Table 6, NAEP Mathematics Performance, and NAEP Rankings of States (1–41)

State	Average SAT I	Residual 3	Residual 4	Residual 5	Estimated SAT I	NAEP Math	Ranking
Alabama	1116	−11.073	−.548	−.750	986.000	12	38
Alaska	1030	8.709	−37.464	−.009	1019.294	30	9
Arizona	1049	2.866	−6.478	.254	1034.097	18	27
Arkansas	1119	−38.002	−43.779	−.629	983.760	13	37
California	1011	−12.435	−20.506	.069	1011.197	17	28.5
Colorado	1076	26.598	14.815	.534	1039.064	25	15
Connecticut	1019	28.308	42.856	.322	1019.174	31	6.5
Delaware	1000	−3.916	7.875	−.778	999.143	19	26
Florida	997	−21.155	−20.808	−.488	991.489	17	28.5
Georgia	969	−38.671	−20.842	−1.209	967.177	16	31
Hawaii	995	−24.764	−11.964	.401	1002.457	16	31
Idaho	1082	−9.260	−20.280	.423	1029.895		
Illinois	1152	44.410	83.395	.460	1036.658		
Indiana	994	−16.906	−10.110	.007	997.367	24	17
Iowa	1192	28.932	28.080	1.055	1050.704	31	6.5
Kansas	1154	25.278	23.754	.603	1034.357		
Kentucky	1094	−15.053	−4.855	−.834	983.500	16	31
Louisiana	1119	−14.678	20.145	−1.292	960.667	7	39.5
Maine	1010	7.504	9.314	.827	1011.889	31	6.5
Maryland	1014	8.455	2.470	−.341	1011.600	24	17
Massachusetts	1022	27.133	31.588	.738	1023.286	28	10.5
Michigan	1122	8.240	22.004	.371	1027.125	28	10.5
Minnesota	1184	57.178	70.876	1.145	1061.260	34	1
Mississippi	1111	−61.594	−48.354	−2.160	917.442	7	39.5
Missouri	1144	12.049	55.989	.660	1036.800	22	20
Montana	1091	16.459	−7.855	.792	1048.520	32	3.5
Nebraska	1139	8.165	8.754	.792	1038.963	31	6.5
Nevada	1029	−16.719	−52.733	.423	1024.080		
New Hampshire	1038	38.929	44.734	.932	1038.649		
New Jersey	1008	14.786	19.871	−.573	1007.048		
New Maxico	1091	−16.400	−35.822	−.855	984.053	14	35
New York	997	.850	−2.544	.780	1003.689	22	20
North Carolina	986	−23.662	−31.238	−1.831	977.781	20	24.5
North Dakota	1199	36.731	35.650	.524	1026.893	33	2
Ohio	1072	9.242	31.932	.418	1033.129		
Oklahoma	1127	−6.284	−.963	−.329	998.857		
Oregon	1050	32.044	−7.190	1.364	1052.406	26	13.5
Pennsylvania	993	−7.718	.875	.143	995.091		
Rhode Island	1003	1.859	12.017	1.422	1005.671	20	24.5
South Carolina	954	−55.975	−60.955	−2.099	947.165	14	35
South Dakota	1173	.676	16.499	.276	1016.919		
Tennessee	1112	8.298	35.404	−.987	978.533	15	33
Texas	993	−28.979	−36.794	−.830	984.963	21	22.5
Utah	1138	−27.890	−9.369	.466	1024.356	24	17
Vermont	1020	18.726	.479	.654	1021.823	27	12
Virginia	1007	1.478	1.748	−.657	1004.764	21	22.5
Washington	1051	31.749	−19.318	1.401	1054.343	26	13.5
West Virginia	1039	−43.980	−67.275	−.787	984.816	14	35
Wisconsin	1179	34.565	48.183	1.360	1064.014	32	3.5
Wyoming	1097	−22.152	−23.544	.455	1026.658	22	20
District of Columbia	972	−22.929	−30.969	−2.625	962.178	5	41

Table 14

Pearson Correlation Coefficients (Upper Triangle) and Spearman Rank-Order Correlation Coefficients (Lower Triangle) Among Average SAT I, Residuals from Tables 3–5, Estimated SAT I from Table 6, and the NAEP Mathematics Performance

	Average SAT I	Residual 3	Residual 4	Residual 5	Estimated SAT I	NAEP Math[a]
Average SAT I		.388	.486	.332	.403	.300
Residual 3	.424		.807	.719	.814	.775
Residual 4	.468	.787		.508	.550	.548
Residual 5	.355	.703	.489		.892	.784
Estimated SAT I	.499	.783	.515	.868		.831
NAEP Math[a]	.325	.779	.554	.774	.838	

[a]The number of cases is 41.

Figure Captions

Figure 1. An inside-out plot comparing the proportion of students taking the SAT I for the SAT states and the ACT states.

Figure 2. An inside-out plot comparing the average SAT I scores for the SAT states and the ACT states.

Figure 3. The scatterplot of the proportion of high school graduates taking the SAT I and the average SAT I score.

Figure 4. Scatterplots of the proportion of high school graduates taking the SAT I and the average SAT I score in 1987–1998.

Figure 5. The scatterplot of the log proportion and the average SAT I score.

Figure 6. Scatterplots of the log proportion and the average SAT I score in 1987–1998.

Figure 7. An inside-out plot comparing the mean percentile ranks in class for those taking the SAT I in SAT states with those in ACT states.

Figure 8. A scatterplot of the percentile rank and the average SAT I score.

Figure 9. A scatterplot of the proportion of high school graduates taking the SAT I and the average percentile rank.

Figure 10. A scatterplot of the log proportion and the average percentile rank.

Figure 11. An inside-out plot comparing the proportion of students taking ACT for the SAT states and the ACT states.

Figure 12. An inside-out plot comparing the average ACT scores for the SAT states and the ACT states.

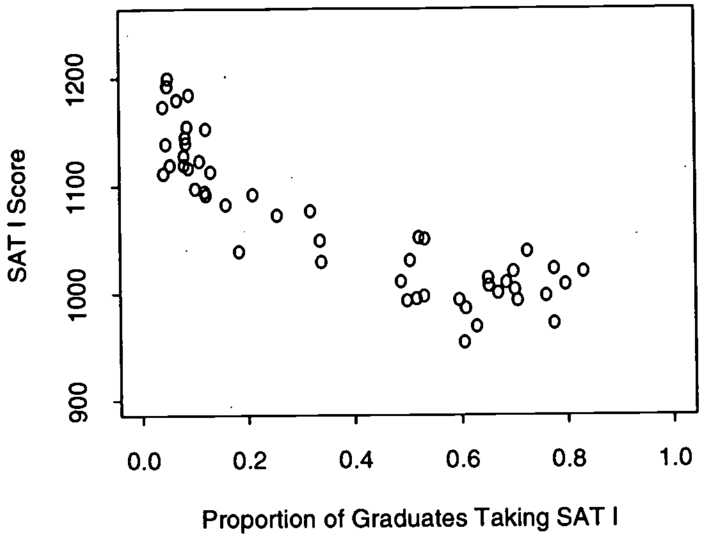
Figure 13. A scatterplot of the proportion of high school graduates taking the ACT and the average ACT score.

Figure 14. Scatterplots of the proportion of high school graduates taking the ACT and the average ACT score in 1994–1998.

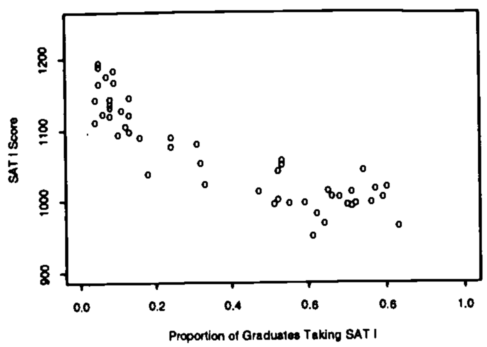
SAT State	SAT I Proportion	ACT State
CT	.80	
NY DC MA NJ	.75	
RI PA NH	.70	
MD VA DE ME VT	.65	
SC NC GA	.60	
IN	.55	
AK HI WA FL OR	.50	
CA TX	.45	
	.40	
	.35	
	.30	CO AZ NV
	.25	OH
	.20	MT
	.15	ID WV
	.10	WY MI KY IL NM TN
	.05	ND AR WI LA OK MO NE KS AL MN
	.00	MS SD UT IA

SAT State	SAT I Score	ACT State
	1180	MN IA ND
	1160	SD WI
	1140	MO IL KS
	1120	MI OK UT NE
	1100	MS TN AL AR LA
	1080	ID MT NM KY WY
	1060	OH CO
OR WA	1040	AZ
VT MA NH AK	1020	NV WV
DE RI VA NJ ME CA MD CT	1000	
NC PA TX IN HI FL NY	980	
GA DC	960	
SC	940	

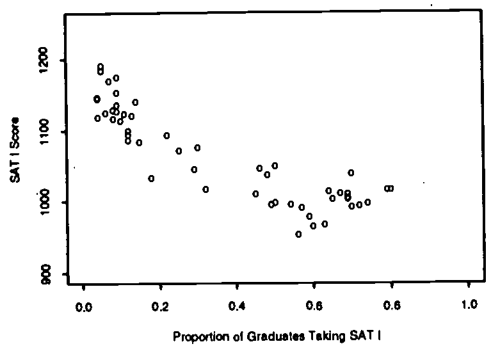
Scatterplot of Proportion and SAT I



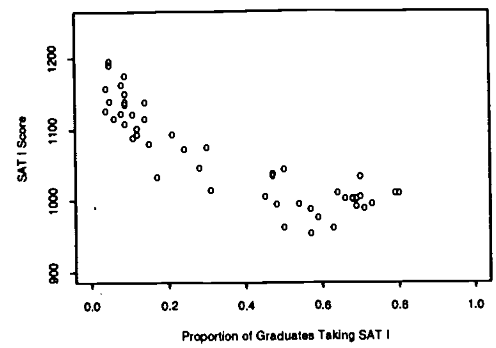
Scatterplot of Proportion and SAT I in 1998



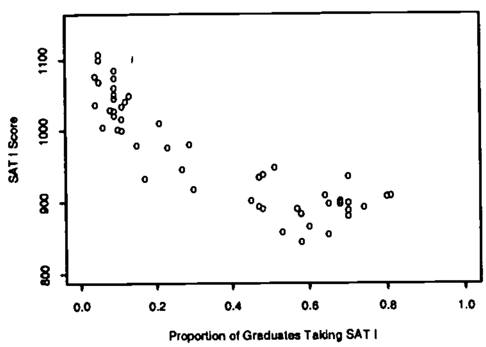
Scatterplot of Proportion and SAT I in 1997



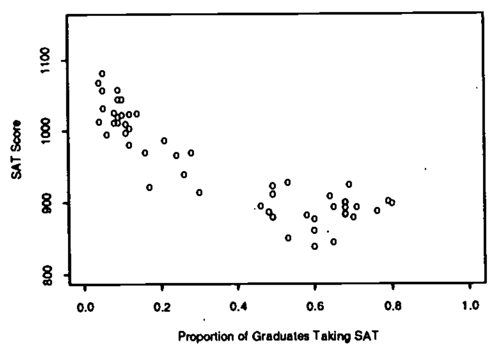
Scatterplot of Proportion and SAT I in 1996



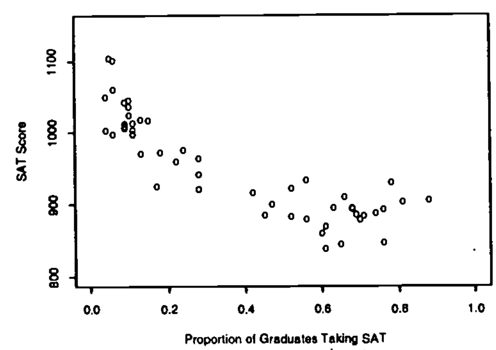
Scatterplot of Proportion and SAT I in 1995



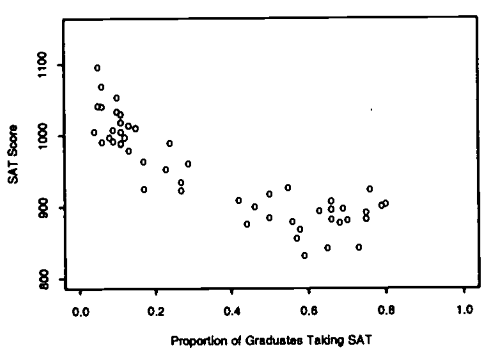
Scatterplot of Proportion and SAT in 1994



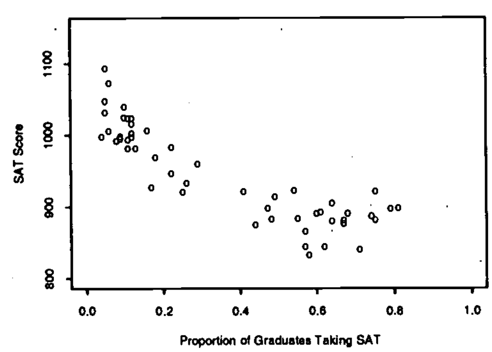
Scatterplot of Proportion and SAT in 1993



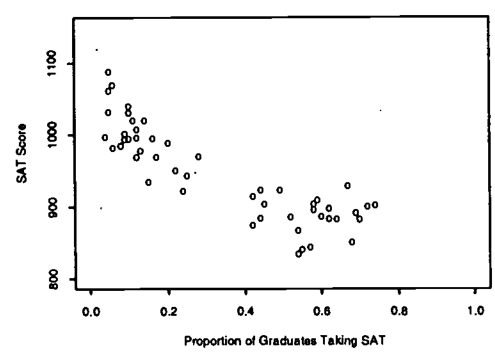
Scatterplot of Proportion and SAT in 1992



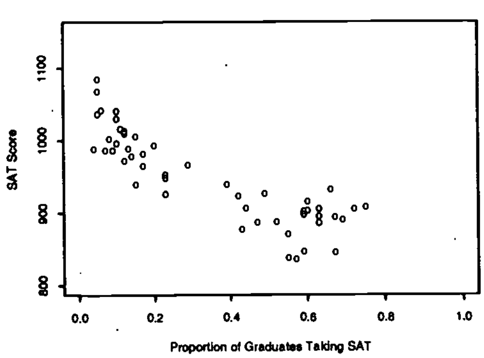
Scatterplot of Proportion and SAT in 1991



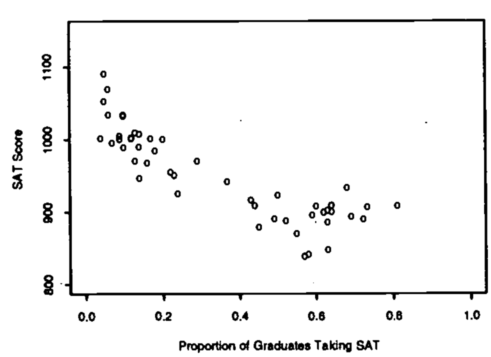
Scatterplot of Proportion and SAT in 1990



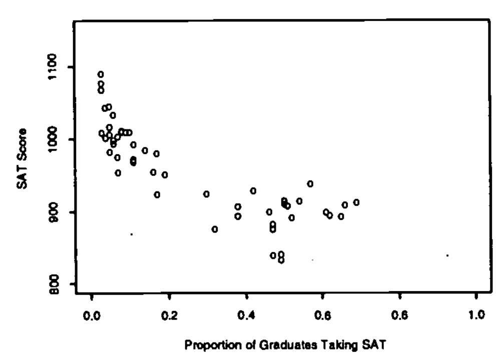
Scatterplot of Proportion and SAT in 1989



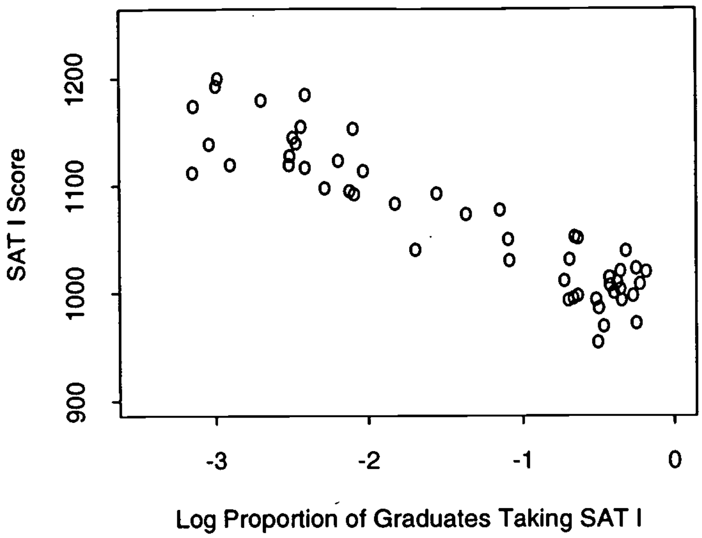
Scatterplot of Proportion and SAT in 1988



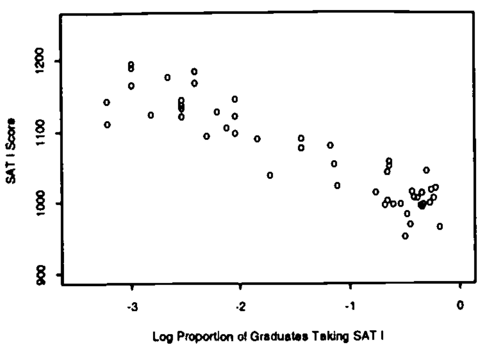
Scatterplot of Proportion and SAT in 1987



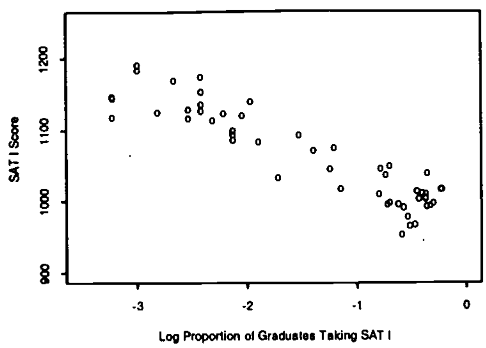
Scatterplot of Log(P) and SAT I



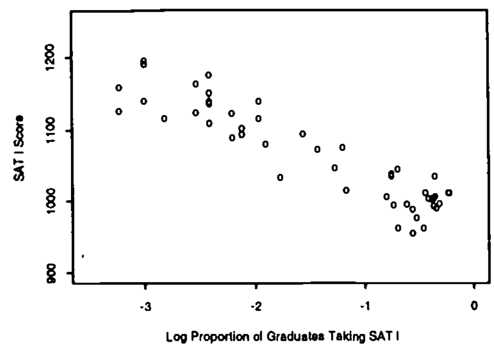
Scatterplot of Log(P) and SAT I in 1998



Scatterplot of Log(P) and SAT I in 1997



Scatterplot of Log(P) and SAT I in 1996



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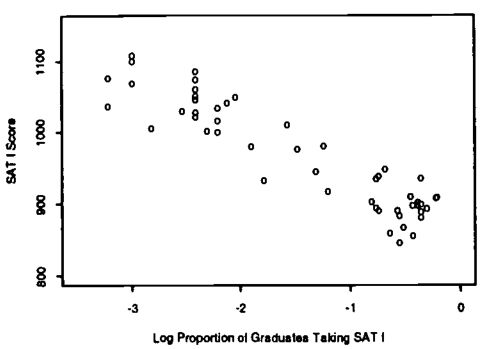

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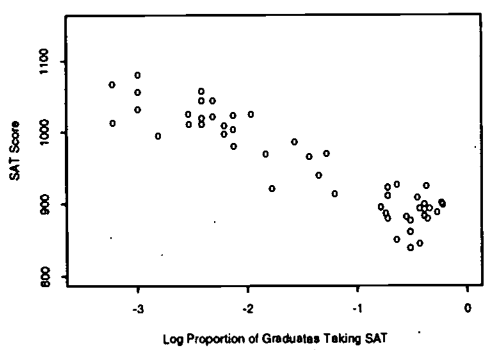
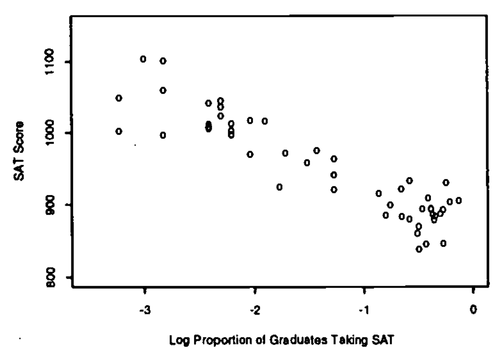
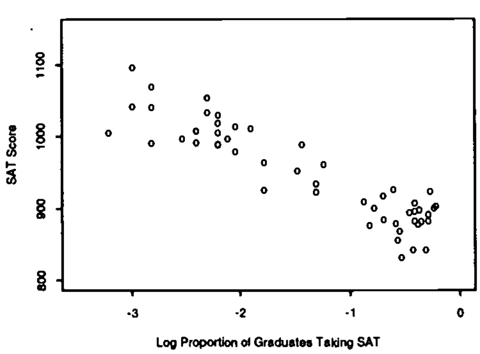


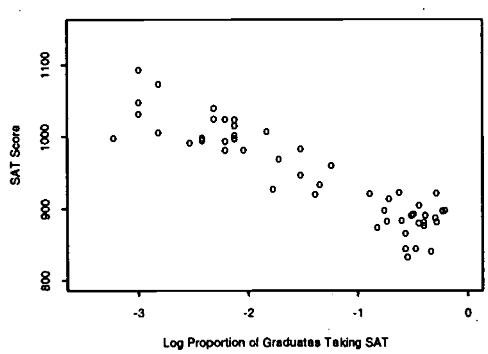
Scatterplot of Log(P) and SAT in 1993



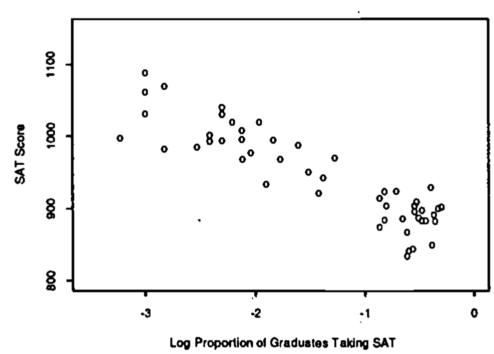
Scatterplot of Log(P) and SAT in 1992



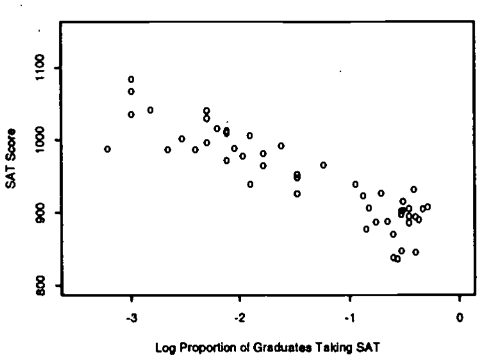
Scatterplot of Log(P) and SAT in 1991



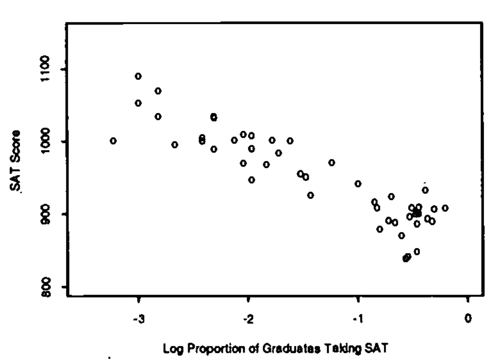
Scatterplot of Log(P) and SAT in 1990



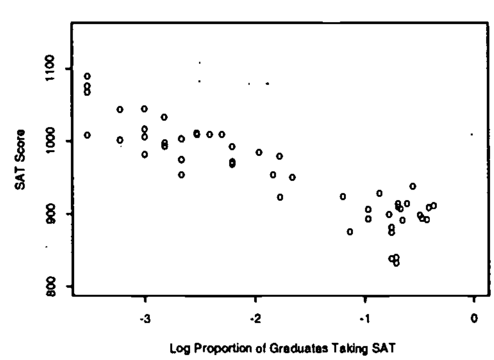
Scatterplot of Log(P) and SAT in 1989



Scatterplot of Log(P) and SAT in 1988

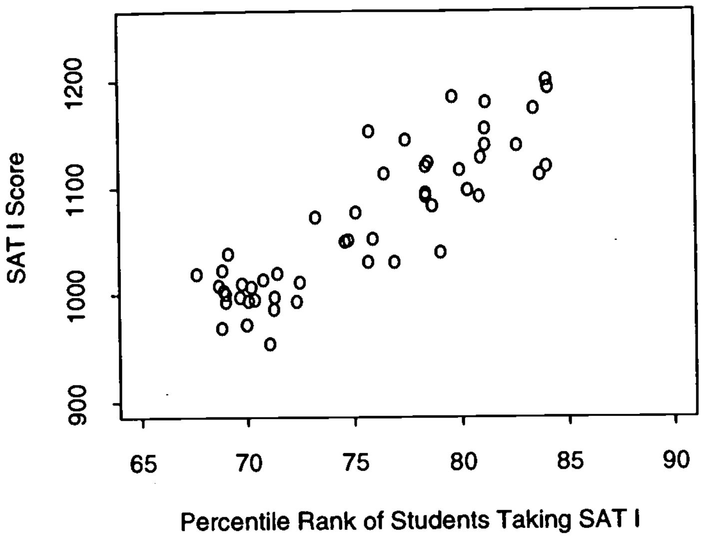


Scatterplot of Log(P) and SAT in 1987

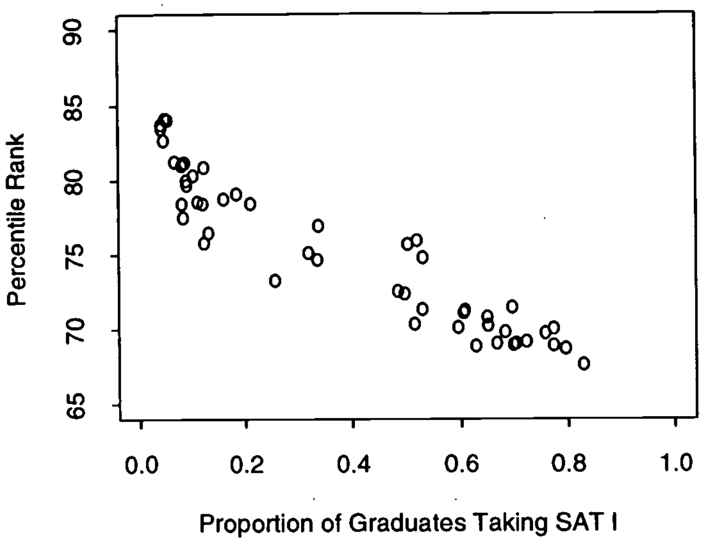


SAT State	Percentile Rank	ACT State
	84	AR ND IA
	83	SD MS
	82	UT
	81	KS NE WI
	80	WY NM OK
	79	WV MN AL
	78	KY LA MT MI ID
	77	MO
	76	TN NV
AK WA	75	CO IL
OR	74	AZ
	73	OH
TX CA	72	
SC NC FL VT	71	
DC IN VA HI MD	70	
DE PA NH NY ME	69	
NJ GA MA RI	68	
CT	67	

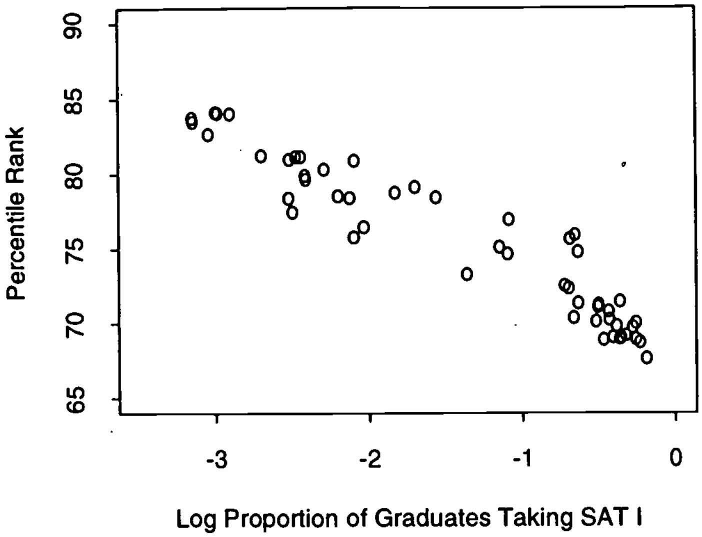
Scatterplot of Percentile Rank and SAT I



Plot of Proportion and Percentile Rank



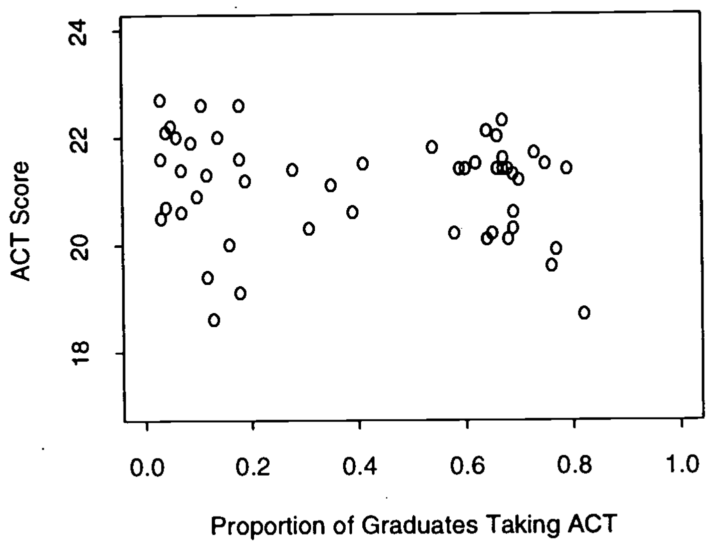
Scatterplot of Log(P) and Percentile Rank



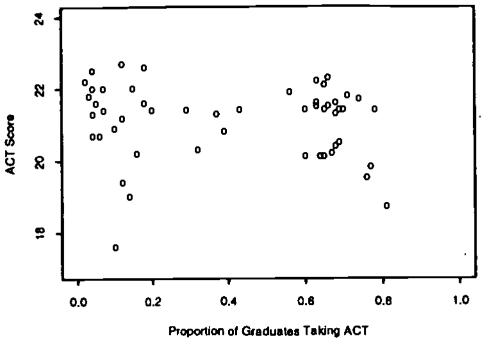
SAT State	ACT Proportion	ACT State
	.80	MS
	.75	KS LA TN ND
	.70	SD NE
	.65	AL IA WY IL MO WI KY UT AR MI OK
	.60	ID CO MN NM
	.55	WV OH
	.50	MT
	.45	
	.40	NV
AK FL	.35	
TX	.30	
	.25	AZ
	.20	
GA HI SC WA IN	.15	
MD OR CA NC DC NY	.10	
NH MA PA VA VT	.05	
CT DE RI ME NJ	.00	

SAT State	ACT Score	ACT State
OR WA RI	22.6	
	22.4	
NH	22.2	WI
MA NY ME	22.0	IA MN
VT	21.8	MT
CT HI	21.6	MO NE
PA	21.4	AZ ID IL ND OH UT WY CO KS NV
IN CA	21.2	SD MI
AK	21.0	
MD	20.8	
FL VA NJ	20.6	OK
DE	20.4	
TX	20.2	AL WV AR
GA	20.0	KY NM
	19.8	TN
	19.6	LA
NC	19.4	
	19.2	
SC	19.0	
	18.8	
DC	18.6	MS

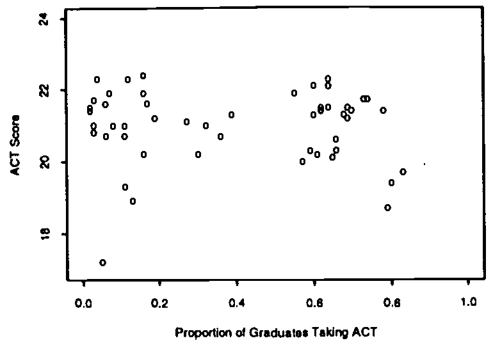
Scatterplot of Proportion and ACT



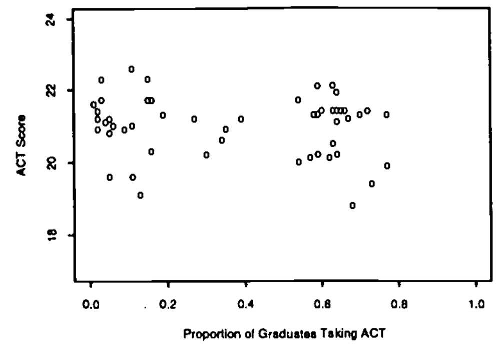
Scatterplot of Proportion and ACT in 1998



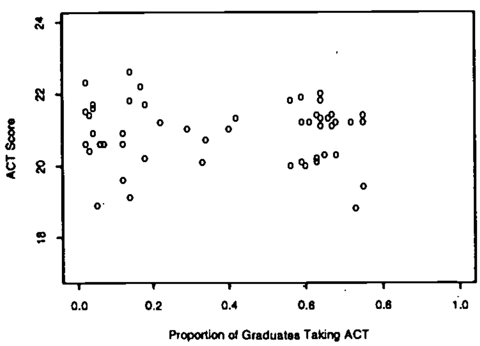
Scatterplot of Proportion and ACT in 1997



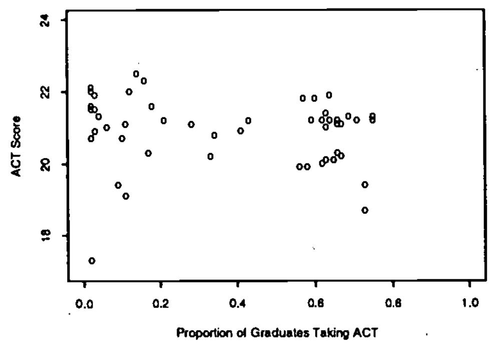
Scatterplot of Proportion and ACT in 1996



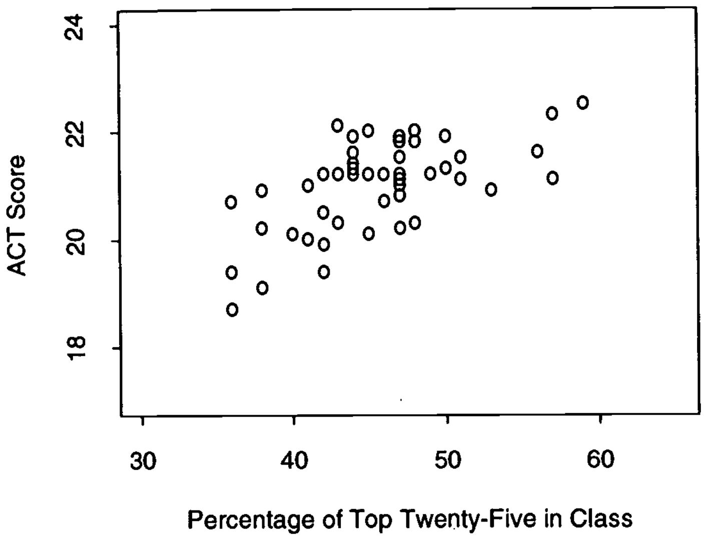
Scatterplot of Proportion and ACT in 1995



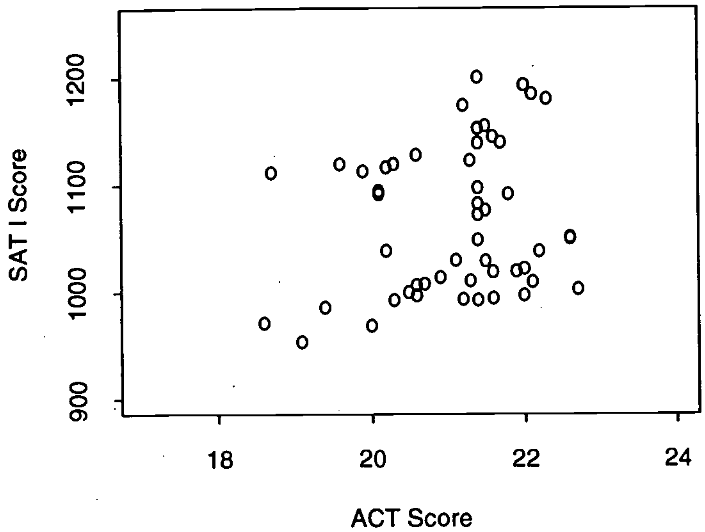
Scatterplot of Proportion and ACT in 1994



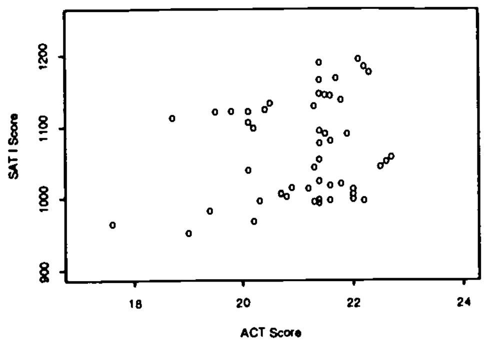
Scatterplot of Percentage and ACT in 1994



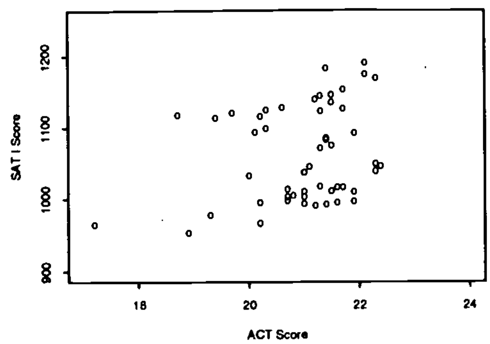
Scatterplot of ACT and SAT I



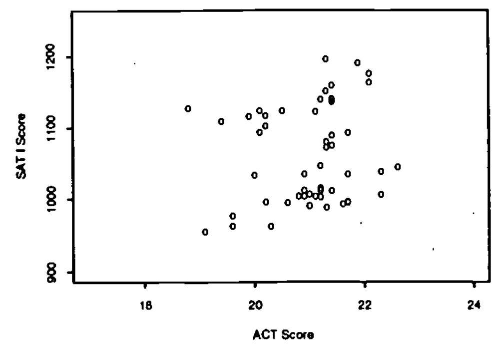
Scatterplot of ACT and SAT I in 1998



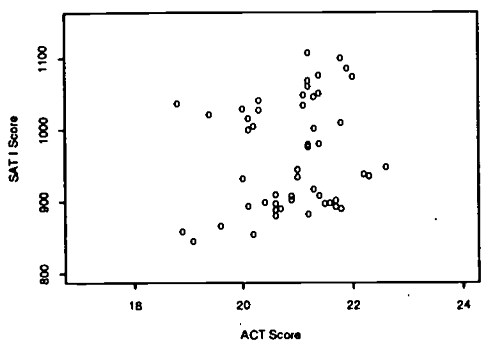
Scatterplot of ACT and SAT I in 1997



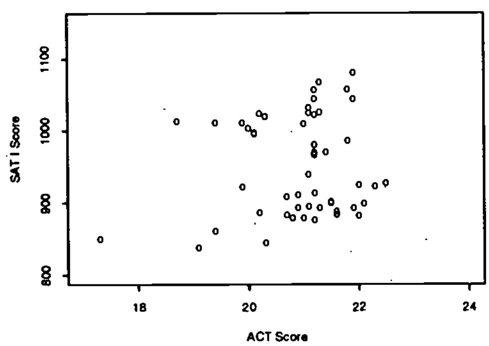
Scatterplot of ACT and SAT I in 1996



Scatterplot of ACT and SAT I in 1995



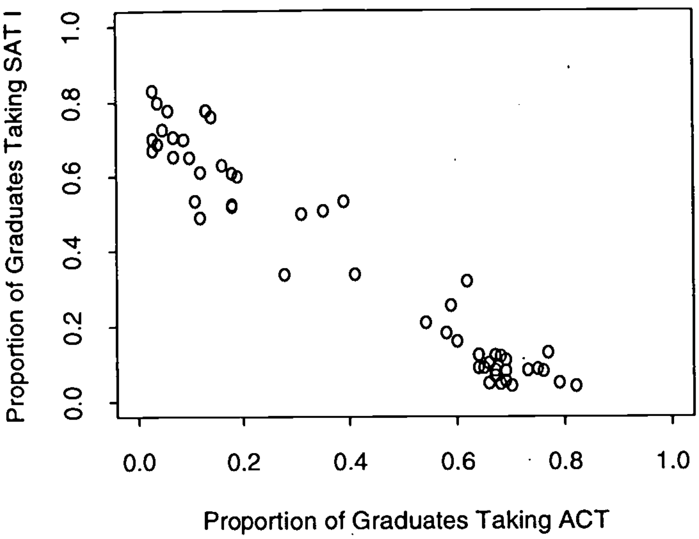
Scatterplot of ACT and SAT I in 1994



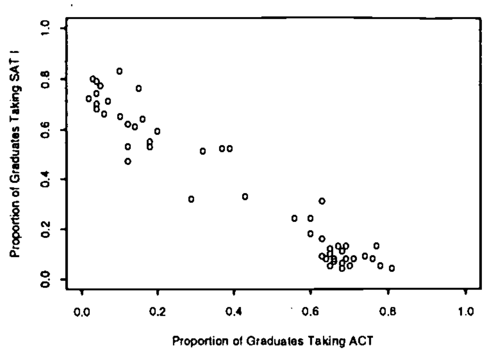
SAT State	Estimated SAT I Score	ACT State
	1060	MN WI
OR WA	1050	IA
	1040	MT
NH	1030	OH AZ KS IL MO NE CO
VT MA	1020	NV UT WY ND MI ID
CA MD ME CT AK	1010	SD
HI NY VA RI NJ	1000	
FL PA IN DE	990	OK
TX	980	KY AR NM WV AL
NC	970	TN
DC GA	960	LA
	950	
SC	940	
	930	
	920	
	910	MS

SAT State	NAEP Performance	ACT State
	34	MN
	32	MT WI ND
AK CT ME	30	NE IA
MA	28	MI
OR WA VT	26	
MD IN	24	UT CO
NY	22	MO WY
NC RI TX VA	20	
DE	18	AZ
GA HI CA FL	16	KY
SC	14	NM WV TN
	12	AL AR
	10	
	8	
	6	MS LA
DC	4	

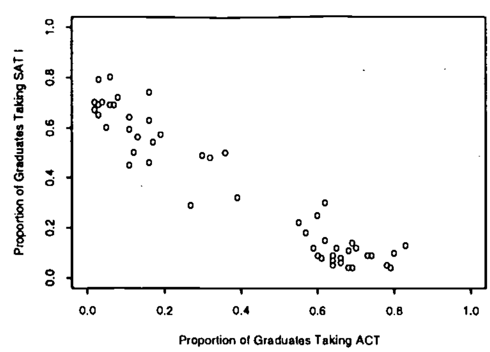
Scatterplot of Two Proportion



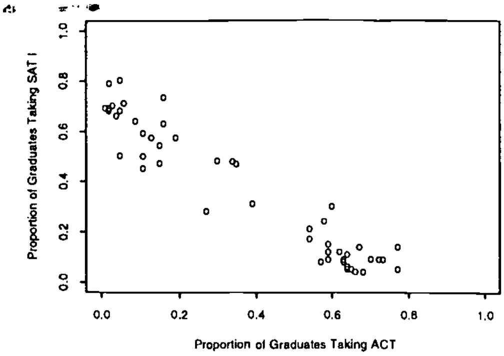
Scatterplot of Two Proportion in 1998



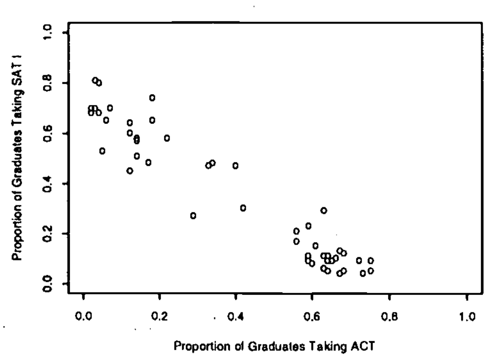
Scatterplot of Two Proportion in 1997



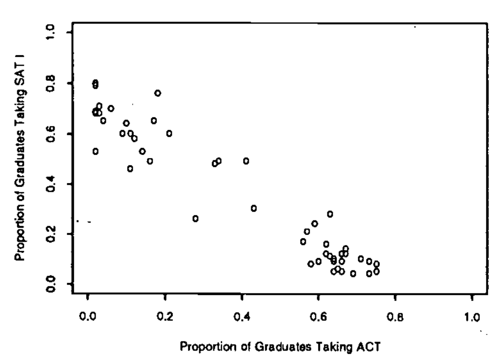
Scatterplot of Two Proportion in 1996



Scatterplot of Two Proportion in 1995



Scatterplot of Two Proportion in 1994



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