Structural Determinants of Graduation Rates: A Causal Analysis

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Purpose

This study exams graduation rates at public two-year, public four-year and private four-year colleges in the United States. Its major purpose is to account for the variance in graduation rates taking into account several institutional and institutionally-related student financial aid predictor variables. United States colleges and universities are the unit of analysis. College graduation rates are viewed as a function of structural differences between institutions.

Literature Review

Any review of the many variables impacting college graduation rates needs to first take into account the strong impact of student input characteristics. Astin (2005-06) concludes that an institution's degree completion rate is primarily a reflection of its entering student characteristics and that differences among institutions in their degree completion rates are primarily attributable to differences among their student bodies at the time of entry. There is such a strong relationship between student characteristics that more than two-thirds of the variation in graduation rates is due to differences in their entering student bodies. Overwhelming support from the literature base supports the proposition that student background characteristics strongly impact degree completion rates (Anderson, 1987; Astin, 1993; Astin and Osequera, 2005; Astin, Tsui and Avalos, 1996; Dey and Astin, Pascarella, Smart and Ethington, 1986).

Two conceptual theories guide a considerable amount of persistence and retention research. Tinto's (1975 and 1987) framework, labeled the Student Integration Model, explains failure to graduate to the lack of congruity between students and institutions. The predictive validity of the model is upheld as far as the role of precollege variables is concerned (Pascarella and Terenzini 1979 and 1980). However, mixed results surround the structural relations among the academic integration, social integration, and institutional and goal commitments (Braxton and Sullivan, 1987, Bers and Smith, 1989; Munro 1981; Nora 1987; Nora and Rendon, 1990; Pascarella and Terenzini 1983; Pascarella, Duby and Iverson, 1983; Pascarella and Chapman 1983; Pascarella, Smart and Ethington, 1986; Stage, 1988 and 1989).

An alternative model, labeled the "Student Attrition Model", has been advanced by Bean (1980, 1982, 1982, 1983, 1985, and 1990). Bean

borrows concepts from psychology whereby beliefs shape attitudes and attitudes, in turn, influence behavioral intents. External factors to the institution also play an influential role in affecting both attitudes and persistence decisions. Bean and Vesper (1990) identified only six environmental, personal and organizational variables accounting for most of the variance in dropping out in a Midwestern college.

Nora and Castaneda (1993) merged Tinto and Bean's conceptual models and tested all the non-overlapping propositions underlying both frameworks. The integrated model accounted for 45 percent of the variance in persistence and 42 percent of the variance in "Intent to Persist". Furthermore, 82 percent of hypothesized relations among the exogenous and endogenous variables were upheld.

Pascarella and Terenzini (1991) found the following organizational variables to influence graduation rates: colleges that attracted a higher proportion of full-time and female students; institutional characteristics that promoted social integration; and instructional expenditures. In 2005 Pascarella and Terenzini found smaller influences of institutional characteristics, but did find an inverse relationship between college size and retention. Hamrick, Schuh and Shelley, II. (2004) modeled graduation rates as dependent on institutional characteristics: Carnegie type, selectivity and resource allocations: instructional expenditures and student affairs expenditures. Astin's (1975) pioneering work identified higher persistence rates among more selective colleges.

Osequera (2005-06) analyzed graduation rates of 63,640 first-time full-time freshman undergraduates at 303 colleges and universities. He found that structural measures affected degree completion over and above student input variables. The principal structural variables inhibiting degree completion are large institutional size, low selectivity, commuting (rather than residence hall living), working off-campus, over reliance on financial aid that accrues debt payments, public control and low levels of instructional expenditures.

Bailey, Calcagno, Jenkins, Kienzl, and Leinbach (2005) found a number of community college characteristics related to student outcomes: Institution size is negatively correlated with successful student outcomes; a larger percentage of minority students (black, Hispanic, and Native American) at an institution is associated with lower graduation rates; higher percentages of students who are part-time tend to be related to lower graduation rates; a larger percentage of faculty who are part-time also correlates with lower student graduation rates at community colleges; rates of instructional expenditures and

student service expenditures have some positive impacts on graduation rates; and the state in which a college is located has significant impact on institutional graduation rates.

The same authors (Bailey, Calcagno, Jenkins, Kienzl, and Leinbach (2005)) determined that 60 percent of the variation in graduation rates were primarily explained by institutional characteristics such as location, size, expenditures, and student composition. Astin, Tsui, and Avalos (1996) in a study of 365 baccalaureate institutions found that private universities had the highest graduation rates, and attributed such outcomes to the enrollment of better prepared students. Also, highly selective institutions and those that enroll large numbers of students in fields like business, psychology, and the social sciences have higher graduation rates. Scott, Bailey, and Kienzl (2005) found that private colleges and those with students with higher average SAT scores, a higher proportion of women, and higher instructional expenditures per full-time equivalent student had higher graduation rates. Lower graduation rates were associated with institutions with higher proportions of older students, minority students and part-time students. Also, they concluded that institutions with higher in-state tuition also tended to have higher graduation rates, controlling for student characteristics.

Modeling baccalaureate college graduation rates Mortenson (1997) and Porter (2000) found similar findings regarding the importance of SAT scores for higher graduation rates. In addition, colleges with higher expenditures per student, higher percentage of freshmen living on campus as well as a higher proportion of enrolled females had higher graduation rates. Lower graduation rates were associated with colleges with many part-time students and relatively large engineering programs. Goenner and Snaith (2004) findings identify students' GPA and SAT scores as important and positive predictors of institutional graduation rates. They also found that institutions in urban areas, the percentage of Native American students, the percentage of male students, and a student body with higher average age are all factors associated with lower institutional graduation rates.

Walker (2005) identified key distinctions between high graduation and low graduation rate institutions. Institutions that experienced high graduation rates exhibited the following characteristics: have higher enrollments of full-time students; are more likely to attract students of traditional college age (18 – 24 years of age); have greater percentages of full-time faculty; have lower student/faculty ratios; have higher expenditures per FTE student; rely on tuition to cover expenditures less than lower graduation rate institutions; are more

likely to enroll students who are academically advantaged upon college entrance and receive financial aid in the form of institutional grants.

Bailey, Alfonso, Scott, and Leinbach (2004) have identified many characteristics of community college students which place those institutions at a "graduation rate" disadvantage when comparisons are made with baccalaureate college graduation rates. Community Colleges typically enroll students with lower test scores in high school and are far more likely to delay enrollment in college after high school, attend part time, or interrupt their college studies. Also, they are much more likely to come from households in the lower socioeconomic quartiles.

Ryan (2004) studied 363 baccalaureate institutions to determine the impact of institutional expenditures for instruction, academic support, student services, and administrative support on graduation rates. Instructional and academic support expenditures have positive and significant effects on graduation rates, supporting research by Astin (1993). Contradicting other research findings, expenditures on student services and expenditures on administrative (institutional) support failed to produce any significant impact on graduation rates.
Bailey, Calcagno, Carlos, Jenkins, Davis, Kienzl, and Leinbach (2005) found an inverse relationship between graduation rates and students enrolled in medium-size community colleges (1,001-5,000 FTE undergraduates. The adverse effect is between 13 and 15 percent higher attrition for students enrolled in a medium-size community college (compared to students in small institutions -- fewer than 1,000 FTE undergraduates). Students enrolled in institutions with large proportions of part-time faculty and minority populations are less likely to graduate.

Titus (2004), merging two national datasets with individual student data, concluded that persistence is higher at more selective, residential, and larger institutions.

The bulk of this literature review appears to support Titus' (2003) claim that structural differences between institutions may be as important to college persistence as differences in individual students' experiences and commitments. The purpose of this analysis is to add to that body of research which analyzes the impact of structural determinants on graduation rates.

Data and Sample

Graduation rate and structural institutional data was obtained from Economic Diversity of Colleges.org. Sample size equals 3,072 public

two-year, public four-year and private four-year colleges in the United States. Of the 3,072 colleges in the sample 20.4% are public four-year institutions, 42.5% are private four-year colleges, and 37.1% are public two-year colleges. All 50 states are represented in the sample. Collectively, these colleges enrolled 10,416,131 full-time equivalent students in 2003-04, the year for the analysis.

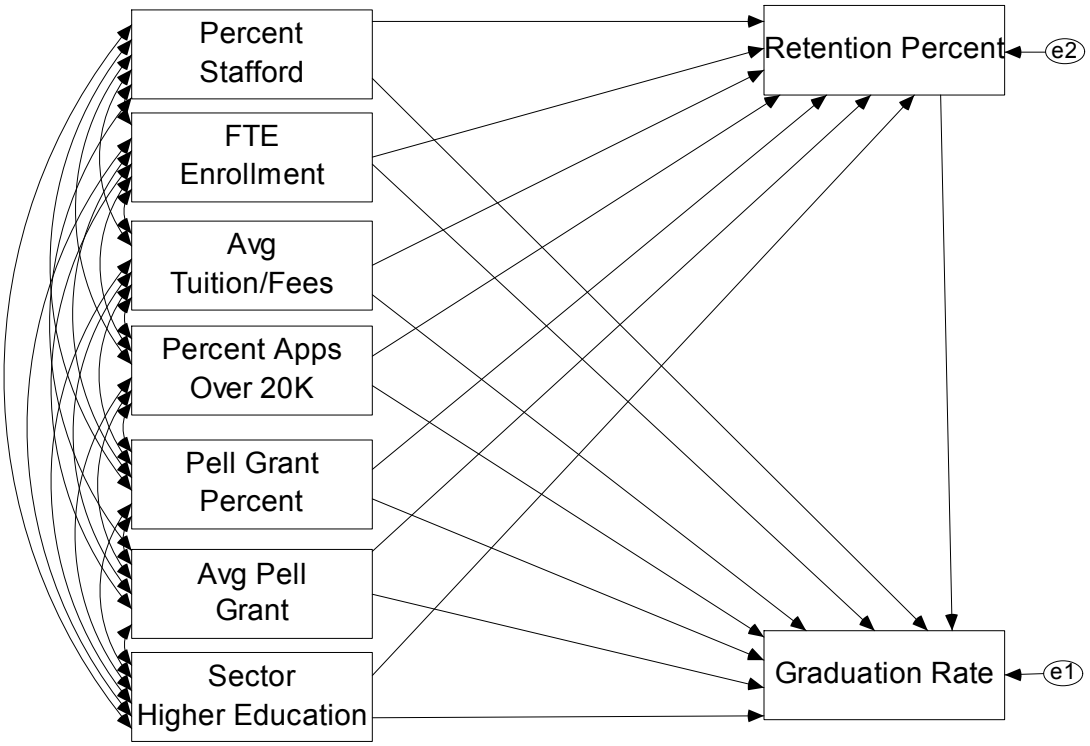
Variables in the analysis:

Variable descriptions follow.

Variable Label	Description
Graduation Rate	Graduation rate The percentage of degree-seeking full-time freshmen who completed a degree at the institution (BA within 6 years or AA within 3 years).
Percent Stafford	Stafford Loans - Subsidized loans: Percent of aid applicants (2003-04): Percent of federal aid applicants who borrowed Stafford subsidized loans.
Percent Apps Over $20K	Aid applicants (percentages): Percent independent over $20,000 Percent of independent undergraduate aid applicants whose income was over $20,000.
Avg Pell Grant	Pell grant average amount Average Pell grant amount received
Pell Grant Percent	Pell grants: Percent of 12-month enrollments The number of Pell grants in 2003-04 as a percentage of the total 12-month undergraduate enrollments.
Avg Tuition/Fees	Tuition and fees average per FTE Average tuition and fees revenue per Full-Time Equivalent undergraduate.
Retention Percent	Full-time freshman retention rate The percentage of degree-seeking full-time freshmen who return and are enrolled at the same school in the next year.
FTE Enrollment	Enrollments – Full-time equivalent students Estimated number of Full-Time Equivalent (FTE) undergraduates enrolled.
Sector Higher Education	Institution sector For purposes of this analysis the data is recast as a dummy variable: 1= four year institution, 0 = a two-year institution.

Path Analysis Model

A *"recursive path analysis model"* was constructed to provide a means to test the hypotheses and to visually interpret the results. The model follows:



Null Hypotheses:

This analysis tests the following eight null hypotheses associated with the direct effects of seven exogenous variables and one endogenous variable (Retention Rate) on Graduation Rate**:**

1. H_o: Graduation Rate is not related to percent of federal aid applicants who borrowed Stafford subsidized loans in 2003-04.

2. H_o: Graduation Rate is not related to full-time freshman retention rate.

3. H_o: Graduation Rate is not related to full time equivalent students.

4. H_o: Graduation Rate is not related to percent of <u>independent</u> undergraduate aid applicants in 2003-04 whose income was over $20,000.

5. H_o: Graduation Rate is not related to average Pell grant amount.

6. H_o: Graduation Rate is not related to the number of Pell grants as a percentage of the total 12-month undergraduate enrollment.

7. H_o: Graduation Rate is not related to average tuition and fees revenue per full-time equivalent undergraduates.

8. H_o: Graduation Rate is not related to the type of institution (four-year vs. two-year).

Likewise, the analysis tests the following null hypotheses associated with the direct effects of seven exogenous variables on Retention Percent:

9. H_o: Retention Percent is not related to percent of federal aid applicants who borrowed Stafford subsidized loans in 2003-04.

10. H_o: Retention Percent is not related to full time equivalent students.

11. H_o: Retention Percent is not related to percent of independent undergraduate aid applicants in 2003-04 whose income was over $20,000.

12. H_o: Retention Percent is not related to average Pell grant amount received.

13. H_o: Retention Percent is not related to the number of Pell grants as a percentage of the total 12-month undergraduate enrollment.

14. H_o: Retention Percent is not related to average tuition and fees revenue per full-time equivalent undergraduates.

15. H_o: Retention Percent is not related to the type of institution (four-year vs. two-year).

As Retention Percent mediates the effects of the exogenous variables on Graduation rate, the direct, indirect and total effects of the exogenous variables on Graduation Rate will be identified and analyzed.

In addition, the path model will be tested to determine if the data fit the model.

16. The null hypothesis (H_o) being tested is that the postulated model holds in the population. *"In contrast to traditional statistical procedures the researcher hopes not to reject H_o."* (Byrne, 2001:78)

Statistical Technique

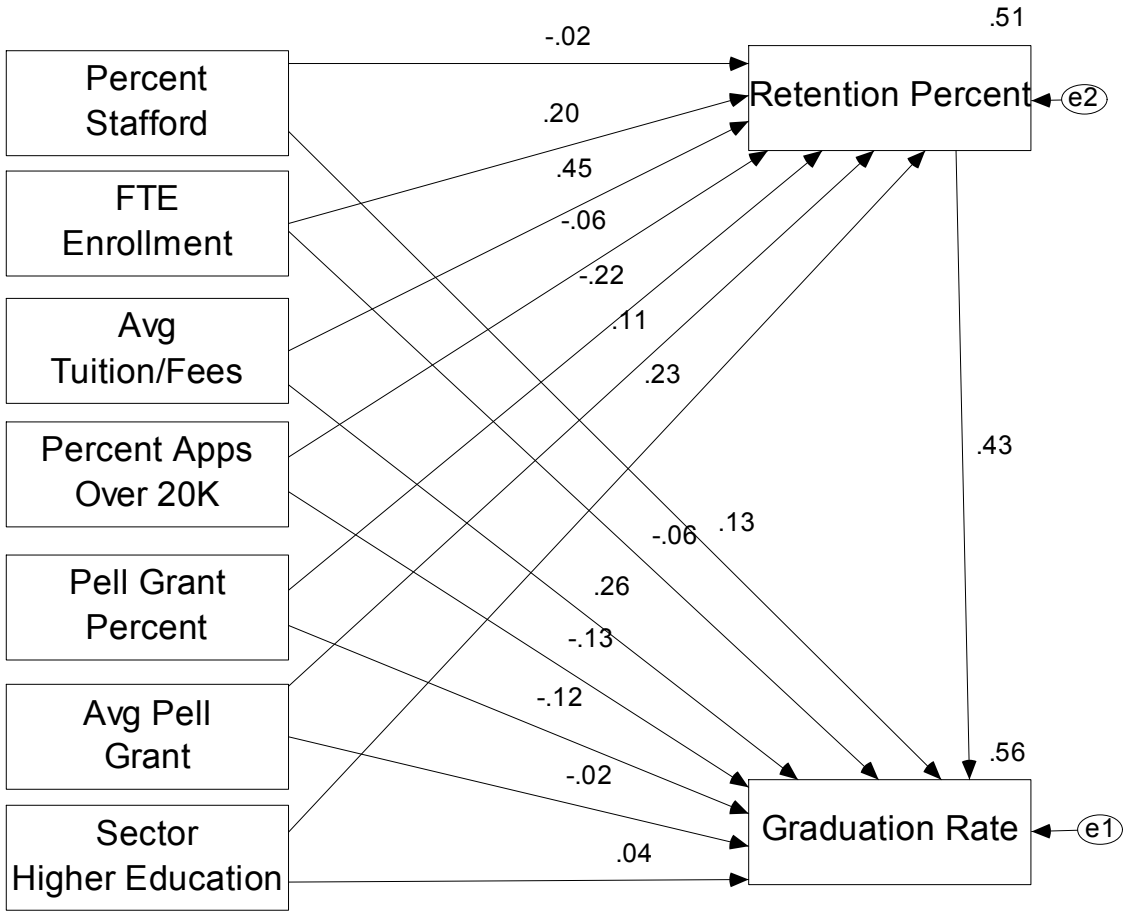
Multiple regression employing maximum likelihood estimation and path analysis techniques were utilized to:

- Test the null hypotheses and the model.
- Determine the amount of variance in Retention Percent and Graduation Rate explained by the model; and
- Develop a parsimonious model for the endogenous variables.

AMOS, version 6, was utilized as the statistical program.

Findings

The results of the initial analysis of the model are depicted below. (Correlation metrics among the exogenous variables are not shown for purposes of clarity.)



As this model is fully saturated the probability level for the model cannot be computed (Joreskog, 1993). As such, the initial analysis will

focus on the parameter estimates and their probabilities. The full model maximum likelihood estimates for the regression coefficients for the endogenous variable Graduation Rate are presented below in Table 1.

Table 1 **Regression Weights on Endogenous Variable Graduation Rate**	**Estimate**	**S.E.**	**C.R.**	**P**
Percent Stafford	.109	.021	5.125	***
Retention Percent	.664	.035	18.825	***
FTE Enrollment	.000	.000	-3.937	***
Avg Tuition/Fees	.001	.000	11.168	***
Percent Apps Over $20K	-.174	.023	-7.471	***
Avg Pell Grant	-.002	.001	-1.231	.218
Pell Grant Percent	-.180	.029	-6.291	***
Sector Higher Education	2.040	1.163	1.754	.079

*** P<.001

It is readily apparent that the direct effects of two variables on Graduation Rate are not statistically significant:

1. Sector Higher Education, a dummy variable specifying type of institution (four-year vs. two-year institutions.) This is an important finding. Sector Higher Education does not directly predict graduation rates. (However, later we shall see that Sector of Higher Education does impact graduation rates through the mediating variable Retention.)

2. Avg Pell Grant. This represents another important structural finding. The average size of Pell Grants, all other variables held constant, does not directly impact graduation rates. (However, as we shall see later, Avg Pell Grant does impact graduation rates through the mediating variable Retention.)

As the above two variables are not statistically significant, the paths from Sector and Avg Pell Grant to Graduation Rate are constrained to equal zero.

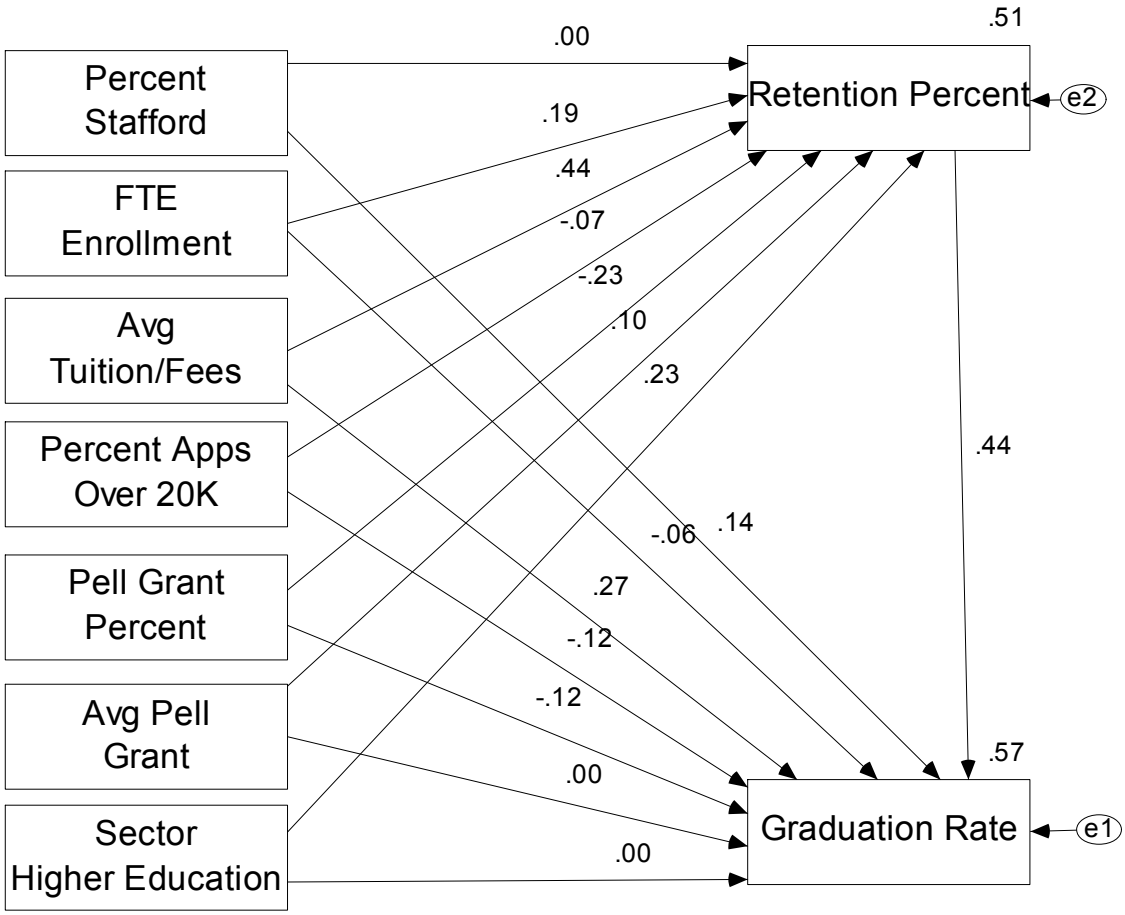
The maximum likelihood estimates for the regression coefficients for the endogenous variable Retention Percent are presented below in Table 2.

Table 2 **Regression Weights on Endogenous Variable Retention Percent**	**Estimate**	**S.E.**	**C.R.**	**P**
Percent Stafford	-.012	.018	-.697	.486
FTE Enrollment	.001	.000	10.046	***
Avg Tuition/Fees	.001	.000	16.531	***
Percent Apps Over $20K	-.051	.020	-2.626	***
Avg Pell Grant	.004	.001	4.307	***
Pell Grant Percent	-.213	.023	-9.236	***
Sector Higher Education	6.996	.958	7.300	***

One exogenous variable, Percent Stafford, is not significant and therefore its path to Retention Percent is set to zero.

Parsimonious Model

A parsimonious model with the above mentioned constraints was developed and is presented below. Constraining the model's paths provides an opportunity to test the fit of the entire model to the data. (Interested readers are referred to Byrne (2201), Duncan (1975), and Joreskog, (1975).



Variance Explained and Goodness of Fit

R-squared values, the amount of variance explained for the endogenous variables, are relatively high, as revealed in Table 3:

Table 3 **R-square**	**Estimate**
Graduation Rate	.567
Retention Percent	.505

Fifty-seven percent of the observed variance in graduation rates among US colleges and universities is accounted for by the combined influence of the six variables in the parsimonious model. Fifty-one percent of the observed variance in Retention Percent is explained by six exogenous variables. Structural differences between institutions of higher education explain a significant amount of the observed variation in both retention and graduation rates.

Table 4 depicts the chi-square for the parsimonious model equal to 3.716 with 3 df and p=.234, indicating that we cannot reject H_o. The model holds for the population.

Table 4 **Model Comparisons**	**NPAR**	**CMIN**	**DF**	**P**	**CMIN/DF**
Full Model	54	.000	0		
Parsimonious Model Goodness of Fit: RMSEA = .009; TLI rho2 = .999 RFI rho1 = .994; CFI = 1.0	51	3.716	3	.234	1.239

Examining *"goodness of fit"* statistics in Table 4 also provides confidence that the model fits the data. RMSEA is very low at .009 and CFI =1.0. This data signals that the parsimonious model fits the data.

Parameter Estimates

The full model maximum likelihood estimates for the regression coefficients for the endogenous variable Graduation Rate and Retention Percent are presented in Tables 5 and 6.

Table 5 **Parsimonious Model** **Regression Weights on Endogenous Variable, Graduation Rate**	**Estimate**	**S.E.**	**Standardized Estimate (Betas)**	**C.R.**	**P**
Percent Stafford	.126	.017		7.194	
Retention Percent	.672	.034	.437	19.987	***
FTE Enrollment	.000	.000	-.057	-3.692	***
Avg Tuition/Fees	.001	.000	.271	11.903	***
Percent Apps Over $20K	-.160	.021	-.118	-7.647	***
Avg Pell Grant	.000		.000		
Pell Grant Percent	-.180	.026	-.121	-6.802	***
Sector Higher Education	.000		.000		

Table 6 Parsimonious Model Regression Weights on Endogenous Variable, Retention Percent	**Estimate**	**S.E.**	**Standardized Estimate (Betas)**	**C.R.**	**P**
Percent Stafford	.000				
FTE Enrollment	.001	.000	.194	9.970	***
Avg Tuition/Fees	.001	.000	.437	17.140	***
Percent Apps Over $20K	-.058	.019	-.066	-3.068	***
Avg Pell Grant	.004	.001	.099	4.007	***
Pell Grant Percent	-.220	.022	-.228	-10.164	***
Sector Higher Education	6.988	.792	.232	8.828	***

Decomposition of Effects

Total Effects: Graduation Rate

Lewis-Beck (1974) observed that using total effect coefficients to measure the relative importance of variables in a path model can alter the relative ranking of the variables when contrasted with the assessment of the variables with one based on beta coefficients in a multiple regression equation. As such, an analysis of total, direct and indirect effects (Alwin and Hauser, 1975; Wright, 1921; 1934; Kenny, 1979); and Duncan, 1975) will be undertaken.

As the variables are measured in different metrics the standardized total effects (betas) for each predictor variable on the endogenous variables are presented below and throughout this analysis.

Table 7 Total Effects	FTE Enrollment	Sector Higher Education	Avg Pell Grant	Percent Apps Over $20K	Percent Stafford	Pell Grant Percent	Avg Tuition/ Fees	Retention Percent
Retention Percent	.194	.232	.099	-.228	.000	-.066	.437	.000
Graduation Rate	.028	.101	.043	-.221	.144	-.146	.462	.437

In order of magnitude the top three variables that have the greatest total effect on Graduation Rate are Avg Tuition/Fees (.462), Retention Percent (.437), and Percent Apps Over $20K (-.221). Higher cost institutions that retain a high percentage of their freshman class and

have proportionately fewer independent financial aid applicants with assets over $20,000 enjoy higher graduation rates. Retention Percent and Avg Tuition/Fees each have twice the impact on Graduation Rate compared to the impact of Percent Apps Over $20K.

More modest total effects are observed for Pell Grant Percent (-.146), Percent Stafford (.144), and Sector Higher Education (.101). As the percentage of Pell grant recipients increases the lower the graduation rates, but as the percent of financial aid applicants who borrow from the Stafford loan program increases, graduation rates are elevated.

It could very well be that the percent of Pell Grant Percent variable is a proxy for socio-economic status (SES), which has a well documented research base revealing an inverse relationship to graduation rates. Avg Pell Grant (.043), on the other hand, has a much more modest and direct total impact. Nonetheless, the percent of total students who receive Pell grants has over three times the impact on graduation rates than the average Pell grant received. Size of the institution, as operationalized by FTE Enrollment (.028), has the least total effect on Graduation Rate.

Total Effects: Retention Percent

Table 6 reveals the top three variables that have the greatest total effect on Retention Percent: Avg Tuition/Fees (.437), Sector of Higher Education (.232), followed very closely by Percent Apps Over $20K (-.228). Four-year institutions with higher than average tuition and fees with proportionately fewer independent financial aid applicants with assets over $20,000 enjoy higher retention rates than two-year institutions with lower average tuition/fees and proportionately higher independent financial aid applicants with assets over $20,000.

All other things equal, higher tuition and fees have nearly twice as much impact on retention rates as the choice to attend a four-year versus a two-year institution. Independent students with assets over $20,000 do not persist as desired. Size of the institution is directly related to retention as is average Pell grant. The two Pell grant variables – Avg Pell Grant (.099) and Pell Grant Percent (-.066) – have more modest total effects and work in opposite directions in impacting Retention Percent, emulating the same pattern as was found for their total effects on Graduation Rate.

Decomposition of Direct and Indirect Effects on Graduation Rate

Table 6 depicts the total, direct and indirect effects of all variables in the parsimonious model of Graduation Rate.

Table 8 Effects on Graduation Rate	FTE Enrollment	Sector Higher Education	Avg Pell Grant	Percent Apps Over $20K	Percent Stafford	Pell Grant Percent	Avg Tuition/ Fees	Retention Percent
Total Effects	.028	.101	.043	-.221	.144	-.146	.462	.437
Direct Effects	-.057	.000	.000	-.121	.144	-.118	.271	.437
Indirect Effects	.085	.101	.043	-.099	.000	-.029	.191	.000

Of particular interest in the path model is the mediating effect Retention Percent has on Graduation Rate. Sector Higher Education has a total effect of .101 on Graduation Rate. All of its impact is transmitted through Retention Percent. (Recall Sector Higher Education was earlier determined to not have a significant direct effect on Graduation Rate. As such, its direct path was constrained to zero.) A similar pattern exists for the impact of Avg Pell Grant on Graduation Rate. Again, 100 percent of its impact is transmitted through the mediating variable, Retention Percent.

Other important effects of the exogenous variables mediated by Retention Percent on Graduation rate are found in analyzing the indirect effects of Percent Apps Over $20K and Avg Tuition/Fees. In both cases over 40 percent of their total effect on Graduation Rate are transmitted through Retention Percent. Nearly 20 percent of the total effect of Pell Grant Percent is transmitted through Retention Percent.

The role of FTE Enrollment on Graduation Rate is interesting because its direct path to Graduation Rate (-.06) reveals an inverse relationship between size of the institution and graduation rates, a finding consistent with the literature review. However, the effect of FTE Enrollment through the mediating variable, Retention Percent, reverses our interpretation of the effect of institutional size on graduation rates. FTE Enrollment has a modest direct effect with Retention Percent (.19) and, in turn, Retention Percent has a strong direct impact on Graduation Rate (.44). This mediating path offsets the direct path's impact on Graduation Rate.

Conclusion

We developed a model of retention and graduation rates and analyzed it on three different levels:

1) The amount of variance accounted for by the model. Overall, we are quite satisfied that the model explains 57 percent of the observed variation in graduation rates, as well as 51 percent of the observed variation in retention rates.
2) Variable parameters were tested against a series of null hypotheses to develop a parsimonious model and to asses the total, direct and indirect effects of each predictor variable on the endogenous variable.
3) The parsimonious model fits the data very well with very good measures of fit. We are confident that the model holds for the population.

Structural characteristics of American colleges, at two and four-year institutions, significantly impact college retention and graduation rates. The path analysis model revealed that graduation rates are regulated by both exogenous variables and significantly by the endogenous variable retention.

The exogenous variables in this analysis

- Percent Stafford
- Percent Apps Over $20K
- Avg Pell Grant
- Pell Grant Percent
- Avg Tuition/Fees
- FTE Enrollment
- Sector Higher Education

are independent, external inputs into the system and as such have the property that they only cause the endogenous variable but not vice versa. These exogenous variables may be thought as the sources of change. Thus, if one desires from purely a structural point of view to improve retention and graduation rates then one could develop strategies to manipulate these structural change agents to maximize desired retention and graduation rates. An example follows.

We have observed that the sector of higher education (two versus four-year colleges) does not have a direct impact on graduation rates. It is only through the mediating effect of retention does sector of higher education have an impact on graduation rates. Therefore, community colleges desiring to improve their graduation rates would be well advised to develop strategies that improve the percentage of degree-seeking full-time freshmen who return and are enrolled at the same school in the next year.

We concluded our review of the literature with Titus' (2003) claim that structural differences between institutions may be as important to college persistence as differences in individual students' experiences and commitments. We end this analysis with the observation that Titus may well be right.

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