A Principal Components Analysis Of The *U.S. News & World Report* Tier Rankings Of National Liberal Arts Colleges

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Abstract

Analyzing the relative contribution of eleven ranking criteria used to construct the 1999 **U.S. News & World Report** *(USNWR) tier rankings of national universities, Webster (2000) found by utilizing principal components analysis the actual contributions differed significantly from the explicit USNWR weighting scheme. This difference was due to the presence of severe and pervasive multicollinearity. Although USNWR assigns the greatest explicit weight to academic reputation, Webster found that the most significant ranking criterion was average SAT (Scholastic Aptitude Test) scores of enrolled students. This paper extends Webster's study to the USNWR tier rankings of national liberal arts colleges. The results of this study reinforces Webster's findings about the importance of academically related ranking criteria, although academic reputation appears to carry greater weight for national liberal arts colleges than for national universities.*

I. Introduction

⫪ he *U.S. News & World Report (USNWR)* tier rankings of colleges and universities, which range from tier 1 (highest) to tier 4 (lowest), have become an important source of information for and about colleges and universities. *USNWR* tier rankings are important to prospective students since this information makes the search process more efficient and less costly. The tier rankings are important for college and university administrators because they partly define the institution's market niche, influence perceptions of the institution by prospective students, which affects enrollments and operating budgets, and serve as a guide to the institution's strategic planning. The

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USNWR tier rankings are also important to corporate recruiters who use the rankings to allocate limited recruitment budgets.

Although the *USNWR* tier rankings are but one of a myriad of factors that influence the institutional decision-making process, it is fair to say that the *USNWR* tier rankings of colleges and universities directly and indirectly influence a number of short-run and long-run aspects of college and university operations. The *USNWR* tier rankings are controversial, however, largely because of the apparently arbitrary weighting scheme applied to the ranking criteria (see, for example, Carter, 1998; Crissey, 1997; Garigliano, 1997; Gilley, 1992; Glass, 1997; Gleick, 1995; Graham & Diamond, 1999; Kirk & Corcoran, 1995; Machung, 1998;

Morse & Gilbert, 1995; Schatz, 1993).

The *USNWR* tier rankings influence the number and quality of admission applications, which affect the overall character of the institution's student body, the quality of the institution's programs, and, ultimately, the perceived value of the degree granted by the institution. These perceptions are likely to influence retention rates, in particular, and enrollment measures, in general. Enrollments, in turn, affect institutions' tuition-based revenues and, therefore, financial resources, operating budgets, per student expenditures, faculty-student ratios, etc. These factors, in turn, may influence institutions' academic reputation, which could affect alumni contributions, foundation grants, and other non-tuition-based revenue sources. This would suggest that important feed back effects are imbedded in the ranking process where tier rankings reinforce existing positive and negative stereotypes about the academic quality of ranked institutions.

II. National Liberal Arts Colleges Undergraduate Ranking Criteria and Weights

U.S. News & World Report tier rankings of colleges and universities are based on a set of up to 16 measures of academic quality that fall into seven broad categories. These ranking criteria include academic reputation, student selectivity, faculty resources, student retention, financial resources, alumni giving, and, for national universities and national liberal arts colleges only, graduate rate "performance."

A cursory examination of the ranking criteria used by *USNWR* suggests that multicollinearity may be pervasive. Multicollinearity in refers to the degree to which changes in the value of one or more of the ranking criteria are related to, and are affected by, changes in one or more of the other ranking criteria. It could be argued, for example, that institutions' academic reputation is influenced by the public's knowledge of *SAT* (Scholastic Aptitude Test) scores of admitted students. Retention rates, enrollments, and alumni contributions are likely to be affected by academic reputation,

which, in turn, could influence institutions' financial resources, per-student expenditures, faculty-student ratios, faculty compensations, etc.

The possibility of pervasive multicollinearity between and among the ranking criteria suggests that the assigned weighting scheme may not accurately reflect actual contributions to *USNWR* tier rankings. Webster (2000) utilized principal components analysis to evaluate the accuracy of the *USNWR* criteria weighting scheme for ranking national universities. The results of that analysis indicated that the actual contributions of the eleven ranking criteria examined differed significantly from the explicit *USNWR* weighting scheme because of the presence of severe and pervasive multicollinearity.

The purpose of this paper is to extend Webster's study by analyzing the accuracy of the *USNWR* criteria weighting scheme applied to the second major *USNWR* category of institutions of higher learning--national liberal arts colleges. The paper concludes with a discussion of the implications for the formulation of marketing strategies of college and university administrators.

III. Data

Data used in this study were obtained from the web-site of *U.S. News & World Report 2000 College Rankings*. *USNWR* classifies institutions of higher learning as national universities, national liberal arts colleges, regional universities, or regional liberal arts colleges according to criteria established by the *Carnegie Foundation for the Advancement of Teaching*. According to *USNWR*, a national university offers a full range of undergraduate majors, and offers masters and doctoral degrees. There were 228 national university included in the 2000 *USNWR* tier rankings.

National liberal arts colleges, on the other hand, emphasize undergraduate education. To be classified as a national liberal arts college at least 40 percent of conferred degrees must be in the liberal arts. These institutions tend to require higher college entrance examination scores than regional

liberal arts colleges. There were 159 national liberal arts colleges in the 2000 *USNWR* rankings.

Regional universities and liberal arts colleges are subdivided into four regions: Midwest, North, South, and West. Regional universities offer a full range of undergraduate and masters degree programs. Unlike national universities, regional universities generally do not confer doctoral degrees. There are 503 regional universities in the 2000 *USNWR* rankings.

Regional liberal arts colleges emphasize undergraduate education and tend to be somewhat less selective than national liberal arts colleges. Fewer than 40 percent of degrees granted by regional liberal arts colleges are in the liberal arts. There are 421 regional liberal arts colleges in the 2000 *USNWR* rankings.

In general, each category (national university, national liberal arts college, regional university, and regional liberal arts college) is divided into four, approximately equally sized, tiers. Tier rankings are based on a variety of weighted ranking criteria. *USNWR* reports data on fourteen ranking criteria for tier 1 national universities and national liberal arts colleges. Eleven of these ranking criteria were also reported for tier 2 through 4 national universities and national liberal arts colleges. Table 1 summarizes the subset of eleven ranking criteria analyzed in this study.

Unlike the Webster study, which analyzed only *SAT* reporting institutions, the present analysis includes all national liberal arts colleges reporting both *SAT* and *ACT* (American College Testing) scores. *ACT* scores were converted into *SAT* equivalents using standardized conversion scores, which are presented in Table 2. To fully exploit the available data set, criteria averages for institutions within specific *USNWR* tiers were used as proxies for missing observations. Proxies accounted for only about 1.5 percent of 1,749 total observations.

According to the weights indicated in Table 1, the eleven ranking criteria analyzed in this study

accounted for 86.5 percent of the *USNWR* tier rankings. The ranking criteria in descending order of importance include: Academic reputation (*REP*, 25 percent), the six-year graduation rate (*ACTGRAD*, 20 percent), average *SAT* scores (*SATACT*, 6 percent), the percentage of classes with enrollment of less than 20 students (*LT20*, 6 percent), the proportion of students enrolled who graduated in the top 10 percent of their high school class (*TOP10*, 5.25 percent), the predicted graduation rate (*PREDGRAD*, 5 percent), the percentage of undergraduate alumni who contributed to the university (*ALUM*, 5 percent), the retention rate (*RET*, 4 percent), the undergraduate acceptance rate (*ACCRAT*, 2.25 percent),the percentage of classes with enrollment of greater than 50 20 students (MT50, 2 percent), and the proportion of total faculty employed on a full-time basis (FTFAC, 1 percent).

IV. Empirical Analysis

IV.A. All Tiers

A cursory examination of the data suggests systematic relationships between the *USNWR* tier rankings and the ranking criteria. The higher the average *SAT* scores, academic reputation scores, retention rates, predicted graduation rates, actual graduation rates, percent of full-time faculty, percentage of classes with enrollment of less than 20 students, etc., for example, then the higher the tier ranking (i.e. the lower the tier number). Webster noted, however, seemingly counter-intuitive relationships, such as the positive relationship between class size and tier ranking, or between and acceptance rates and improved tier rankings.

The positive relationship between tier ranking and the *MT50*, for example, is controversial since it could be argued that, from the student's perspective, smaller class enrollments are preferred to larger ones. In other words, one would expect that the larger the average class enrollment lower the tier ranking. On the other hand, an argument in favor of a positive relationship between *MT50* and *TIER* could be made on the basis of increasing returns to enrollments. Larger class sizes would en-

Table 1
Definitions of U.S. News & World Report Explanatory Variables

Variable	Definition
ACCRAT (X_1)	The ratio of the number of students admitted to the number of applicants for admission for the fall 1997 semester. (2.25%)
ACTGRAD (X_2)	The percentage of freshmen who graduated within a six-year period between 1989 and 1992. (20%)
ALUM (X_3)	The average percent of undergraduate alumni of record who donated money to the institution during the years 1996 and 1997. (5%)
FTFAC (X_4)	The proportion of total faculty employed on a full-time basis during the 1997 academic year. (1%)
LT20 (X_5)	The percentage of undergraduate classes, excluding class sections, with fewer than 20 students enrolled during the fall 1997 semester. (6%)
MT50 (X_6)	The percentage of undergraduate classes, excluding class sections, with 50 students or more enrolled during the fall 1997 semester. (2%)
PREDGRAD (X_7)	The predicted graduation rate, which is based on entering test scores and education expenditures. (5%)
REP (X_8)	The average rating of the quality of institutions' academic programs as evaluated by officials at similar institutions. The survey was conducted in the spring of 1998. (25%)
RET (X_9)	The ratio of the number of students admitted to the number of applicants for admission for the fall 1997 semester. (4%)
SATACT (X_{10})	Average of the first and fourth percentile of SAT or ACT test scores of enrolled students. (6%)
TOP10 (X_{11})	The proportion of students enrolled at national universities and liberal arts colleges in the fall 1997 academic year graduating in the top 10 percent of their high school class. (5.25%)

Notes: 1. Numbers in parentheses represent criteria weights applied to *U.S. News & World Report* tier rankings.
      2. The total of all weights applied to *U.S. News & World Report* tier rankings--86.5%.

able administrators to economize on faculty salaries thereby permitting reallocation of scarce financial resources to other academically related activities.

A similar observation may made about the ratio of the number of students admitted to the number of admission applications on the grounds that the more prestigious the institution, the lower should be the acceptance rate. The relationship between acceptance rates and tier rankings, however, appears to ignore the "self selection" phenomenon. There are a number of transaction costs associated with the search and application process (processing and examination fees, campus visits, temporal opportunity costs, etc.). The "self selection" phenomenon refers to the situation where under-qualified students do not apply to tier 1 institutions because, in their judgement, they would not be admitted. The effect of "self selection" would be to upwardly bias reported the acceptance rates of more academically prestigious institutions. Moreover, as lower qualified students swell the number of applications to less prestigious institutions, the acceptance rates at lower ranked national universities tend to be biased downwards.

Webster noted that a multiple regression analysis of the *USNWR* tier rankings against the eleven ranking criteria strongly suggested the presence of multicollinearity.[1] The pervasive nature of multicollinearity among the ranking criteria was

Table 2
ACT/SAT Conversion Scores

36/1560	22/920
35/1510	21/880
34/1450	20/840
33/1400	19/790
32/1350	18/740
31/1300	17/700
30/1260	16/650
29/1210	15/600
28/1170	14/560
27/1130	13/520
26/1090	12/480
25/1050	11/440
24/1010	10/420
23/970	9/400

also evident upon examination of the correlation coefficient matrix of the independent variables. The estimated matrix of pair-wise correlation coefficients for national liberal arts colleges presented in Table 3 also indicates the presence of severe and pervasive multicollinearity.

The pair-wise correlation coefficients for national liberal arts colleges reveal that variations in tier rankings (TIER) are most closely associated (in descending order) with variations in *REP* (-0.88), *PREDGRAD* (-0.80), *ACTGRAD* (-0.80), *RET* (-0.76), *SATACT* (-0.75), *TOP10* (-0.74), *ACCRAT* (0.60). These results are consistent to those reported by Webster for national universities, which were *ACTGRAD* (-0.86), *RET* (-0.84), *REP* (-0.80), *SATAVG* (-0.78), *TOP10* (-0.74), and *ACCRAT* (0.67). Interestingly, as in the Webster study, each pair-wise correlation has the anticipated sign, with the exception of *ACCRAT*. In both instances, the higher the acceptance rates the lower (higher number) tier ranking, which seems to support the self-selection hypothesis. The results also verify Webster's findings that large class sizes contribute to a more favorable tier ranking, which supports the interpretation that larger classes enable institutions to allocate their financial re-

sources more efficiently.

The results presented in Table 3 also verify Webster's conclusion of the pervasiveness and severity of multicollinearity in the data. Academic reputation (REP) and predicted graduation rates (PREDGRAD) are highly correlated (0.88), as are retention rates (RET) and six-year graduation rate (ACTGRAD) (0.87), average *SAT/ACT* scores (SATACT) and *PREDGRAD* (0.87), and *SATACT* and *REP* (0.82). Similar results were found for *SATACT* and the proportion of students enrolled who graduated in the top 10 percent of their high school class (TOP10)(0.79), *REP* and *TOP10* (0.78), *REP* and *ACCRAT* (-0.78), PREDGRAD and TOP10 (0.77), REP and ACTGRAD (0.77), SATACT and ACCRAT (-0.75), *REP* and *RET* (0.73), RET and TOP10 (0.72), *TOP10* and *ACTGRAD* (0.70), etc.

The data presented in Table 3 indicate that the highest degree pair-wise correlation (coefficients 0.60 and greater) involved academically related ranking criteria, such as academic reputation, predicted graduation rates, retention rates, average *SAT/ACT* scores, the proportion of students graduating in the top 10 percent of their high school class, and acceptance rates. Of 23 pair-wise correlations that fall into this group, seven involved *PREDGRAD*, six each involved *ACCRAT*, *ACTGRAD*, *REP*, *RET*, and *TOP10*, and two each for the percentage of undergraduate alumni who contributed to the university (*ALUM*) and PREDGRAD. As in the Webster study, the only ranking criteria that do not exhibit systematic multicollinearity were class size, and the percentage of full time faculty.

More importantly, the information contained in Table 3 confirm that the relative weights assigned by *USNWR* to the ranking criteria are not representative of their actual contributions to *TIER*. A university's academic reputation, for example, is highly correlated with academic qualifications of its students as measured by average *SAT/ACT* scores. Academic reputation is also highly correlated with undergraduate retention rates, perhaps because students who believe that their degree has

Table 3
Correlation Matrix of USNWR Ranking Criteria

	TIER	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}
TIER	1.00											
X_1	0.69	1.00										
X_2	-0.80	-0.65	1.00									
X_3	-0.62	-0.44	0.52	1.00								
X_4	-0.53	-0.31	0.44	0.52	1.00							
X_5	-0.03	-0.01	-0.24	0.18	-0.12	1.00						
X_6	-0.26	-0.37	0.36	0.24	0.24	-0.19	1.00					
X_7	-0.80	-0.74	0.67	0.60	0.43	0.11	0.34	1.00				
X_8	-0.88	-0.78	0.77	0.60	0.50	-0.02	0.39	0.88	1.00			
X_9	-0.76	-0.64	0.87	0.49	0.47	-0.27	0.36	0.66	0.73	1.00		
X_{10}	-0.75	-0.75	0.68	0.53	0.35	0.08	0.29	0.87	0.82	0.69	1.00	
X_{11}	-0.74	-0.69	0.70	0.53	0.42	-0.02	0.35	0.77	0.78	0.72	0.79	1.00

a high market value are more likely to remain with that institution. On the other hand, students who believe that the institution's degree is tainted by an inferior academic reputation may be more likely to transfer to a more academically prestigious college or university.

A possible chain of causality may begin with an institution's admission standards, which influence perceptions of academic quality that in turn affect undergraduate retention rates. College and university administrators, who are interested in bolstering retention rates, presumably for financial reasons, may consider the long-term effect of raising admission standards. These cause and effect relationships also suggest that lowering admissions standards to increase tuition-based revenues may be ultimately self-defeating because of the potentially negative impact this may have on an institutions academic reputation.

The data in Table 3 also indicate that academic reputation is positively correlated with alumni contributions. Alumni who are proud of their *alma mater* and who believe that their degree provides a competitive advantage in the market place may be more prone to provide financial assistance after graduation than those who believe that they did not get their tuition's worth. The positive correlation

between academic reputation and alumni contributions is underscored by the fact that major corporations tend to allocate their scarce recruitment dollars to institutions with high academic reputations (Tier 1 and 2), and tend to shun colleges and universities that are perceived to be of inferior academic quality (tiers 3 and 4). The logical connection between the perceived academic quality and the students that attend these institutions is inescapable.

The relationship between academic reputation and alumni contributions is particularly important since a university's ability to provide state-of-the-art educational facilities and hire world-class faculty depends crucially on non-tuition-based sources of income. In this case, the possible chain of causality runs from admission standards to academic quality to alumni contribution. Raising alumni contributions, therefore, may partly depend on raising admission standards.

Webster argued that it is reasonable to suppose that an accurate understanding of the actual contribution of the ranking criteria to an institution's overall academic standing is an essential element in the formulation of a university's strategic agenda. Given the inherent shortcomings of the multiple regression methodology in the presence of multi-

collinearity, Webster employed principal components regression analysis to develop a more refined understanding of the relationships between the *USNWR* ranking criteria and the tier rankings of colleges and universities. What follows is an application of the principal components methodology to the data set on national liberal arts colleges.

The objective of principal components analysis (See, for example, Chatterjee and Price, 1977; Green, 1997; Hair, Anderson & Tatham, 1987; Hotelling, 1933, 1936; Judge, Griffiths, Hill & Lee, 1985; Maddala, 1992; Malinvaud, 1997) is to derive alternative linear combinations of the original variables, with coefficients equal to the eigenvectors of the correlation or covariance matrix. The principal components are then sorted in descending order by eigenvalue, which are equal to the variances of the components. Intuitively, the first principal component should be able to explain variations in the value of the dependent variable better than any other linear combination of explanatory variables.

In geometric terms, principal components analysis is similar to the method of ordinary least squares. Principal components analysis of a *k*-dimensional linear sub-space spanned by the first *k* principal components gives the best possible fit to the data points as measured by the sum of squared perpendicular distances from each data point to the surface. Ordinary least squares regression analysis, on the other hand, minimizes the sum of the squared vertical distances.

The principal components have certain desirable properties. The first desirable property is that the sum of the variances of the principal components is equal to the sum of the variances of the original explanatory variables. The second desirable property is that unlike the original explanatory variables, the principal components are mutually orthogonal (that is, they are uncorrelated).

Although principal components analysis appears to offer a solution to the multicollinearity problem, the procedure does have drawbacks. To begin with, while the first principal component has the greatest variance subject to the normalization condition, it need not necessarily be the most highly correlated with the dependent variable. Another drawback is that the principal components have no meaningful economic interpretation. Finally, changing the units of measurement of the original explanatory variables will change the principal components. This problem may be overcome, however, by standardizing the explanatory variables with unit variance.

Table 4 summarizes the eigenvalues of the eleven calculated principal components and their proportional explanatory contributions to the *U.S. News & World Report* tier rankings. The eigenvalues indicate that first principal component (Prin1) explains about 58 percent of the standardized variance in TIER, the second principle component (Prin2) explains another 12 percent, the third principal component (Prin3) another 8 percent, and so on.

The first five principal components, which explain about 89 percent of the standardized variance in TIER, are summarized in Table 5. The first principal component, which explains variations in the value of the dependent variable better than any other linear combination of explanatory variables, is a measure of the overall *USNWR* tier rankings. The first eigenvector indicates that there are approximately equal loadings on seven of the eleven ranking criteria examined, accounting for approximately 78 percent of the absolute standardized variance. These seven ranking criteria in descending order of their individual contribution to the standardized variance of the first principal component are *REP* (11.8 percent), *PREDGRAD* (11.4), *SATACT* (11.2 percent), *TOP10* (11.0 percent), *ACTGRAD* (10.9 percent), *RET* (10.8 percent), and *ACCRAT* (10.7 percent). The remaining contributions are *ALUM* (8.5 percent), *FTFAC* (7.0 percent), *MT50* (5.9 percent), and *LT20* (0.8 percent).

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Table 4
Principal Component Analysis
Eigenvalues, Proportion Explained, and Cumulative Total (n=159)

Principal Component	Eigenvalue	Difference	Proportion Explained	Cumulative Total
Prin1	6.338	5.002	0.576	0.576
Prin2	1.338	0.515	0.122	0.678
Prin3	0.822	0.052	0.075	0.773
Prin4	0.770	0.258	0.070	0.843
Prin5	0.513	0.193	0.047	0.889
Prin6	0.321	0.023	0.029	0.918
Prin7	0.298	0.060	0.027	0.945
Prin8	0.238	0.077	0.022	0.967
Prin9	0.161	0.047	0.015	0.982
Prin10	0.114	0.028	0.008	0.992
Prin11	0.086	--	0.008	1.000

Notes: 1. Eigenvalues represent the column sum of squares for a factor; sometimes referred to as a latent root. It represents the amount of variance accounted for by a factor.
2. Prin$j$ is the jth principal, where j = 1, ..., 11.

The results presented in Table 5 verify the importance of academically related ranking criteria, although the order of importance is different, albeit not statistically different from that found for national universities. In the Webster principal components analysis of national universities the most important ranking criteria was *SATAVG* (11.8 percent), followed by *PREDGRAD* (11.7 percent), *ACTGRAD* (11.3 percent), *REP* (11 percent), *RET* (10.9 percent), *ACCRAT* (10.8 percent), *TOP10* (10.6 percent), and *ALUM* (9.9 percent). One possible explanation for the relatively greater importance of *REP* in the national liberal arts tier rankings may be that national liberal arts colleges are less likely to benefit from the "halo effect" of non-academically related programs, such as nationally recognized athletic programs. The academic reputations of national liberal arts colleges (which, for the most part, do not benefit from the national media coverage of, say, Division 1-A *NCAA* national basketball championships) are probably more closely associated with the quality of their academic programs and less likely to be "tainted" by non-academic considerations.

As expected, these eight ranking criteria had the highest pair-wise correlation coefficients with *TIER*. The second principal component, however, which explains only 12.2 percent of the standardized variance in TIER, appears to add little to our understanding of the *USNWR* tier rankings. *LT20* in the second principal component has a high positive loading, but this result is counterintuitive. Webster's analysis of the second eigenvector found high positive loadings for *MT50* and *FTFAC*, and a high negative loading on *LT20*. In that study, the interpretations of *MT50* and *LT20* were straightforward, but the contribution of *FTFAC* was counterintuitive. In the present analysis, only the first principal component appears to make intuitive sense.

Table 5
Principal Component Analysis
Eigenvalues (n = 159)

Variable	Prin1	Prin2	Prin3	Prin4
ACCRAT	-0.337	-0.072	0.321	0.029
ACTGRAD	0.341	-0.205	0.005	-0.199
ALUM	0.266	0.255	0.392	0.197
FTFAC	0.219	-0.153	0.787	0.142
LT20	-0.025	0.800	0.031	0.229
MT50	0.184	-0.301	-0.268	0.882
PREDGRAD	0.358	0.199	-0.076	-0.022
REP	0.371	0.054	-0.028	-0.019
RET	0.339	-0.239	0.027	-0.205
SATACT	0.350	0.177	-0.189	-0.145
TOP10	0.346	0.043	-0.084	-0.080

A simple way to assess the explanatory power of principal components regression analysis is to simulate the predictions of the first principal component, which explains variations in the value of the dependent variable better than any other linear combination of explanatory variables subject to the normalization rule. Table 6, which compares the results of this re-centered simulation to the *USNWR* tier rankings, underscores the explanatory power of the principal components methodology.

VI.B. Tier 1

As was noted above, *USNWR* reports data on fourteen ranking criteria for tier 1 national universities and national liberal arts colleges. Eleven of these ranking criteria are reported for tiers 2 through 4 national universities and national liberal arts colleges. The three additional ranking criteria for tier 1 national liberal arts colleges include a ranking of institutions by faculty compensation (FACRES), student-faculty ratio (SFRAT), and a ranking of financial resources (FINRES). *FACRES* is actually an index of several ranking criteria including faculty compensation, the proportion of faculty with the highest terminal degree, and the percentage of full-time faculty. Ranking criteria included in *FACRES* that were considered above

included *FTFAC, LT20,* and *MT50.* Collectively, *FACRES* accounts for 20 percent of the explicit *USNWR* weighting scheme.

FACRES, which accounts for 7 percent of the explicit *USNWR* weighting scheme, is the average faculty pay and benefits adjusted for regional differences in cost of living using indices from *Runzheimer International* during the 1997 and 1998 academic years for full-time assistant, associate, and full professors. *SFRAT* is the ratio of full-time-equivalent students to full-time-equivalent faculty members (including graduate-teaching assistants) during the Fall 1998 semester, excluding the students and faculty of stand-alone professional programs. *SFRAT* accounts for 1 percent of the explicit *USNWR* weighting scheme.

FINRES, which represents the institution's average expenditure per full-time student on instruction, research, public service, academic support, student services, institutional support, and the operations and maintenance during the 1997 and 1998 fiscal years.[2] *FINRES* accounts for 10 percent of the explicit *USNWR* weighting scheme.[3]

Table 6
U.S. News and World Report National Liberal Arts College
Rankings and First Principal Component Simulations

Simulated Rank[a]	College	USNWR Tier[b]	Simulated Prin1
1 (1)	Amherst College	1 (2)	-0.217
2 (2)	Williams College	1 (3)	-0.059
3 (3)	Swarthmore College	1 (1)	0.074
4 (5)	Haverford College	1 (5)	0.437
5 (4)	Pomona College	1 (7)	0.458
6 (7)	Bowdoin College	1 (9)	0.484
7 (6)	Middlebury College	1 (5)	0.567
8 (9)	Wesleyan University (Connecticut)	1 (10)	0.574
9 (10)	Claremont McKenna College	1 (14)	0.688
10 (11)	Carleton College	1 (8)	0.745
11 (14)	Davidson College	1 (11)	0.749
12 (12)	Washington and Lee University	1 (14)	0.753
13 (8)	Wellesley College	1 (4)	0.788
14 (15)	Colby College	1 (18)	0.830
15 (19)	Barnard College	1 (25)	0.845
16 (17)	Bates College	1 (23)	0.856
17 (13)	Grinnell College	1 (11)	0.937
18 (18)	Colgate University	1 (18)	1.013
19 (16)	Vassar College	1 (17)	1.069
20 (20)	Bryn Mawr College	1 (18)	1.128
21 (21)	Smith College	1 (13)	1.142
22 (24)	Oberlin College	1 (25)	1.214
23 (22)	Hamilton College	1 (18)	1.257
24 (27)	Bucknell University	1 (30)	1.285
25 (28)	College of the Holy Cross	1 (30)	1.294
26 (23)	Trinity College	1 (22)	1.380
27 (25)	Macalester College	1 (24)	1.434
28 (26)	Mount Holyoke College	1 (16)	1.468
29 (29)	Franklin and Marshall College	1 (35)	1.544
30 (31)	Connecticut College	1 (25)	1.553
31 (32)	Union College	1 (33)	1.584
32 (33)	Kenyon College	1 (32)	1.585
33 (30)	Colorado College	1 (25)	1.594
34	Wheaton College	2	1.657
35	Reed College	2	1.700
36	Furman University	2	1.755
37 (35)	Lafayette College	1 (40)	1.788
38	Rhodes College	2	1.848
39 (37)	Whitman College	1 (35)	1.850
40	Skidmore College	2	1.869
41 (34)	University of the South	1 (25)	1.878
42 (38)	Scripps College	1 (35)	1.944
43 (36)	Sarah Lawrence College	1 (38)	2.001
44 (39)	Bard College	1 (40)	2.060

45	Centre College	2	2.076
46	Illinois Wesleyan University	2	2.096
47 (40)	Occidental College	1 (40)	2.114
48	DePauw University	2	2.157
49	Drew University	2	2.190
50 (39)	Dickinson College	1 (39)	2.191
51	Gettysburg College	2	2.199
52	Kalamazoo College	2	2.206
53 (42)	Lawrence University	1 (40)	2.252
54	Gustavos Adolphus College	2	2.319
55	Wabash College	2	2.322
56	St. Maryls College of Maryland	2	2.338
57	Beloit College	2	2.341
58	Willamette University	2	2.358
59	Pitzer College	2	2.368
60	Southwestern University	2	2.367
61	Earlham College	2	2.404
62	St. Olaf College	2	2.404
63	Denison University	2	2.416
64	St. Johnls College (Maryland)	3	2.431
65	University of Puget Sound	3	2.432
66	Ursinus College	2	2.433
67	Muhlenberg College	2	2.445
68	Allegheny College	2	2.507
69	Wofford College	2	2.519
70	Knox College	2	2.530
71	College of Wooster	2	2.547
72	Hobart and William Smith College	2	2.618
73	Wheaton College (Massachusetts)	2	2.624
74	Augustana College	3	2.642
75	Luther College	3	2.652
76	Spelman College	3	2.669
77	St. Lawrence University	2	2.681
78	Randolf-Macon Womanls College	2	2.681
79	Austin College	2	2.694
80	Lewis and Clark College	3	2.698
81	Oglethorpe University	3	2.714
82	Hampshire College	3	2.717
83	Hendrix College	3	2.720
84	Millsaps College	2	2.725
85	Goucher College	3	2.733
86	Agnes Scott College	2	2.746
87	Juniata College	3	2.762
88	Transylvania University	3	2.762
89	St. Johnls College (New Mexico)	3	2.776
90	Birmingham-Southern College	2	2.783
91	Washington and Jefferson College	3	2.807
92	Hollins University	2	2.812
93	Hanover College	3	2.813

Table 6 (continued)

94	Ohio Wesleyan University	3	2.816
95	University of Minnesota-Morris	4	2.819
96	Hope College	3	2.845
97	Houghton College	3	2.868
98	Presbyterian College	3	2.891
99	Alma College	3	2.895
100	Albion College	3	2.902
101	Sweet Briar College	2	2.925
102	Gordon College	4	2.968
103	Wittenberg University	3	2.974
104	Morehouse College	4	3.007
105	Siena College	3	3.008
106	Wells College	3	3.033
107	Bennington College	4	3.045
108	Westminster College (Pennsylvania)	3	3.074
109	University of Dallas	4	3.078
110	Hamline University	3	3.083
111	Washington College	3	3.091
112	College of St. Benedict	3	3.126
113	Wartburg College	4	3.135
114	Eckerd College	3	3.142
115	Moravian College	3	3.144
116	Guilford College	3	3.157
117	Ripon College	3	3.168
118	Christendom College	4	3.200
119	Erskine College	4	3.213
120	Marlboro College	4	3.226
121	Mills College	2	3.229
122	Condordia College-Moorhead	4	3.237
123	St. John□s University (Minnesota)	3	3.249
124	Lake Forest College	3	3.275
125	Western Maryland College	3	3.279
126	Westmont College	4	3.282
127	Goshen College	4	3.286
128	Virginia Military Institute	3	3.312
129	Randolph-Macon College	3	3.324
130	Richard Stockton College of New Jersey	4	3.326
131	Hampden-Sydney College	3	3.359
132	Salem College	4	3.397
133	Bethany College	4	3.438
134	Simon□s Rock College of Bard	4	3.449
135	Whittier College	3	3.497
136	Hartwick College	4	3.498
137	Manhattanville College	4	3.498
138	Cornell College (Iowa)	3	3.513
139	University of North Carolina-Ashville	4	3.518
140	Coe College	3	3.523

141	Albright College	4	3.553
142	Nebraska Wesleyan University	4	3.555
143	Wesleyan College (Georgia)	4	3.559
144	Hiram College	3	3.569
145	Franklin College	4	3.593
146	Central College	4	3.693
147	Illinois College	4	3.734
148	Monmouth College (Illinois)	4	3.744
149	Antioch College	4	3.746
150	William Jewell College	4	3.784
151	Georgetown College (Kentucky)	4	3.788
152	Chatham College	4	3.794
153	Hastings College	4	3.799
154	Westminster College (Missouri)	4	3.926
155	Huntingdon College	4	4.080
156	Judson College	4	4.190
157	Virginia Wesleyan College	4	4.433
158	St. Andrews Presbyterian College	4	4.514
159	Shepherd College	4	4.948

Notes: a. Numbers in parentheses indicate simulated tier rankings when principal components analysis was
applied to institutions within Tier 1 only.
b. Numbers in parentheses designate the USNWR ranking within Tier 1.

Principal components analysis was applied to tier 1 national liberal arts colleges utilizing these fourteen ranking criteria.[4] A comparison of the explanatory power of the principal components methodology was possible in this instance since tier 1 national universities and liberal arts colleges institutions are listed in rank order. Institutions in tiers 2 through 4, on the other hand, are listed alphabetically. The first five principal components (not presented) explain about 83 percent of the standardized variance in *TIER*. The first principal component, however, explains only about 44 percent of the absolute standardized variance, compared with about 58 percent for all tiers.

The first eigenvector supports the earlier results of approximately equal loadings on seven ranking criteria, accounting for approximately 68 percent of the absolute standardized variance, compared with about 78 percent when all tiers are considered. The fourteen ranking criteria in descending order of their individual contribution to the absolute standardized variance of the first principal component for tier 1 national liberal arts col-

leges are *REP* (10.6 percent), *SATACT* (10.4 percent), *TOP10* (10.2 percent), *PREDGRAD* (9.6 percent), *ACCRAT* (9.3 percent), *ACTGRAD* (9.1 percent), *RET* (9.1 percent), ALUM (7.2 percent), FINRES (6.4 percent), SFRAT (5.6 percent), MT50 (5.1 percent), FACRES (3.9 percent), LT20 (1.9 percent), FTFAC (1.8 percent).

As before, these results verify the importance of academically related criteria in constructing the USNWR tier rankings. These results also demonstrate the relatively minor importance of the three additional ranking criteria, which collectively account for only about 12 percent of the absolute standardized variance of the first principal component, suggesting that the controversy surrounding the importance *FINRES* in the weighting scheme may be misplaced.

The first and third column Table 6 summarizes the re-centered simulation the *USNWR* tier 1 rankings. In the first column, the numbers in parentheses designate the USNWR ranking within Tier 1. In the third column, the numbers in parentheses

designate the simulated tier rankings when principal components analysis was applied to tier 1 institutions.

V. Conclusions

The foregoing analysis expands on Webster's principal components analysis of the *USNWR* tier rankings by analyzing the second major *USNWR* category of institutions of higher learning--national liberal arts colleges. Unlike Webster, this study utilizes data from both *SAT* and *ACT* reporting institutions. Nevertheless, this study supports Webster's findings that the actual contributions of the eleven ranking criteria examined differ significantly from the explicit *USNWR* weighting scheme because of the presence of severe and pervasive multicollinearity. The eigenvalues of the first principal component presented confirms that academic reputation is the most important ranking criteria, although its contribution to tier rankings was only about 11.8 percent, compared with a nominal weight of 25 percent. The second and third most significant ranking criteria were the predicted graduation rate (11.3 percent) and average *SAT/ACT* scores (11.2 percent). The nominal weights assigned to these criteria by *USNWR* were 5 and 6 percent, respectively. The remaining contributions are *TOP10* (11.0 percent), *ACTGRAD* (10.9 percent), *RET* (10.8 percent), *ACCRAT* (10.7 percent), *ALUM* (8.5 percent), *FTFAC* (7.0 percent), *MT50* (5.9 percent), and *LT20* (0.8 percent).

The Webster study of national universities found that the most significant ranking criterion was average *SAT* scores (11.8 percent) of enrolled students with academic reputation ranking fourth (11 percent). One possible explanation for this discrepancy may be that national liberal arts colleges to not benefit from the "halo effect" of non-academically related programs associated with larger institutions, such as nationally recognized athletic programs. In other words, academic reputations of national liberal arts colleges may be more closely associated with the quality of their academic programs and less likely to be tainted by non-academic considerations.

Finally, principal components analysis was applied to tier 1 national liberal arts colleges utilizing fourteen ranking criteria. The first eigenvector supports the earlier results of approximately equal loadings on seven ranking criteria. The fourteen ranking criteria in descending order of their individual contribution to the absolute standardized variance of the first principal component for tier 1 national liberal arts colleges are *REP* (10.6 percent), *SATACT* (10.4 percent), *TOP10* (10.2 percent), *PREDGRAD* (9.6 percent), *ACCRAT* (9.3 percent), *ACTGRAD* (9.1 percent), *RET* (9.1 percent), ALUM (7.2 percent), FINRES (6.4 percent), SFRAT (5.6 percent), MT50 (5.1 percent), FACRES (3.9 percent), LT20 (1.9 percent), FTFAC (1.8 percent).

These results verify the importance of academically related criteria in constructing the USNWR tier rankings, as well as the relatively small contribution of the three additional ranking criteria. This result is significant since it suggests that the controversy surrounding the importance an institution's average expenditure per full-time student on instruction, research, public service, academic support, student services, institutional support, and operations and maintenance in the weighting scheme may be misdirected.

Suggestions for Future Research

The next logical extension would be to analyze regional universities and regional liberal arts colleges. Other avenues of further research are subtler.

The results presented in this paper suggest that a policy of lower admission standards to bolster enrollments to increase or maintain tuition-based revenues may be counterproductive. Lowering *SAT* entrance requirements may lead to decline in academic reputation and tier rankings, which could lead to a decline in admission applications by better academically qualified students. This, in turn, could contribute to a decline in enrollments and declines in tuition-based revenues. Further lowering *SAT* entrance requirements to compensate could result in a "vicious cycle" where academic

reputation, enrollments, and revenues are further eroded.

The above discussion suggests that further research on the interrelationship between *SAT* scores, academic reputation, and retention rates is necessary. It could be argued, for example, that *SAT* scores influence retention rates, with academic reputation being the transmission mechanism. Moreover, this transmission mechanism may operate at several levels. A college or university degree has an imputed market value. Investors in university degrees will at least implicitly compare the marginal cost of a college education with the marginal benefits associated with increased career opportunities, lifetime earnings, etc. If the marginal cost of a degree is greater than the perceived marginal benefits, then students are likely to seek refuge at another college or university where the cost-benefit relationship is more favorable. The student will do this by transferring to a university with a better academic reputation, or an institution where tuition costs are lower, or both.

Another area of research is the relationship between retention rates and classroom management. It could be argued that retention rates decline when students with above average academic qualifications become dissatisfied with a classroom environment that accommodates academically lesser qualified students. A lower and slower pace of instruction may result in academically superior students transferring to what they perceive to be academically superior institutions where instruction is more advanced and accelerated. This phenomenon might be described as Gresham's law of higher education with "bad" students driving out "good" students.[5] Moreover, efforts to bolster enrollments by increasing the size of the freshman class by lowering admission standards could be more than offset the loss of sophomores and juniors transferring to other institutions.

Another area for further research would focus on the observation that *SAT* admission requirements entering freshmen are higher than for transfer students. It could be argued that students use their second- and third-choice colleges and universities as stepping-stones to admission into their first- and second-choice colleges and universities after the first year. ⌷

End Notes

1. Multicollinearity is the condition where one or more of the ranking criteria are interrelated. The main consequences of multicollinearity are unreliable *t*- and *F*-statistics, and incorrectly signed parameter estimates (Ramanathan, 1998).
2. A full-time equivalent student is defined by *USNWR* as the total number of full-time enrollment plus 33 percent, all of which is multiplied by total part-time enrollment.
3. This ranking criteria has recently generated considerable controversy since, in general, it costs more to train students in the sciences (engineering, medicine, etc.) because of the requisite physical resources than it does to educate students in the liberal arts.
4. Statistical results available from the author upon request.
5. "Gresham's Law," as it is generally understood, states that "bad" money tends to drive "good" money out of circulation. The distinction relates to two or more species, say, gold and silver, of different intrinsic value but with the same face value. According to this "law," undervalued coins, i.e. coins with a face value less than its intrinsic value (say, gold), will tend to disappear from circulation, while overvalued coins (say, silver) continue to be used for transaction purposes.

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Notes