An efficiency analysis of U.S. business schools

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Abstract

In the current economic climate, business schools face crucial decisions. As resources become scarcer, schools must either streamline operations or limit them. An efficiency analysis of U.S. business schools is presented that computes, for each business school, an overall efficiency score and provides separate factor efficiency scores, indicating the extent to which the school can reduce each resource and increase each output. Using data envelopment analysis and AACSB data, the model rates the managerial performance of 438 U.S. business schools. For 21.5% of the schools, the analysis finds no evidence that they can improve their performance. For each remaining school, the analysis identifies the extent to which it can improve its overall efficiency and its efficiency within specific areas. The results are useful to business schools in developing long-term strategic plans, making resource allocation decisions, preparing for AACSB accreditation review, and improving overall performance.

Keywords: Business schools, efficiency, Data Envelopment Analysis, AACSB, strategic planning.

Introduction

In the current economic climate, all organizations – universities and business schools among them – face crucial decisions. As resources become scarcer, educational organizations must either streamline their operations or limit them and put their missions at risk. This paper presents an efficiency analysis of U.S. business schools that computes, for each business school, an overall efficiency score. The analysis also provides separate factor efficiency scores that indicate the extent to which the school can reduce its use of each of resource (money, faculty, and staff) and increase its production of each of output (program enrollments and endowment).

Note that the model produces efficiency scores, not performance rankings of the type published by *Business Week*, *U.S. News and World Report*, *Forbes*, and the *Wall Street Journal*. These business school rankings, as currently devised, provide little or no guidance to deans and other administrators who seek to improve efficiency.

Moreover, the model measures efficiency, not effectiveness, which are considered two separate components of organizational performance. Effectiveness is the extent to which the business school achieves its stated goals, while efficiency is a measure of the degree to which the business school maximizes outputs while minimizing inputs. The model does not consider the mission of the business school, only how much the school might increase its outputs and decrease it inputs.

The model is an internal management improvement tool for business school deans and other administrators at universities that have business schools. The efficiency scores produced by the model are of fundamental importance in assessing the business school for accreditation review, developing long-term strategic plans, making wise resource allocation decisions, and seeking to improve the overall performance of the business school. In addition, prospective donors may be interested in knowing how efficiently the school's administrators allocate its limited resources. Moreover, other providers of financial support, such as state and federal government agencies, benefit from efficiently run schools that keep total salary under control. Finally, students (or their parents or employers) who pay tuition benefit to the extent that inefficiency can drive up tuition.

The next section describes the efficiency model, with particular attention to Data Envelopment Analysis (DEA), the methodology upon which the model is based. Then follows a description of how the efficiency model is applied to 438 U.S. business schools. The paper concludes with a description of the data and results, and finally a discussion of the findings.

Methodology and Application

DEA Methodology

DEA is a linear programming-based methodology that has proven to be a successful tool in efficiency measurement. It is particularly well suited for efficiency evaluation when the organization's efficiency is measured along multiple dimensions. When linked with an adjustment process that accounts for the organization's operating conditions, DEA will produce efficiency scores that neither reward organizations that are fortunate enough to operate under favorable conditions nor penalize those that operate under unfavorable conditions.

DEA differs from other types of efficiency measurement, such as regression analysis or stochastic frontier analysis, in that it is a nonparametric approach. DEA empirically identifies the best organizations by forming the efficient frontier based on observed indicators from all organizations. Organizations are referred to as *decision-making units* (DMUs). Consequently, DEA bases the resulting efficiency scores and potential efficiency improvements entirely on the actual performance of other DMUs, free of any questionable assumptions regarding the mathematical form of the underlying production function. Instead, DEA simply assumes that any weighted average of observed DMUs is feasible. This means that the efficient frontier formed by DEA will be a conservative estimate of the true production function in the sense that a DMU will not need to change as much to reach the DEA efficient frontier as it would to reach the true production function. On the other hand, DEA is an extreme point method and therefore is sensitive to unusual observations or large data errors. On balance, many analysts view DEA as preferable to other forms of efficiency measurement.

The mathematical development of DEA traces to Charnes et al. (1981) who built on the work of Farrell (1957) and others. The procedure has been applied in such diverse fields as health care (Sherman 1984, Nunamaker 1983, Sexton *et al*. 1989), education (Bessent *et al*. 1982), electricity production (Färe and Primont 1984), criminal justice (Lewin *et al*. 1982), recreation (Rhodes 1982), strip mining (Byrnes *et al*. 1984), and public financing for pupil transportation (Sexton *et al*. 1994). The technique is well documented in the management science literature (Charnes *et al*. 1979, Forsund *et al*. 1980, Sexton 1986, Sexton *et al*. 1986), and it has received increasing attention as researchers have wrestled with problems of efficiency measurement, especially in the services and nonmarket sectors of the economy. Anderson (2004) and Emrouznejad (2004) have each provided a web site with extensive bibliographies of over 1000 articles that document the theoretical development of DEA and its broad range of application. Tavares (2002) provides a comprehensive bibliography of the DEA literature.

Application of DEA to Business Schools

In the present analysis, the DMUs are business schools whose efficiency are measured using 11 indicators. The indicators are categorized into two groups, inputs and outputs. For example, the school's budget is an input since money is clearly a resource that the school requires to operate. Similarly, the school's undergraduate enrollment is an output since the school expends some of its resources for educating undergraduate students. Table 1 shows the inputs and outputs in the model.

*** Table 1 here ***

Using these inputs and outputs, the DEA model identifies those schools whose performance cannot be exceeded by any weighted average of other schools. Such schools define the *efficient frontier*. For those schools not on the frontier, the model identifies a target school that maximally outperforms the given school across all indicators. Specifically, for each input,

$$\text{Input at target school} \leq \text{Input at the given school}$$

and, for each output,

$$\text{Output at target school} \geq \text{Output at the given school.}$$

The target school is a hypothetical school whose indicators are weighted averages of schools on the efficient frontier. Consider Figure 1, which presents a very simple model with only one input (number of faculty) and only one output (total enrollment). Schools A through E are on the efficient frontier because there is no school, or weighted average of schools, that lies both above and to the left of any of these schools. Now consider School F, which has 35 faculty members and 1240 students. School C lies both above and to the left of School F, meaning that School C employs fewer faculty members (30) and has higher total enrollment (1800). Thus, School C is one possible target school for School F.

*** Figure 1 here ***

However, suppose that School F were interested in increasing its enrollment without reducing its number of faculty. Then it would choose its target school as the point on the frontier that lies directly above it, corresponding to 35 faculty members and 2000 students. This point is School F's output-oriented target school. While there is no school located at that point, one can imagine a hypothetical school at that location that is a weighted average of Schools C and D. A fundamental assumption of DEA is that it is possible for a school to operate with indicators that are the weighted average of any number of schools, and therefore this point would be a feasible target school for School F.

Similarly, suppose that School F were interested in decreasing its faculty without increasing its enrollment. Then it would choose its target school as the point on the frontier that lies directly to its left, corresponding to 22 faculty members and 1240 students. This point is School F's input-oriented target school. Again, while there is no school located at that point, one can imagine a hypothetical school at that location that is a weighted average of Schools B and C.

In fact, School F could choose its target school anywhere on the section of the frontier that lies between the output-oriented target school and the input-oriented target school. One possible orientation, called the *hyperbolic orientation* (Färe 1985, Färe 1994, Chavas 1999), corresponds to the curve in Figure 1 that passes through School F. It produces a target school that has 27.1 faculty members and 1600 students. One difficulty with the hyperbolic orientation is that it requires the solution of one nonlinear optimization problem for each school. Relative to a linear model, a nonlinear model requires greater computation time, may lead to convergence difficulties, and provides considerably less sensitivity information. Pitocco and Sexton (2005) introduced a second orientation that is a linear approximation to the hyperbolic orientation. Called the *H1 orientation*, it corresponds to the line that is tangent to the curve at School F. It produces a target school that has 26.4 faculty members and 1546 students. The H1 orientation has the property that it produces a target school whose percentage increase in enrollment equals the percentage decrease in faculty. In this example, the target school under the H1 orientation has 24.7% fewer faculty and 24.7% higher enrollment relative to School F. The present analysis uses the H1 orientation.

Adjusting for Site Characteristics

The efficiencies produced by the model do not account for site characteristics, which are attributes of the business school's environment that may influence its efficiency but that are not under the control of the business school. For example, a business school cannot control its community type (urban, suburban, or rural), determine whether the university is public or private, or set its own tuition (in almost all cases). However, if these site characteristics affect the business school's efficiency, it is important to remove this effect from the evaluation to ensure that the results are unbiased. Table 2 shows the site characteristics in the present analysis.

*** Table 2 here ***

Discretionary Factors

Finally, consider a set of discretionary factors, which are attributes of the DMU's environment that may influence its efficiency but that are completely or partially under the control of the DMU. For example, a business school has partial control over whether it has AACSB accreditation or whether it has its own undergraduate advising office. Using several multivariate models, one for the adjusted across-the-board efficiency measure, and one for each of the adjusted factor efficiency measures, one can to identify those discretionary factors that are associated with the efficiency of the DMUs. Table 3 shows the discretionary factors in the present analysis.

*** Table 3 here ***

Data

All the data for required for the model was acquired from the Association to Advance Collegiate Schools of Business (AACSB) for 2005-06 academic year. Part-time students are converted to full-time equivalent students using Integrated Postsecondary Education Data System (IPEDS) (National Center for Education Statistics 2007) conversion factors.

All non-US business schools and one US school business school are omitted from the analysis due to missing budget data. Three additional schools are omitted because to the absence of enrollment data. Finally, six other schools that showed enrollment equal to zero in all programs are dropped. The final data set includes n = 438 business schools.

Note that these data are self-reported by the institutions. Thus, the accuracy of the data cannot be confirmed. However, there is little reason to believe that business schools would misrepresent themselves in the AACSB database.

Results and Discussion

The detailed results for each of the 438 business schools is available from the authors upon request. The analysis shows 94 business schools (21.5%) are on the efficient frontier. For these schools, there is no evidence that they can simultaneously reduce all inputs and increase all outputs.

Table 4 shows the summary statistics for the across-the-board efficiency measures, including those on the efficient frontier. Note that, on average, business schools can reduce inputs and increase outputs by approximately 20% across the board.

*** Table 4 here ***

Table 5 shows the summary statistics for the factor efficiencies. In this table, one should focus on the medians since there is some evidence of skewness, most notably in Endowment, Specialized Masters Enrollment, MBA Enrollment, and EMBA Enrollment. Observe that, on average, business schools can reduce individual inputs by between approximately 20% and 30%. The same percentage range applies to all the outputs except for EMBA Enrollment and Doctoral Enrollment, for which the median percentage increases are 6.8% and 4.4%, respectively.

There are two possible explanations for these better factor efficiency scores. First, observe that notably fewer schools report positive EMBA Enrollment or Doctoral Enrollment. This can lead to relatively better factor evaluations for these outputs. For example, assume that hypothetical School X enrolls doctoral students. The reference set for School X, i.e., the schools upon which School X places a positive weight, must include at least one school on the efficient frontier that also enrolls doctoral students. Because there are relatively few schools that enroll doctoral students, there are relatively few possible reference sets for School X, and therefore School X may receive a relatively better factor efficiency score for this output. Second, both the EMBA and doctoral programs are often high visibility offerings closely tied to the business school's reputation. Thus, schools may manage these programs more carefully, resulting in relatively better factor efficiency scores for these outputs.

*** Table 5 here ***

Table 6 shows the statistically significant (at the 5% level) coefficients of the site characteristics in the adjustment models for each input. Note that schools that operate on a semester basis have, on average, lower budgets, fewer full-time faculty members, and fewer staff and administrators relative to those schools that operate on a quarter system. Similarly, schools located in rural areas have, on average, smaller budgets, fewer part-time faculty members, and fewer staff and administrators relative to those schools located in either urban or suburban areas.

*** Table 6 here ***

Next, consider the analysis of discretionary factors. Table 7 shows the business school emphasis categories defined by AACSB and the frequency distribution of the 438 business schools by business unit emphasis. Note that nearly half of the schools are in category A, over 30% are in category E, and over 10% are in category B. These three categories, which comprise over 90% of the schools, all represent either high or medium emphasis on both teaching and intellectual contributions.

*** Table 7 here ***

Table 8 shows the scholarly emphasis categories defined by AACSB and the frequency distribution of the 438 business schools by scholarly emphasis. Categories A and B are most common, each with slightly more than 20% of the schools. These categories are quite dissimilar in that one represents a high emphasis on discipline-based scholarship while the other represents a low emphasis on discipline-based scholarship.

*** Table 8 here ***

Table 9 shows the signs of the statistically significant (at the 5% level) coefficients of the discretionary factors in the models for overall efficiency and the factor efficiencies of the inputs. Here, one should focus on the columns in Table 9 that have several (typically four or more) statistically significant coefficients as a way to identify systematic effects of the discretionary factors on overall efficiency and the factor efficiencies of the inputs. Observe that Scholarly Emphases I and E have negative and positive associations, respectively, with overall efficiency and with many of the inputs. However, note that in Table 8 there are only 8 schools in category I and 18 schools in category E. Therefore, these associations affect only 26 schools. However, Scholarly Emphasis A is positively associated with overall efficiency and with the factor efficiencies for Budget, Tenured/Tenure-Track Faculty, and Part-Time Faculty. Thus, schools that select category A have better factor efficiency scores, on average, in these areas relative to schools that select other scholarly emphasis categories.

*** Table 9 here ***

Schools that provide their own information technology support and those that provide their own graduate career services have, on average, better factor efficiency scores in several areas. Similarly, schools that provide their own undergraduate advising have, on average, worse factor efficiency scores in several areas.

Table 10 shows the signs of the statistically significant (5% level) coefficients of the discretionary factors in the models for the output factor efficiencies. There are no strong patterns, suggesting that none of the discretionary factors relates systematically to any of the outputs.

*** Table 10 here ***

Figure 2 presents the factor efficiencies at one school. This school has overall efficiency scores of $E_k = 0.996$ and $\theta_k = 1.004$, suggesting that the school is very close to the efficient frontier. These values tell us that the school can reduce all inputs and increase all outputs by at least 0.4%. However, the factor efficiency for tenured and tenure-track faculty is 0.489, meaning that the school can reduce this input by 51.1%. Similarly, the factor efficiency for non-tenure track faculty is 0.702 and that for budget is 0.751, meaning that the school can reduce these inputs by 29.8% and 24.9%, respectively. Similarly, the factor efficiency for endowment is 1.406, meaning that the school can increase this output by 40.6%. Thus, a careful examination of the factor efficiencies leads us to conclude that this school has four distinct areas for improvement, a conclusion one would overlook by simply reporting the across-the-board measures $E_k = 0.996$ and $\theta_k = 1.004$. This example illustrates the importance of the factor efficiency measures.

*** Figure 2 here ***

Conclusion

This paper provides a mathematical model that evaluates the efficiency of 438 U.S. business schools. The model identifies schools that are on the efficient frontier and, for schools that are not on the frontier, it identifies specific areas of improvement and the extent to which improvement is possible.

The analysis shows that 21.5% of business schools are on the efficient frontier, meaning that nearly 80% of U.S. business schools can improve the efficiency of their operations. While the extent of the possible improvement varies considerably across school, business schools can improve overall efficiency by roughly 20%, on average. Moreover, further improvements of roughly 10% are possible for each efficiency factor, with smaller amounts possible for EMBA and doctoral enrollments.

The model uses data that the AACSB collects annually. Therefore, repeated analysis will reveal efficiency trends both for individual schools and for the full set of business schools.

The model is an internal management improvement tool for business school deans and other administrators at universities that have business schools. Deans and administrators can examine which of their factor efficiency scores suggest the need for improvement and focus on corresponding improvement strategies. They can also compare their own results with those of other schools that they consider their peers or other schools that they aspire to emulate.

In addition, prospective donors may be interested in knowing how efficiently the school's administrators allocate its limited resources. Moreover, other providers of financial support, such as state and federal government agencies, benefit from efficiently run schools that keep total faculty salary under control. Finally, students (or their parents or employers) who pay tuition benefit to the extent that inefficiency can drive up tuition.

Note that the model excludes research as an output. It is very difficult to measure research output because it is highly varied (refereed journal articles, conference proceedings, professional presentations, books, and so forth) and because there is no centralized database containing these data. Even if there were, there would be considerable debate on the relative weights to be associated with each type of research production if one were to create a single research output. Alternatively, one could treat the different forms of research production as separate outputs, but because there are so many forms, this would lead to inflated efficiency scores, a natural by-product of increasing the number of inputs or outputs. Even then, if one could solve these problems, the analyst would still have no commonly accepted measure of research quality that applies across all types of research. Therefore, one must recognize that a school that performs more research than another, or higher quality research than another, will not "get credit" for it in the present efficiency evaluation. These difficulties, and the incorporation of professional and community service outputs, are areas of future research.

Thus, the efficiency evaluations in this paper apply only to the teaching mission of the schools. Moreover, recognize that the present evaluation does not credit a school with a deliberately high faculty-to-student ratio that keeps class sizes small and enhances faculty/student interactions. Such schools may well provide a higher quality of education, but this approach will lead to lower efficiency scores. Finally, recall that the efficiency ratings produced by this model are distinct from the business school rankings that are common in the media. While a business school may improve its rankings by polishing its image, only substantive change can improve its efficiency.

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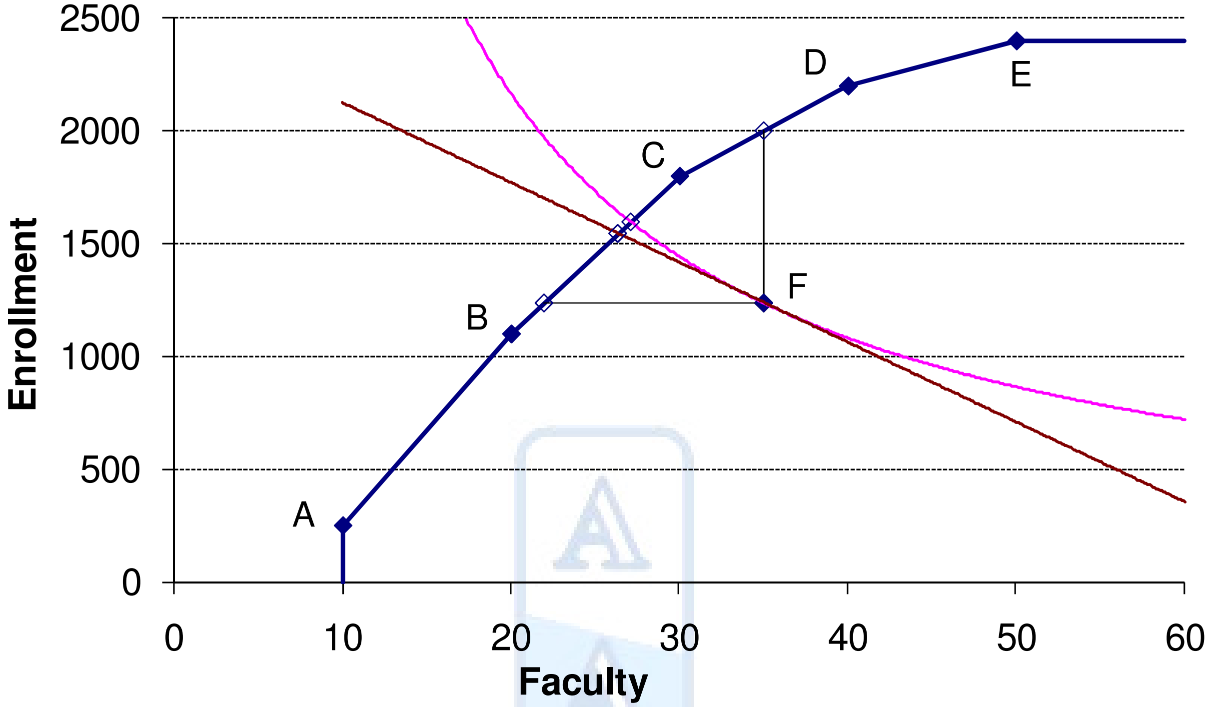

Figure 1: The efficient frontier for the example.

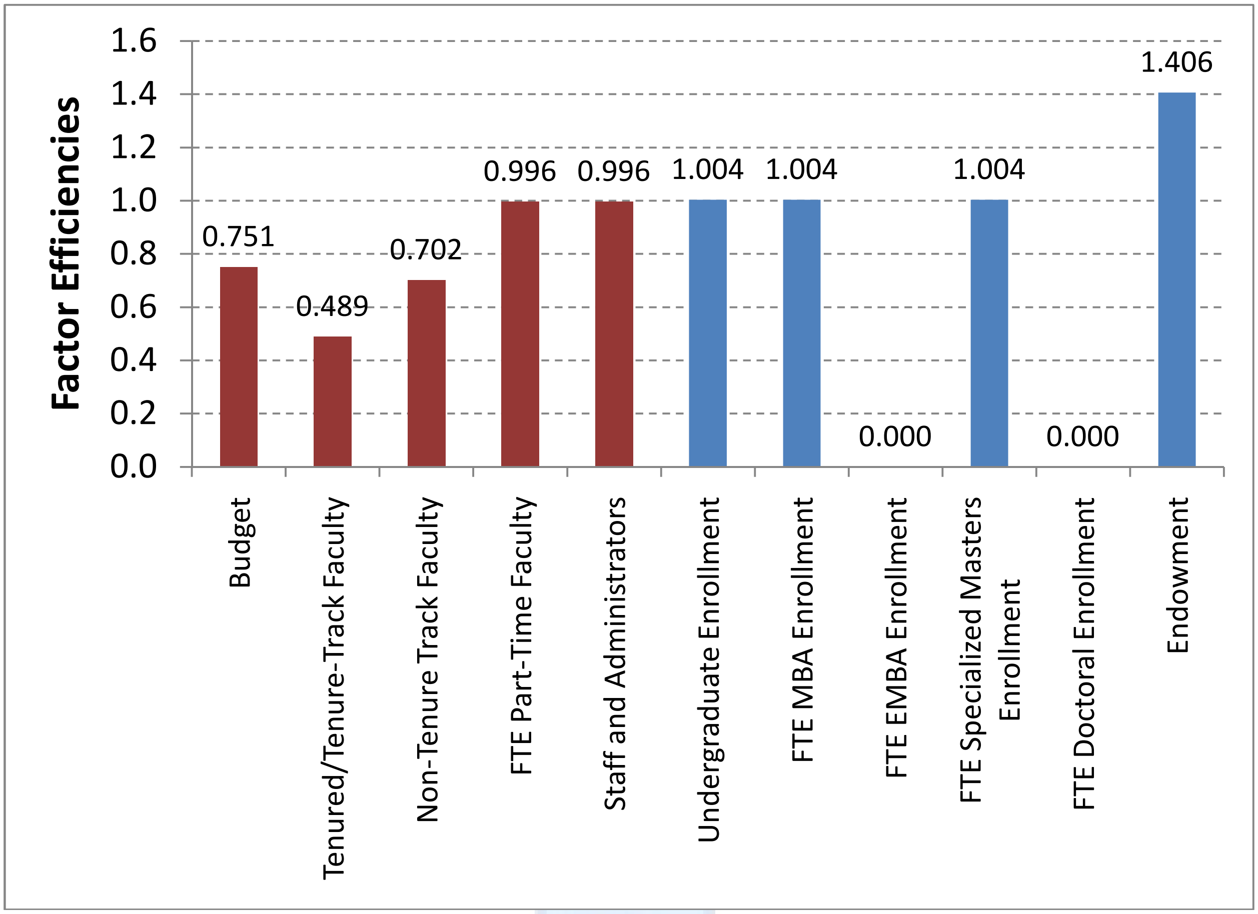

Figure 2: The factor efficiencies at one school.

Inputs	Outputs
Budget	Undergraduate Enrollment
Tenured/Tenure-Track Faculty	FTE MBA Enrollment
Non-Tenure Track Faculty	FTE EMBA Enrollment
FTE Part-Time Faculty	FTE Specialized Masters Enrollment
Staff and Administrators	FTE Doctoral Enrollment
	Endowment

Table 1: The inputs and outputs in the business school model.

Site Characteristics (SC)
Community (urban/suburban/rural)
Undergraduate type (commuter vs. residential)
Graduate type (commuter vs. residential)
School type (public vs. private)
Hour basis (semester vs. quarter)
Undergraduate annual in-state tuition and fees ($)
Undergraduate annual out-of-state tuition and fees ($)
MBA total program tuition and fees in-state ($)
MBA total program tuition and fees out-of-state ($)

Table 2: The site characteristics in the business school model.

Discretionary Factors (DF)
AACSB business accreditation (binary)
AACSB accounting accreditation (binary)
EQUIS accreditation (binary)
AMBA accreditation (binary)
ACBSP accreditation (binary)
Other accreditation (binary)
Non-degree programs (binary)
Business unit emphasis (A-G)
Scholarship emphasis (A-M)
Business building (binary)
Business library (binary)
Undergraduate career services (binary)
Graduate career services (binary)
Undergraduate admissions (binary)
Graduate admissions (binary)
Development (binary)
Communications (binary)
Alumni relations (binary)
Undergraduate advising (binary)
Graduate advising (binary)
Information technology support (binary)
Research center (binary)
Assistance center (binary)
Executive education (binary)
Proportion of participating faculty academically qualified
Proportion of participating faculty professionally qualified
Proportion of supporting faculty academically qualified
Proportion of supporting faculty professionally qualified

Table 3: The discretionary factors in the business school model.

	θ	E
Mean	1.203	0.797
Median	1.189	0.811
Standard Deviation	0.170	0.170
Lower Quartile	1.032	0.666
Upper Quartile	1.334	0.968

Table 4: Summary statistics for the across-the-board efficiency measures.

Input	n	**Mean**	**Median**	**SD**
Budget	438	0.732	0.726	0.208
Tenured/Tenure-Track Faculty	435	0.739	0.708	0.185
Non-Tenure Track Faculty	414	0.744	0.755	0.203
FTE Part-Time Faculty	419	0.778	0.795	0.182
Staff and Administrators	437	0.734	0.758	0.227
Output	n	**Mean**	**Median**	**SD**
Undergraduate Enrollment	422	1.225	1.209	0.204
FTE MBA Enrollment	287	1.489	1.212	1.117
FTE EMBA Enrollment	92	1.298	1.068	0.596
FTE Specialized Masters Enrollment	218	1.612	1.222	1.254
FTE Doctoral Enrollment	103	1.138	1.044	0.311
Endowment	372	4.186	1.250	25.878

Table 5: Summary statistics for the factor efficiencies.

Input	Semester	Rural	Public	UG Comm	Grad Comm
Budget	-0.38665	-0.34117		-0.20348	
Tenured/Tenure-Track Faculty	-0.27664				
Non-Tenure Track Faculty	-0.45359				
FTE Part-Time Faculty		-0.33268	-0.20018		0.24363
Staff and Administrators	-0.35303	-0.32481			

Table 6: Statistically significant coefficients (at the 5% level) of the site characteristics in the adjustment models for the inputs.

Code	High Emphasis	Medium Emphasis	Low Emphasis	Freq	Percent
A	Teaching	Intellectual Contributions	Service	217	49.5
B	Intellectual Contributions	Teaching	Service	49	11.2
C	Teaching	Service	Intellectual Contributions	4	0.9
D	Intellectual Contributions	Service	Teaching	0	0.0
E	Equal for Teaching and Intellectual Contributions		Service	135	30.8
F	Teaching	Equal for Intellectual Contributions and Service		26	5.9
G	Equal for Teaching, Intellectual Contributions, and Service			7	1.6
			Totals	438	100.0

Table 7: The business school emphasis categories defined by AACSB and the frequency distribution of the 438 business schools.

Code	High Emphasis	Medium Emphasis	Low Emphasis	Freq	Percent
A	Discipline-based	Practice	Pedagogical	94	21.5
B	Practice	Pedagogical	Discipline-based	93	22.2
C	Pedagogical	Discipline-based	Practice	3	0.7
D	Discipline-based	Pedagogical	Practice	22	5.0
E	Pedagogical	Practice	Discipline-based	18	4.1
F	Practice	Discipline-based	Pedagogical	27	6.2
G	Equal Emphasis on Discipline-Based and Practice		Pedagogical	64	14.6
H	Equal Emphasis on Practice and Pedagogical		Discipline-based	34	7.8
I	Equal Emphasis on Discipline-Based and Pedagogical		Practice	8	1.8
J	Pedagogical	Equal Emphasis on Discipline-Based and Practice		6	1.4
K	Discipline-based	Equal Emphasis on Practice and Pedagogical		20	4.6
L	Practice	Equal Emphasis on Discipline-Based and Pedagogical		19	4.3
M	Equal Emphasis on Discipline-based, Practice, and Pedagogical			30	6.8
			Totals	438	100.0

Table 8: The scholarly emphasis categories defined by AACSB and the frequency distribution of the 438 business schools.

	Business Unit Emphasis B	Scholarly Emphasis A	Scholarly Emphasis D	Scholarly Emphasis E	Scholarly Emphasis I	Business Building	Undergrad Advising	Undergrad Admissions	Graduate Admissions	Graduate Career Services	Information Technology Support	Research Center	Accounting Accreditation
Overall Efficiency	+	+		+	−	+	−				+		
Budget		+		+	−		−			+	+		
Tenured/Tenure-Track Faculty		+	+	+	−		−	+	−	+	+		
Non-Tenure Track Faculty	+				−				−	+	+	+	
FTE Part-Time Faculty		+		+	−					+	+		
Staff and Administrators	+			+	−		−						+

Table 9: The statistically significant (at the 5% level) coefficients of the discretionary factors in the models for overall efficiency and the factor efficiencies of the inputs.

	Business Unit Emphasis A	Business Unit Emphasis C	Business Unit Emphasis F	Business Unit Emphasis G	Scholarly Emphasis E	Scholarly Emphasis F	Scholarly Emphasis I	Scholarly Emphasis K	Scholarly Emphasis M	Executive Education	Business Building	Undergraduate Advising	Research Center	Business Accreditation	Accounting Accreditation
Undergraduate Enrollment							−	−			+			−	+
FTE MBA Enrollment												−	+	+	
FTE EMBA Enrollment															
FTE Specialized Masters Enrollment										−					
FTE Doctoral Enrollment	−	−		+					−			+		−	
Endowment			−		−	−								−	

Table 10: The statistically significant (at the 5% level) coefficients of the discretionary factors in the models for the factor efficiencies of the outputs.