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IQ and the wealth of states

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Abstract

In *IQ and the Wealth of Nations* (2002), Lynn and Vanhanen estimate the mean IQs of 185 nations and demonstrate that national IQs strongly correlate with the macroeconomic performance of the nations, explaining about half of the variance in GDP per capita. I seek to replicate Lynn and Vanhanen's results across states within the United States. I first estimate "state IQs" from the SAT data, and show that the state IQs correlate moderately with the economic performance of the states, explaining about a quarter of the variance in GSP (gross state product) per capita.

Keywords: *IQ and the Wealth of Nations*; General intelligence; Economic performance

1. Introduction

Lynn and Vanhanen begin their 2002 book *IQ and the Wealth of Nations* with the question "Why are some countries so rich and others so poor?" They first review the vast literature on the effect of general intelligence on earnings at the individual level, which incontrovertibly demonstrates that more intelligent individuals earn more money than less intelligent individuals. They then extend this finding at the microeconomic level to the macroeconomic level and posit that, if more intelligent individuals earn more than less intelligent individuals, then nations with higher average intelligence should be wealthier than nations with lower average intelligence. Their hypothesis can explain, among other things, why the relative wealth and poverty of nations with few exceptions have remained more or less the same over the last 200 years, from 1820 to 1998, during the worldwide process of industrialization, postindustrialization, and globalization.

Lynn and Vanhanen then estimate the mean IQ of the population in 185 nations in the world from existing data on IQ tests conducted throughout the world. They demonstrate that the estimated national IQs strongly and statistically significantly correlate with GDP per capita. The mean Pearson's product–moment correlation between national IQ and various measures of GDP per capita across numerous years among the 185 nations is .577; the mean Spearman's rank–order correlation is .677 (Lynn & Vanhanen, 2002, pp. 110–116). It means that Lynn and Vanhanen's national IQ alone can explain a third of the variance in GDP per capita, and nearly half of the variance in the nations' relative ranking in wealth.

In this paper, I seek to replicate Lynn and Vanhanen's results across states within the United States. Their original logic should hold for subnational macroeconomic units such as the American states. If more intelligent individuals earn more money than less intelligent individuals, then states with higher average intelligence should be wealthier than states with lower average intelligence. In this endeavor, I first estimate the mean state IQs from incomplete and truncated SAT data, relying on Johnson and Thomopoulos' (2002)

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work on the characteristics of the left-truncated standard normal distribution. I then correlate the estimated state IQs with three measures of state economic performance: gross state product (GSP) per capita, median family income, and percentage of persons in poverty. All three macroeconomic measures show moderate and significant correlations with state IQ. Replicating Lynn and Vanhanen's results across nations albeit at a slightly attenuated level, state IQ alone explains about a quarter of the variance in state economic performance, both by Pearon's product–moment and Spearman's rank–order correlations.

2. Estimating state IQs

2.1. The SAT as the preferred measure of general intelligence

There are no genuine IQ tests that are widely and routinely administered to representative samples of state populations in the United States. The Scholastic Aptitude Test (SAT) comes closest for this purpose (Frey & Detterman, 2004).

The SAT has a significant advantage as a proxy IQ test over other standardized academic tests, such as the American College Testing (ACT), an alternative university admisions test, or the National Assessment of Educational Progress (NAEP), administered to representative samples of fourth and eighth graders in public schools every year. While the SAT measures the students' critical reasoning ability, both the ACT and the NAEP measure their learned knowledge of academic subjects. This distinction between the SAT and the ACT is well recognized by both testing services. "The SAT I is designed to focus on developed veral and mathematical reasoning skills, while the ACT emphasizes achievement related to high school curricula" (Schneider & Dorans, 1999, p. 1). "The ACT is an achievement test, measuring what a student has learned in school. The SAT is more of an aptitude test, testing reasoning and verbal abilities" [http://www.actstudent.org/faq/answers/actsat.html]. A principal component analysis of SAT and ACT scores shows that the former load on two factors (verbal and quantitative) while the latter load on four additional factors (information, English, natural sciences, and social studies) (Cassell & Eichsteadt, 1969). Frey and Detterman (2004) show that the correlation between SAT scores and g is .857 (corrected for nonlinearity) when the measure of g is the Armed Services Vocational Aptitude Battery, and it is .72 (corrected for restricted range) when the measure of g is Raven's Advanced Progressive Matrices. They conclude that "this is strong evidence that the SAT is an intelligence test" (Frey & Detterman, 2004, p. 374).

Similarly, the NAEP assesses what students in public schools have learned in their educational system. "The National Assessment of Educational Program (NAEP) is a nationally representative and continuing assessment of what America's students know and can do in various subject areas" (Perie, Grigg & Donahue, 2005, p. i). The SAT Reasoning Test (usually known simply as the SAT or the SAT I) is therefore a preferable measure of general intelligence, defined as the ability to reason deductively or inductively, think abstractly, use analogies, synthesize information, and apply knowledge to new domains (Kanazawa, 2004), akin to Cattell's (1971) fluid intelligence (Gf). In contrast, the ACT and the NAEP, as well as the SAT subject Tests, are better measures of acquired knowledge, akin to Cattell's crystallized intelligence (Gc).

As a result, across the 50 states and the District of Columbia, the unadjusted (observed) SAT scores in 2005 are not highly significantly correlated with the ACT scores or the NAEP scores for either the fourth or eighth graders in the same year (r=.0737, ns; r=.1349, ns; r=.2487, p<.10, respectively), while the ACT scores are significantly correlated with the NAEP scores (r=.6630, p<.0001, for fourth graders, and r=.6853, p<.0001, for eighth graders). I will therefore use the SAT as a proxy measure of state IQ (mean general intelligence of state populations) in this paper.

2.2. Dealing with the left-censoring problem

The SAT has one significant problem as a population measure of intelligence, however; it has a strong selection bias (Lehnen, 1992, pp. 25–26; Wainer, 1986, pp. 75–79). Only high school seniors who intend to go on to the university usually take the SAT. The selection bias operates at two stages: not everyone stays in high school until the senior year, and not all high school seniors take the SAT. The proportion of the population which finishes high school in 2003 varies from 77.2% in Texas to 92.1% in New Hampshire (U.S. Census Bureau, 2005a, p. 143, Table 216). The proportion of high school seniors who take the SAT in 2005 varies widely, from the low of 4% in Mississippi and North Dakota to the high of 92% in New York (www.collegeboard.com/prod_downloads/about/news_info/cbsenior/yr2005/table3-mean-SAT-reasoning-test.pdf).

In order to use the incomplete, truncated data on SAT scores to compute state IQ, however, I make two simplifying assumptions.

1. Students who complete high school are uniformly more intelligent than those who do not.
2. High school seniors who take the SAT are uniformly more intelligent than those who do not.

Given a very high correlation between educational attainment and intelligence (Herrnstein & Murray, 1994, pp. 143–154), the first assumption seems unproblematic. Even among the lowest cognitive class (those with IQs below 75) in Herrnstein and Murray's analysis of the National Longitudinal Survey of Youth data, 45% graduate from high school or attain a GED (Herrnstein & Murray, 1994, p. 146), even though 6% of those with normal intelligence (IQs between 90 and 110) fail to do so. Given that the SAT is specifically designed as a university admissions test, and given that those who enter university on average are more intelligent than those who do not (Herrnstein & Murray, 1994, pp. 151–153), the second assumption appears also largely valid, although it is probably slightly less valid than the first assumption.

If I assume that whatever proportion of an age cohort which takes the SAT is its brightest segment, then I can use Johnson and Thomopoulos' (2002) work on the characteristics of the left-truncated standard normal distribution to estimate the "true" means of SAT scores for each state, i.e., what the means and the standard deviations would have been had everyone in a birth cohort taken the SAT. If one left-censors a standard normal distribution, with a mean of 0 and a standard deviation of 1, the mean will invariably move to the right ($\mu>0$), and the standard deviation will invariably shrink ($\sigma<1$). Johnson and Thomopoulos demonstrate that a point of truncation uniquely determines the mean and the standard deviation of a left-truncated normal distribution, and construct two tables which convert various points of truncation into associated means and standard deviations.

I can convert the proportion of a birth cohort which takes the SAT, which, under my two assumptions above, compose the right tail of the normal distribution, into a unique point of truncation. Since this is now a left-truncated normal distribution, I can use Johnson and Thomopoulos' tables to convert the observed (unadjusted) means and standard deviations of SAT scores into "true" (adjusted) means and standard deviations which would have obtained had everyone taken the SAT. Then, on the assumption that the mean IQ in the United States is 100 and the standard deviation is 15, I can convert the adjusted SAT scores into state IQ scores. In all cases, I use data from the most recent available year. (See Appendix for the details of the state IQ computation.)

To the extent that one or both of the two simplifying assumptions that I make above are violated, in other words, to the extent that some high school graduates or SAT test takers are less intelligent than high school dropouts or high school seniors who do not take the SAT, respectively, then it has the effect of uniformly underestimating the "true" (adjusted) means of SAT scores. However, it would not affect the computation of state IQs or the states' standing relative to each other, as

Table 1
Unadjusted and adjusted mean SAT scores (Verbal and Quantitative) and state IQ

	Unadjusted SAT mean score ($V+Q$)	Adjusted SAT mean score ($V+Q$)	State IQ
Alabama	1126	105.5	79.9
Alaska	1042	742.4	103.6
Arizona	1056	573.2	97.3
Arkansas	1115	−70.7	73.3
California	1026	662.1	100.5
Colorado	1120	584.3	97.6
Connecticut	1034	901.7	109.4
Delaware	1005	819.8	106.4
District of Columbia	968	731.8	103.1
Florida	996	751.1	103.8
Georgia	993	803.2	105.8
Hawaii	1006	740.5	103.5
Idaho	1086	449.8	92.6
Illinois	1200	263.3	85.7
Indiana	1012	795.1	105.5
Iowa	1204	19.1	76.6
Kansas	1173	179.8	82.6
Kentucky	1120	204.6	83.6
Louisiana	1127	−19.6	75.2
Maine	1014	836.3	107.0
Maryland	1026	803.5	105.8
Massachusetts	1047	913.4	109.9
Michigan	1147	177.3	82.5
Minnesota	1189	338.7	88.5
Mississippi	1118	−356.1	62.7
Missouri	1176	62.4	78.3
Montana	1080	620.0	99.0
Nebraska	1153	108.7	80.0
Nevada	1021	611.3	98.6
New Hampshire	1050	924.1	110.3
New Jersey	1020	878.4	108.6
New Mexico	1105	207.4	83.6
New York	1008	888.8	108.9
North Carolina	1010	798.2	105.6
North Dakota	1195	−39.1	74.5
Ohio	1082	548.5	96.3
Oklahoma	1133	28.0	77.0
Oregon	1054	791.8	105.4
Pennsylvania	1004	814.1	106.2
Rhode Island	1008	775.3	104.8
South Carolina	993	728.9	103.0
South Dakota	1178	−11.1	75.5
Tennessee	1135	346.8	88.8
Texas	995	627.6	99.2
Utah	1123	−21.7	75.1
Vermont	1038	823.8	106.5
Virginia	1030	837.5	107.1
Washington	1066	785.7	105.1
West Virginia	1034	326.9	88.1
Wisconsin	1191	65.7	78.4
Wyoming	1087	294.5	86.9

long as the extent to which the assumptions are violated does not vary significantly across states. If the degree of violation is more or less the same across all states, my method of estimation uniformly underestimates the adjusted mean SAT scores, but does not affect the estimated state IQs.

Table 1 presents the unadjusted and adjusted SAT scores, and state IQs, for all 50 states and the District of Columbia. The estimated state IQ varies from 62.7 in Mississippi to 110.3 in New Hampshire. The weighted mean (weighed by the state population size) is 97.1 and the weighted standard deviation is 11.1. Interestingly, despite the large white–black gap in IQ (Jensen, 1969; Rushton & Jensen, 2005), the state IQ is not at all correlated with the racial composition of the state populations. The correlation between state IQ and percent black is $r=.0176$, $p>.9$, in the full sample, and $r=-.0499$, $p>.7$, without Washington DC, which is anomalous both in its highest concentration of blacks (58.9%) and a relatively high state IQ (103.1). This, however, is not a consequence of my state IQ estimation procedure. The unadjusted (observed) SAT scores are not correlated with percent black across the states ($r=-.2733$, $p>.05$).

General intelligence is known to correlate with educational performance. It is therefore very important to note that, while unadjusted (observed) SAT scores are correlated with none of the components of the total NEAP scores for either the fourth or the eighth graders, the adjusted SAT scores, which forms the basis of my state IQ scores, are significantly correlated with all but one of the components of the NEAP scores across the 50 states (without the significant outlier District of Columbia): $r=.3256$, $p<.05$, for fourth-grade math; .3019, $p<.05$, for fourth-grade reading; .3238, $p<.05$, for fourth-grade total; .3002, $p<.05$, for eighth-grade math; .1623, ns, for eighth-grade reading; .2438, $p<.10$, for eighth-grade total. Since the NEAP scores are based on representative samples of all pupils in public schools, these significant correlations seem to suggest construct validity of my SAT adjustment procedure. McDaniel (2006) provides alternative estimates of state IQs based on the NEAP scores.

3. Associations with macroeconomic performance measures

Fig. 1 plots the association between state IQ and the gross state product (GSP) per capita (http://www.bea.gov/bea/newsrel/gspnewsrelease.htm), which is the state-level equivalent of GDP per capita at the national level. The Pearson's correlation $r=.3217$ ($p<.05$), and Spearman's $\rho=.5425$ ($p<.0001$). Across the states, the higher the mean intelligence of its population, the greater the GSP per capita, and thus the wealthier the state is.

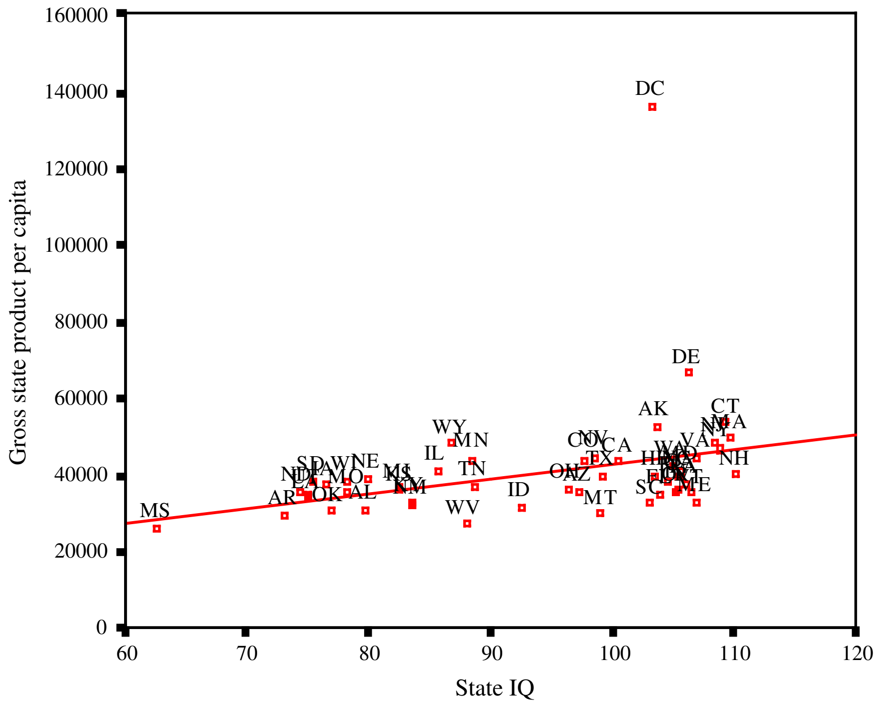

Fig. 1. Association between state IQ and gross state product per capita.

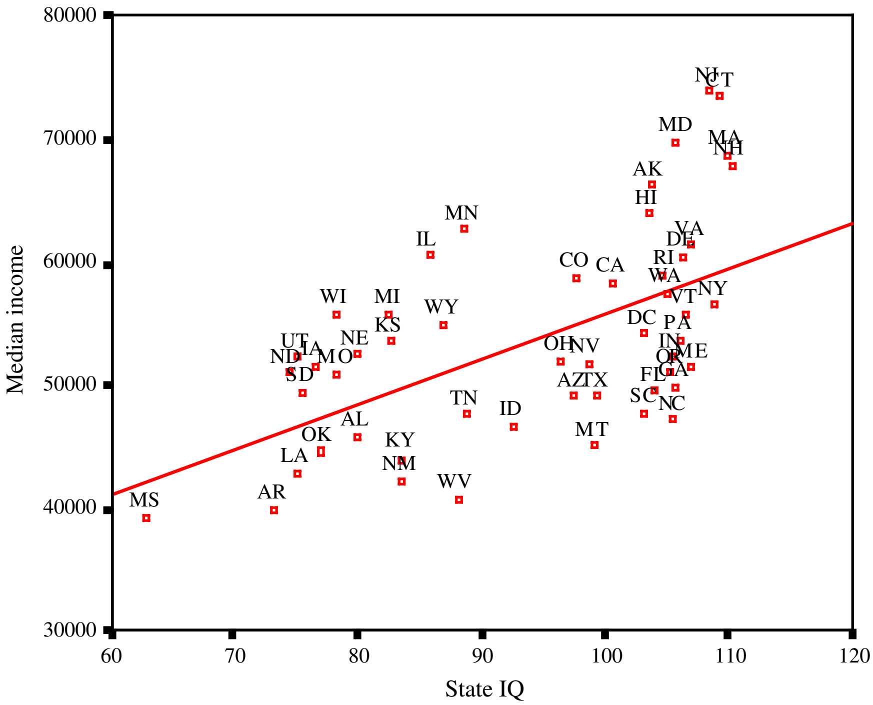

Fig. 2. Association between state IQ and median family income.

It is clear in Fig. 1 that Washington DC is an extreme outlier. This is understandable, given its status as the nation's capital, with its relatively large economic output despite a small population. When Washington DC is removed from the sample, the Pearson's correlation increases to r=.5034 (p<.001) and Spearman's rho to ρ=.5481 (p<.0001).

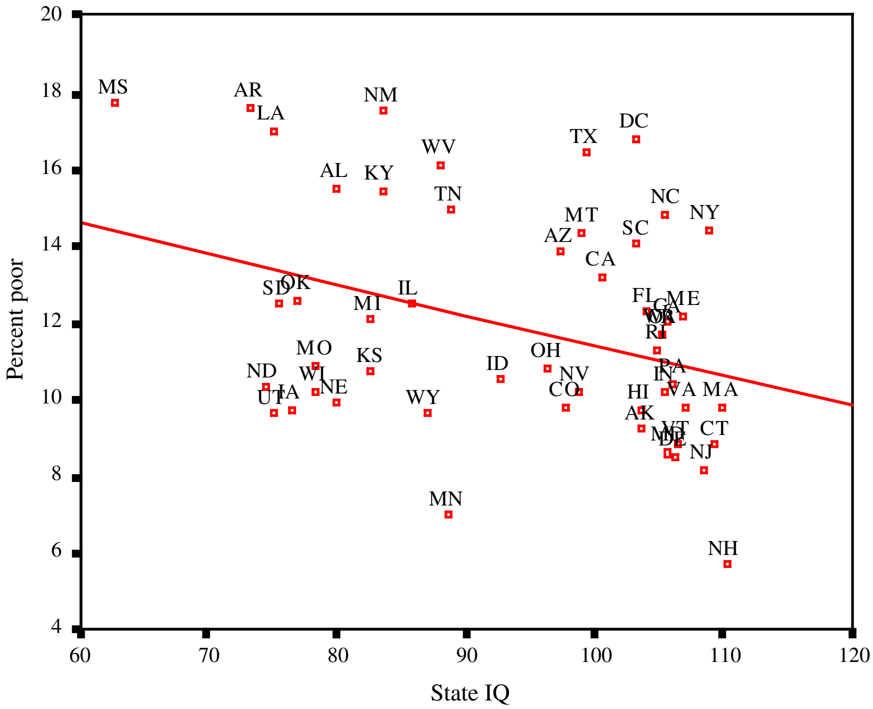

Fig. 3. Association between state IQ and the mean proportion of persons in poverty 2002–2004.

Fig. 2 shows the association between state IQ and median family income (http://www.census.gov/hhes/www/income/medincsizeandstate.html). The correlations are much stronger here than in Fig. 1. The Pearson's correlation $r=.5708$ ($p<.0001$), and Spearman's rho $\rho=.5425$ ($p<.0001$). Across the states, the higher the mean intelligence of its population, the higher the median family income.

Finally, Fig. 3 presents the negative association between state IQ and the percent of the population in poverty during 2002–2004 (U.S. Census Bureau, 2005b, p. 25, Table 10). The Pearson's $r=-.3506$ ($p<.05$) and Spearman's $\rho=-.3772$ ($p<.01$). Across the states, the higher the state IQ, the smaller the proportion of its population in poverty.

4. Discussion

Figs. 1–3 collectively demonstrate that, just as national IQ is very strongly correlated with GDP per capita and other national macroeconomic performance measures (Lynn & Vanhanen, 2002), state IQ is strongly correlated with GSP per capita (albeit at a slightly lower level) and other state macroeconomic performance measures such as median family income and the proportion of the population in poverty. It appears that, just as some nations are wealthier than others because their populations have higher average intelligence, some American states are wealthier than others because their populations have higher average intelligence.

To the best of my knowledge, this is the first attempt to estimate the average IQ of state populations in the United States in half a century. (The last similar attempt was Davenport & Remmers, 1950.) The current method of estimating state IQs from SAT scores has several potential problems. First, conceptually, the accuracy of estimation crucially depends on the validity of the two simplifying assumptions. Simple violation of one or both of the assumptions merely underestimates the adjusted SAT scores across all states but does not affect the estimation of state IQs; however, if the extent to which they are violated varies widely between states, it biases the state IQ calculation.

Second, empirically, state IQs are largely determined by the proportion of high school seniors who take the SAT. Recall that three variables go into the calculation of state IQs: the proportion of an age cohort who finishes high school, the proportion of high school seniors who takes the SAT, and the unadjusted (observed) SAT scores. Of the three, the second has much greater variation than the other two. The coefficient of variation for the first is .04332, for the second, .7557, for the third, .0632. As a result, the correlation between state IQ and the proportion of high school seniors who take the SAT is very high ($r=.9336$, $p<.0001$). Ideally, the state IQ should be a greater reflection of the test scores than the number of test takers.

This, however, is an empirical problem, not a logical or conceptual one. When a larger proportion of high school seniors take the SAT, it is logically possible for the observed SAT scores to decline much further than they actually do in reality. The state IQs would then correlate more strongly with the observed SAT scores than they currently do. The fact that the observed SAT scores do not fluctuate more widely with the proportion of test takers might suggest that high school seniors (and their parents and teachers) can accurately estimate how well the students would do on the SAT and only those students who are expected to (and actually do) perform at a certain level choose to take the SAT. This might be why the observed SAT scores do not vary very much and do not go down as much when the proportion of test takers goes up. If this is the case, however, it is not a problem that state IQs correlate highly with the proportion of seniors who take the SAT because the latter is in part an effect of the former.

Finally, while the state IQ estimates do correlate very highly with the macroeconomic performance measures and thus appear to have some validity, it is difficult to take the estimates at the face value. For example, it is difficult to believe that the true mean IQ of the population of Mississippi is 62.7, lower even than the average IQs in sub-Saharan Africa (Lynn & Vanhanen, 2002). Until more accurate estimates of the absolute levels of state IQ appear (derived, for example, from actual IQ tests administered to large, representative samples of state populations), perhaps it is best to treat the current estimates as reflecting the relative standings of states (for example, New Hampshire and Massachusetts have higher state IQs than Texas and California, which in turn have higher state IQs than Mississippi and Arkansas) than estimating the absolute levels of state IQs.

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Appendix A. Example: Alabama

A.1. Preliminary information

According to the College Board (http://www.collegeboard.com/about/news_info/cbsenior/yr2005/reports. html), the mean SAT Reasoning Test scores in the state of Alabama in 2005 are 567 in the Verbal section, and 559 in the Quantitative section. The standard deviations are 107 in the Verbal section, and 111 in the Quantitative section.

According to the Census Bureau (United States Census Bureau, 2005a, p. 143), the proportion of the population which graduate from high school in Alabama in 2003 is 79.9%.

According to the College Board (http://www.collegeboard.com/prod_downloads/about/news_info/cbsenior/ yr2005/table3-mean-SAT-reasoning-test.pdf), the proportion of high school seniors which take the SAT in Alabama in 2005 is 10%.

It means that the proportion of the birth cohort which takes the SAT in Alabama is .799 * .10 = .0799.

Using the Java applet written by Professor David M. Lane of Rice University (http://davidmlane.com/hyperstat/z_table.html), I determine the point of truncation in the standard normal distribution to be 1.4057.

Using Table 2 in Johnson and Thomopoulos (2002), and linear interpolation, I calculate the mean of the left-truncated standard normal distribution to be .4532 + 1.4057 = 1.8589, and its standard deviation to be .3971.

A.2. Adjustment of the mean and standard deviation of SAT scores

If the observed (unadjusted) standard deviation in the left-truncated distribution of the Verbal scores is 107, and if this corresponds to .3971 in the standardized distribution, then the true (adjusted) standard deviation (σ_V) in the untruncated distribution will be:

$$1 : .3971 = \sigma_V : 107$$

$$\sigma_V = 269.5$$

From this I estimate the true mean of the Verbal score (μ_V):

$$\frac{567 - \mu_V}{269.5} = 1.8589$$

$$567 - \mu_V = 500.9$$

$$\mu_V = 66.1$$

I similarly calculate the adjusted mean and standard deviation of the Quantitative score (σ_Q, μ_Q).

$$1 : .3971 = \sigma_Q : 111$$

$$\sigma_Q = 279.5$$

$$\frac{559 - \mu_Q}{279.5} = 1.8589$$

$$559 - \mu_Q = 519.6$$

$$\mu_Q = 39.4$$

A.3. Estimation of state IQ

By the similar method, I estimate the mean of the SAT Verbal score for the whole nation to be 319.8, and the standard deviation to be 200.1. I estimate the mean of the SAT Quantitative score to be 328.5 and the standard deviation to be 203.6.

From this information on the adjusted national scores, I can calculate the relative position of Alabama in the nation, on the assumption that the mean of IQ in the United States is 100, and the standard deviation is 15.

$$\frac{66.1 - 319.8}{200.1} = -1.2679$$

$$15 * -1.2679 = -19.0180$$

$$\mathrm{IQ}_V = 81.0$$

$$\frac{39.4 - 328.5}{203.6} = -1.4199$$

$$15 * -1.4194 = -21.2991$$

$$\mathrm{IQ}_Q = 78.7$$

where IQ_V = state IQ based on SAT Verbal score and IQ_Q = state IQ based on SAT Quantitative score.

The state IQ of Alabama is the mean of Verbal and Quantitative IQs:

$$\frac{81.0 + 78.7}{2} = 79.9$$

References

Cassell, R. N., & Eichsteadt, A. C. (1969). Factorial structure of CQT, ACT, and SAT test scores for 50 available college freshmen. *Journal of Psychology: Interdisciplinary and Applied*, *71*, 199–204.

Cattell, R. B. (1971). *Abilities: Their structure, growth, and action.* Boston: Houghton Mifflin.

Davenport, K. S., & Remmers, H. H. (1950). Factors in state characteristics related to average A-12 V-12 test scores. *Journal of Educational Psychology*, *41*, 110–115.

Frey, M. C., & Detterman, D. K. (2004). Scholastic assessment or *g*?: The relationship between the scholastic assessment test and general cognitive ability. *Psychological Science*, *15*, 373−378.

Herrnstein, R. J., & Murray, C. (1994). *The bell curve: Intelligence and class structure in American life.* New York: Free Press.

Jensen, A. R. (1969). How much can we boost IQ and scholastic achievement? *Harvard Educational Review*, *39*, 1−123.

Johnson, A. C., & Thomopoulos, N. T. (2002). Characteristics and tables of the left-truncated normal distribution. *Proceedings of the Midwest Decision Sciences*, 133−139.

Kanazawa, S. (2004). General intelligence as a domain-specific adaptation. *Psychological Review*, *111*, 512−523.

Lehnen, R. G. (1992). Constructing state education performance indicators from ACT and SAT scores. *Policy Studies Journal*, *20*, 22−40.

Lynn, R., & Vanhanen, T. (2002). *IQ and the wealth of nations.* Westport: Praeger.

McDaniel, Michael A. (2006). *Estimating state IQ: Measurement challenges and preliminary correlates. Department of Management: Virginia Commonwealth University.*

Perie, M., Grigg, W., & Donahue, P. (2005). *The nation's report card: Reading 2005 (NCES 2006-451). U.S. Department of Education, National Center for Educational Statistics.* Washington DC: U.S. Government Printing Office.

Rushton, J. P., & Jensen, A. R. (2005). Thirty years of research on race differences in cognitive ability. *Psychology, Public Policy, and Law*, *11*, 235−294.

Schneider, D., and Dorans, N. (1999). Concordance between SAT I and ACT scores for individual students. Research notes RN-07. Office of Research and Development. College Board. [http://www.collegeboard.com/research/abstract/3866.html]

United States Census Bureau (2005a). *Statistical abstract of the United States 2006.* Washington DC: United States Census Bureau.

United States Census Bureau (2005b). *Income, poverty, and health insurance coverage in the United States: 2004 (P60-229).* Washington D.C.: U.S. Census Bureau.

Wainer, H. (1986). Five pitfalls encountered while trying to compare states on their SAT scores. *Journal of Educational Measurement*, *23*, 69−81.