DOCUMENT RESUME

ED 049 297 TM 000 484

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TITLE Interactive Effects of Year and Academic Predictors on College GPA.
PUB DATE Feb 71
NOTE 13p.; Paper presented at the Annual Meeting of the American Educational Research Association, New York, New York, February 1971

EDRS PRICE EDRS Price MF-$0.65 HC-$3.29
DESCRIPTORS Academic Performance, Academic Standards, Aptitude Tests, *College Admission, *Grade Point Average, Higher Education, Predictive Measurement, *Predictor Variables, *Selection, Statistical Analysis, *Test Reliability
IDENTIFIERS ACT C, *American College Test Composite, University of Illinois

ABSTRACT

Multiple regression equations predicting first semester grade point average (GPA) from high school percentile rank (HSPR) and Composite score on the American College Test (ACT:C) were examined for five successive fall freshman classes (1965-1969) at the University of Illinois. Slopes were significantly different among the five equations. Further analysis indicated a systematic decline in the ACT:C regression coefficients over time while the HSPR coefficients remained approximately constant. Possible explanations advanced for these findings were unequal test score intervals, a low GPA ceiling, and changes in the GPA criterion. (Author)

INTERACTIVE EFFECTS OF YEAR AND ACADEMIC PREDICTORS ON COLLEGE GPA

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A paper presented at the 1971 annual meeting of the American Educational Research Association held in New York, New York.

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Many colleges routinely select freshmen each year according to their rank-ordering on the linear combination of high school rank and test scores found to be most predictive, in a least squares sense, of grade point average in a derivation sample. The regression coefficients of the predictors in these selection equations are typically unstable from year to year. Under the rather unrealistic assumptions of constant ability in the applicant pool, unchanging grading standards at both the high school and college level, and a high degree of test form parallelism, the equation instability might be explained by sampling variation or unreliability in the predictors and criteria. However, if the yearly sample size of selectees is large and systematic changes are observed in the regression coefficients over time, sampling error becomes a less plausible explanation of regression instability and other alternative causes might be advanced. For example, intercept differences in regression equations over time have been interpreted as disclosing shifts in grading standards (Hills, 1964; Bowers, 1967; Hills and Gladney, 1968). Equally pertinent interpretations of shifts in slopes might be possible. When a college selects applicants using an equation combining two or more predictors such as high school percentile rank and test scores, the effectiveness of the predictors may change over time. Changes in grading habits of faculties or changes in the characteristics of applicants could also be responsible for such shifts in regression coefficients. The present paper reports an analysis of changes over a five-year period in the weights given to high school percentile rank (HSPR) and ACT Composite (ACT:C) in predicting first term grade point average (GPA) at the University of Illinois.

Method

Complete records containing HSPR, ACT:C, and first semester GPA were obtained for fall freshmen entering the College of Liberal Arts and Sciences at the University of Illinois, Urbana-Champaign, for five successive years, from 1965 through 1969. GPA was based on a five point scale, with A = 5, B = 4, C = 3, D = 2, E = 1.

Separate regression equations were calculated, predicting GPA from HSPR and ACT:C for each year's entering group. The five separate regression equations, each containing three parameters, $y_{ij} = a_j + b_{Hj}x_{Hi} + b_{Aj}x_{Ai} + e_{ij}$, can be subsumed within a single equation (for example, see Norton, et al., 1961):

$$y_{ij} = a_o + \sum_j a_j x_{ij} + b_H x_{Hi} + \sum_j b_{Hj} x_{Hi} x_{ij} + b_A x_{Ai} + \sum_j b_{Aj} x_{Ai} x_{ij} + e_{ij} \qquad (1)$$

where y_{ij} = GPA for subject i in group j

x_{ij} = 1 for a subject in group j, 0 otherwise

x_{Hi} = HSPR for subject i

x_{Ai} = ACT:C for subject i .

Equation 1 has 18 parameters; since $\sum_j x_{ij} = 1$, $\sum_j x_{Hi}x_{ij} = x_{Hi}$, and $\sum_j x_{Ai}x_{ij} = x_{Ai}$ for all y_{ij} , the rank of the matrix of coefficients is 18 - 3 = 15. If Equation 1 is reparameterized with

$a'_j = a_j - a_o$

$b'_{Hj} = b_{Hj} - b_H$

$b'_{Aj} = b_{Aj} - b_A$

and $\sum_j a'_j = \sum_j b'_{Hj} = \sum_j b'_{Aj} = 0$

then

$$y_{ij} = a_o + \sum_j a'_j x_{ij} + b_H x_{Hi} + \sum_j b'_{Hj} x_{Hi} x_{ij} + b_A x_{Ai} + \sum_j b'_{Aj} x_{Ai} x_{ij} + e_{ij} \ . \qquad (2)$$

Since $\sum_j a'_j = 0$, let $a'_5 = - a'_1 - a'_2 - a'_3 - a'_4$.

Since $\sum_j b'_{Hj} = 0$, let $b'_{H5} = - b'_{H1} - b'_{H2} - b'_{H3} - b'_{H4}$.

Since $\sum_j b'_{Aj} = 0$, let $b'_{A5} = - b'_{A1} - b'_{A2} - b'_{A3} - b'_{A4}$.

Now there are 15 parameters to estimate, and the normal equations have a unique solution.

Equation 2 partitions the intercepts and regression coefficients for each predictor for the five groups into effects for the entire set of data plus separate effects for each group. The significance of the overall and the individual group effects can then be tested, thus extending the description provided by the overall test of common versus separate regression equations.

Results

Means, standard deviations, and intercorrelations for HSPR, ACT:C and GPA are shown in Table 1 for each of the five groups. HSPR means and standard deviations were somewhat erratic; ACT:C and GPA means tended to increase over time while the standard deviations decreased. The 1968 group, the most selective in recent years, showed considerable restriction in its predictor standard deviations and in the correlations among the three variables.

Regression coefficients for each group are listed in Table 2, together with the multiple correlations and the standard errors of estimate. While the regression coefficients for HSPR tended to be approximately similar among the groups, the regression coefficient for ACT:C steadily declined. Except for the inversion of the 1966 and 1967 groups, intercepts increased over time. Multiple correlations, except for the anomalous 1968 data, showed a consistent decrease, while standard errors of estimate remained relatively constant.

The fifteen parameter estimates resulting from fitting Equation 2 to the data are shown in Table 3. Overall regression coefficients for HSPR and ACT:C were significant at alpha = .01. Except for the 1966 group, there were no significant Group X HSPR effects; only the regression coefficient for the 1966 group was significant at alpha = .01. ACT:C regression coefficients for the two temporally extreme groups, 1965 and 1969, were significant; the reversal of sign from 1965 to 1969 confirms the trend shown in Table 2 indicating that the regression coefficient for ACT:C significantly decreased over time.

Discussion

These analyses support the conclusion that the slope differences among the equations for the five groups are due mainly to the decreasing effectiveness of the ACT:C predictor; the effectiveness of HSPR remained substantially the same for all groups.

One can only speculate why the ACT:C has become a less effective predictor since the University began use of the two-predictor selection procedure.

Characteristics of either the ACT:C scale or the GPA scale could affect the slope of GPA on ACT:C. As the ACT:C scale approaches its ceiling, one might suspect that "true" differences between successive, high ACT:C scores are larger than those between lower scores. This kind of ACT:C scaling would reduce the slope of an equal interval GPA measure on ACT:C. On the other hand, if the GPA scale were such that the "true" difference between a GPA of A and B is less than that between B and C, then the slope of GPA on an equal interval

ACT:C would also decrease for freshmen earning high GPA's. Very good students may earn high GPA's, but the very best students may not earn GPA's much higher, because the GPA scale does not provide a sufficiently high ceiling.

It is possible that the nature of the GPA criterion has changed. Although intercept differences cannot be clearly interpreted because of slope differences, one might suspect from these data that grading standards have become somewhat less stringent over time. There may have been sufficient public knowledge and discussion of the University's freshman selectivity to have caused the freshmen faculty to make a conscious adjustment in their grading. In addition, the expansion of placement testing during the period studied, if effective, would realize the objective of increasing GPA. The restructuring of some freshman year coursework may have the same effect and could change the quality of the criterion as well.

Distributions of HSPR, ACT:C, and GPA for the 1965 and 1969 groups, listed in Table 4, tend to support the notion that GPA as currently scaled has an artificially low ceiling. In 1965, both GPA and ACT:C were distributed approximately symmetrically, while HSPR was quite skewed negatively. In 1969, the ACT:C distribution still looked roughly symmetrical but the GPA distribution displayed distinct negative skew. The difference in the shape of the ACT:C and GPA distributions for 1969, which was not so distinct in 1965, could itself be a partial explanation for the decrease in the effectiveness of ACT:C as a predictor.

Another factor which may be involved in the decreasing importance of ACT:C scores is a shift in sex ratio between 1965 and 1969. In 1965, 52.5% of the entering Liberal Arts and Sciences freshmen were male, while in 1969, 54.8% were female. Some preliminary data, based on the 1967 Liberal Arts and Sciences sample, suggest that the slope of GPA on HSPR is steeper for females than for males. Possibly separate equations should be used for the two sexes, or if this is administratively unpalatable, students could be admitted to programs of study within Liberal Arts and Sciences which, though defined on the basis of homogeneity of interests and ability of their students, tend to be quite homogeneous in terms of sex. (Loeb and Bowers, 1970; Bowers and Loeb, 1970).

What are the expected consequences of applying this two-variable selection equation approach if the ACT:C predictor is losing its effectiveness relative to HSPR? Since the 1969 group serves as a derivation sample for the selection of 1971 fall freshmen, the predicted GPA for 1971 applicants will be determined more by HSPR than by ACT:C. Their selection equation converts a difference of one ACT:C score into approximately half of the predicted GPA value (.0364) as did the equation derived from the 1965 group (.0731). If this trend were to continue, obviously the ACT:C would cease to discriminate effectively between applicants, and admission would be solely determined by HSPR. Such a trend would contravene the policy that introduced test scores in order to adjust for the variation in grading that exists among the many high schools supplying freshmen to the University.

To allow the ACT:C weight to vanish would be unfortunate, for it would mean at least a temporary return to a less efficient selection system. It makes little educational sense to follow a course that abandons external evaluation of the applicants' general language and number abilities. This could lead to declining GPA's in future groups since in an unselected group HSPR alone cannot predict GPA as effectively as HSPR and ACT:C in combination.

Since the selection equation functions only to rank order applicants and is used only when applications exceed quotas, one possible way to preserve the selective effectiveness of ACT:C is by fixing its combining weight at some arbitrary value, e.g., that calculated for earlier, less select groups. Another possibility is to validate the predictors against a GPA criterion (or a survival criterion) based upon more than a single semester's work. This solution may succeed if the correlation between first term grades and subsequent academic survival has been reduced by widespread use of placement tests. A third possibility might be to introduce a harder admissions test, but this would result in little change if a GPA ceiling exists. Finally, it may be necessary to add to the regression equation a nonlinear term involving ACT, in order to take into account decreasing slope of GPA on ACT at higher test score levels.

Table 1

Means, Standard Deviations, and Intercorrelations of HSPR, ACT:C and GPA

Group	N	HSPR		ACT:C		GPA		r_{HA}	r_{HG}	r_{AG}
		$\bar{X}$	S	$\bar{X}$	S	$\bar{X}$	S			
1965	2679	87.8	10.0	25.9	3.2	3.42	0.76	.32	.46	.42
1966	2606	84.2	13.2	25.9	3.0	3.43	0.77	.32	.46	.37
1967	2935	86.7	10.7	26.6	2.8	3.54	0.75	.35	.46	.35
1968	2284	90.6	8.4	27.3	2.5	3.81	0.71	.17	.32	.23
1969	2430	88.9	10.0	27.1	3.0	3.91	0.69	.29	.38	.25

Table 2

Regression Coefficients, Multiple Correlations and Standard Errors of Estimate for Entering Freshman Groups

Group	Regression Coefficients[a]			Sample R	Sample Standard Error of Estimate
	$\hat{a}$	$\hat{b}_{HG}$	$\hat{b}_{AG}$		
1965	-.9126	.0278	.0731	.547	.64
1966	-.0876	.0221	.0641	.516	.66
1967	-.3654	.0271	.0589	.506	.65
1968	.1592	.0247	.0515	.367	.66
1969	.8833	.0229	.0364	.407	.63

a) The hypothesis of common slopes for the five regression equations was rejected at alpha = .01 with F (12,12919) = 3.51.

Table 3

Overall and Year X Predictor Regression Coefficients

Group	Group Constants	HSPR-coefficient	ACT-coefficient
Overall	-.0646	.0249**	.0568**
1965	-.8480**	.0029	.0163**
1966	-.0227	-.0028**	.0073
1967	-.3006**	.0021	.0021
1968	.2236	-.0002	-.0053
1969	.9477**	-.0020	-.0204**

**p<.01

Table 4

Distributions of Predictors and Criterion for First and Last Entry Group

	1965		1969	
ACT:C	f	%	f	%
30-36	333	12.4	532	21.7
20-29	2259	84.3	1891	77.1
1-19	87	3.2	29	1.2
HSPR				
80-99	2183	81.5	2067	84.3
50-79	485	18.1	370	15.1
0-49	11	.4	15	.6
GPA				
4.00-5.00	656	24.5	1277	52.1
3.00-3.99	1336	49.9	976	39.8
1.00-2.99	687	25.6	199	8.1

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