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Graduate Admission Variables and Future Success

We cannot tell whether the standard selection measures used by graduate schools are valid.

Robyn M. Dawes

The standard variables considered in selecting students for graduate school do not correlate well with later measures of the success or attainments of the selected students (*1*, *2*). The low correlations have led at least one investigator (*3*) to propose abandoning one of these standard variables, the Graduate Record Examination (GRE). The purpose of the present report is to demonstrate that variables that are the basis for admitting students to graduate school *must* have low correlations with future measures of the success of these students.

The usual reason given for such low correlations is that the admitted students tend to have scores within a restricted (high) range on each of these variables and that empirical investigations are necessarily limited to these students, the rejected ones being typically unavailable to the researcher. *Potential* correlations based on the whole applicant group might be much higher, but there is no way of evaluating such correlations empirically, and "prophecy" formulas for estimating them are of dubious value because the restriction is so severe and because the covariance structure of the variables for the selected group is different from that of the applicant group. With the ratio of applicants to selected students increasing every year (it was 14 to 1 for the class entering the psychology department of the University of Oregon in the fall of 1974), the problem of restricted range likewise becomes worse. But, as will be demonstrated later in this article, that is not the main problem.

The main problem concerns the covariance structure of the admissions variables in the selected group. That structure consists largely of negative correlations because "whatever vague methods are used by admissions committees for combining criteria, these methods tend to be compensatory" (*1*). Even if a multiple elimination procedure is used to screen out unacceptable applicants at an initial selection phase, choice from among those passing the screening tends to be compensatory. Thus, if selected applicants are low on any particular variable, they will be high on others. It follows that for any two variables important in selection there will be people who are high-high, high-low, and low-high, but few

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or none who are low-low; negative correlations are a likely result. Pairs of variables on which there are many selected applicants in the low-low quadrant will consist only of those variables that the admissions committee considers to be relatively unimportant to selection—that is, not predictive of later success.

As has been pointed out by others (*4*), negative correlations between predictor variables can result in large multiple correlations even when the predictor variables considered singly have only moderate validity. This article makes the converse point. Knowledge of the covariance structure together with assumptions about possible values of the multiple correlation yields information about the potential validity of the predictors. Specifically, it is assumed that given the vagaries of graduate education and professional development it would not be possible to predict meaningful later measures of success or attainment with a high degree of precision from a combination of the variables used in selecting students for graduate school. It follows (as will be demonstrated algebraically below) that when these predictors themselves are negatively correlated their single validities must be low. The point will be illustrated with two variables—undergraduate grade point average (GPA) and GRE aptitude score (the total scaled score on both the verbal and the quantitative tests).

Figure 1 presents data showing that these compensate for each other in selection and therefore tend to be negatively correlated among the selected students. The figure shows scaled GRE scores plotted against GPA for each of the last six entering graduate classes in the psychology department at the University of Oregon (*N*'s vary from 9 to 22). The correlations are all negative, ranging from $-.04$ (not statistically significant) to $-.54$ ($P < .01$). The years for which the correlations are most negative are those in which a number of "late bloomers" with master's degrees were admitted; several of these students had strikingly low undergraduate GPA's but high GRE's and demonstrated ability to do graduate work. (Incidentally, the correlations between GPA's and GRE's for the *applicants* to these entering classes are all positive; for example, $r = +.19$ for 1973, $+.18$ for 1969.)

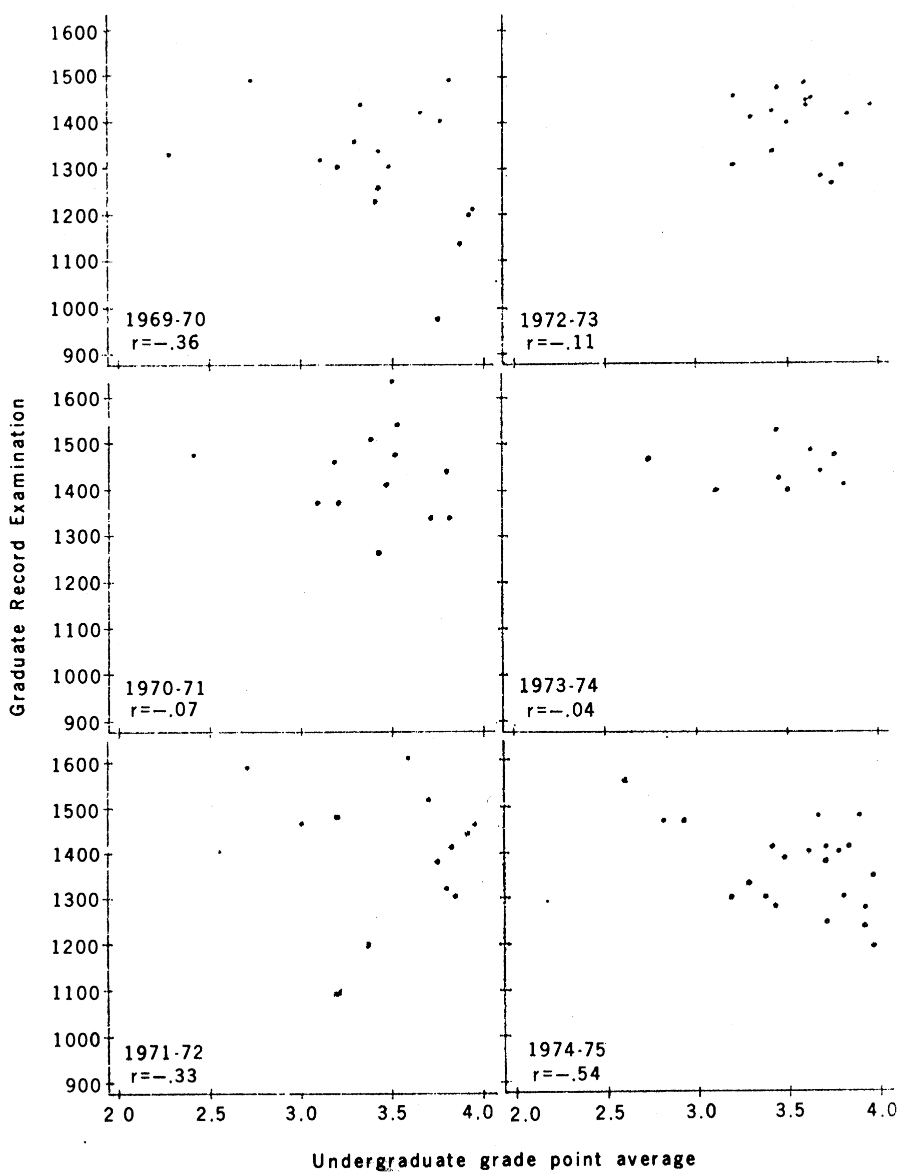

Fig. 1. Scatter plots for classes of graduate students in psychology, University of Oregon.

Now consider the degree to which a linear combination of GPA and GRE can predict some future variable of interest (such as measure of success or attainment). The R^2 for the prediction is

$$R^2 = \frac{r_1^2 + r_2^2 - 2r_1r_2r}{1 - r^2} \quad (1)$$

where r_1 = correlation of GPA with the variable, r_2 = correlation of GRE with the variable, and r = correlation between GPA and GRE. This equation may be found in a number of elementary texts (*5*). Multiplying both sides by $1 - r^2$ yields

$$(1 - r^2)R^2 = r_1^2 + r_2^2 - 2r_1r_2r \quad (2)$$

Rearranging terms yields

$$1 = \frac{(r_1 + r_2)^2}{R^2[2(1 + r)]} + \frac{(r_1 - r_2)^2}{R^2[2(1 - r)]} \quad (3)$$

which defines an ellipse in the two variables $(r_1 + r_2)$ and $(r_1 - r_2)$, as illustrated in Fig. 2.

Now consider a potential study conducted on the selected students for the academic year 1974–75. (This year is chosen because it illustrates the problem most dramatically.) Given the vicissitudes of graduate study (the personal, professional, and random components of professional development are probably well known to the reader), surely no linear combination of GPA and GRE is going to account for more than 50 percent of the variance in any meaningful measure of future success, attainment, or self-actualization. (Readers with a less Ecclesiastes-like view of life than that of the author may substitute their own values in what follows —as may those who believe that professional development is even less predictable from entrance characteristics, especially when only those students who are selected may be studied.) Substituting the value of $-.54$ for r and assuming an upper bound of .50 for R^2 yields (by Eq. 2) the inequality

$$.3542 \geqslant r_1^2 + r_2^2 + 1.08 r_1 r_2 \qquad (4)$$

This inequality is very restrictive; possible positive values for r_1 and r_2 are illustrated by the area of the ellipse in the first quadrant of Fig. 2 (hatched area). If, for example, r_1 equaled r_2, its largest value would be .34, not altogether atypical of the actual values found.

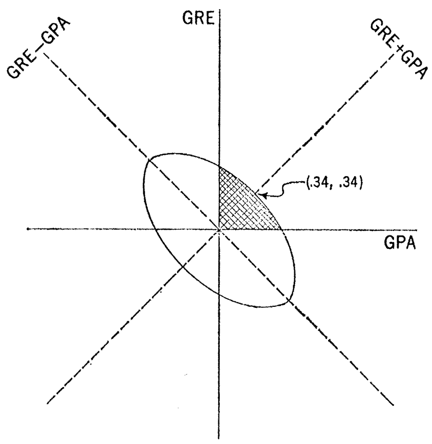

Fig. 2. The ellipse defined by Eq. 3.

As pointed out to me by Hoffman (*6*), the values of r will be particularly negative for schools that tend to be applicants' second or third choice. Applicants with both high GPA's and high GRE's are more likely than others to be admitted by their first-choice schools; hence, second-choice schools will have a preponderance of students who are high-low or low-high. Such schools would be especially unlikely to yield studies in which GPA or GRE considered singly predicts a later variable.

If, on the other hand, r is not negative—or in general the correlation between admissions criteria is not negative—then the school from which the sample is obtained must either have mainly students who are high on all variables (and hence have a greatly restricted range), or have a large group of students who are low on all variables (in which case the school is atypical). The point is that a desirable range can be obtained on the variables only at the expense of inducing a negative covariance structure, because a school that considers students who are low on some variable will admit only those who are high on others; this negative covariance structure in turn restricts the zero-order correlation between the variables and any future measure of interest.

There simply is no way in which the single correlations can be high. But note that the multiple correlation may contrast strikingly with the single validities; in the 1974–75 class, for example, it is possible to have a multiple correlation as high as .71 based on two single validities of only .34.

But even such multiple correlations would describe only the group of selected students, whereas the question of interest in the admissions procedure is how well the variables evaluate the applicant population. Without a study in which a sample of the applicants—rather than of the selected students—is evaluated, it is impossible to tell. Yet such a study is completely infeasible. Even if rejected applicants are monitored throughout the rest of their work careers, it is impossible to evaluate how they would have done had they been admitted, because the rejection itself constitutes an important "treatment" difference between them and the selected students. The alternative is to admit a sample of the applicant population without using the standard admission variables to select them—preferably, to select at random. At worst, such a procedure can be considered to be unethical, and at best it does not arouse much enthusiasm at departmental meetings. The result is a dilemma. Studies involving admission variables will yield low correlations of necessity, and hence these low correlations cannot be used to determine whether the admissions variables are any good. They may be. Or on the other hand, they may be unfair or invalid—and their use may merely perpetuate an unfortunate status quo.

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NEWS AND COMMENT

Oil and Gas Resources: Academy Calls USGS Math "Misleading"

In 1922, before the discovery of a vast pool of oil under eastern Texas, the U.S. Geological Survey solemnly predicted that the nation's cumulative oil production would not exceed 15 billion barrels, a figure that suggested the United States might soon run out of oil. Happily, the Geological Survey was wrong, although its estimate was not unreasonable considering the infant state of petroleum geology.

Now, with the passage of more than half a century, it looks as if the Geological Survey may have erred again, this time on the high side. According to a new survey* put out by the National Academy of Sciences concerning fuels and basic material resources, the amount of oil and gas left to be discovered and produced with current technology in the United States is "considerably smaller" than the 200 to 400 billion barrels of oil and the 1000 to 2000 trillion cubic feet of natural gas estimated as of last March by the Geological Survey.

A more realistic estimate, in the opinion of the Academy's Committee on Mineral Resources and the Environment, is that 113 billion barrels of oil and 530 trillion cubic feet of gas remain to be found and produced onshore and offshore, mostly in Alaska. The

* *Mineral Resources and the Environment* (National Academy of Sciences, Washington, D.C., February 1975), 348 pp.