DOCUMENT RESUME

ED 259 629 HE 018 510

AUTHOR	Brinkman, Paul T.; Leslie, Larry L.
TITLE	Economies of Scale in Higher Education: Fifty Years of Research. ASHE 1985 Annual Meeting Paper.
PUB DATE	Mar 85
NOTE	44p.; Paper presented at the Annual Meeting of the Association for the Study of Higher Education (Chicago, IL, March 15-17, 1985).
PUB TYPE	Information Analyses (070) -- Speeches/Conference Papers (150)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	Educational Finance; Enrollment Influences; Expenditure per Student; *Expenditures; Higher Education; Program Costs; *School Size; *Two Year Colleges; *Unit Costs; *Universities
IDENTIFIERS	*ASHE Annual Meeting; *Research Universities

ABSTRACT

Results of empirical studies of the size-cost relationship in higher education are synthesized, with emphasis on comprehensives, standardization, and mathematical integration. Results of research on economies of scale at two- and four-year colleges and research are summarized as follows: (1) two- and four-year colleges, on average, do experience positive returns to size; (2) substantive size-related economies are most likely to occur at the low end of the enrollment range; (3) the enrollment range over which such economies are likely to be found differs by type of institution; (4) the extent of such economies differs by function, with the administrative area typically experiencing the greatest reduction in unit cost and instruction the least; (5) for educational and general expenditures, the broadest category, a three- to four-fold difference in enrollment among small institutions is accompanied by a difference in cost per student, at the mean, of 25 percent for two-year institutions and 23 percent for four-year institutions; and (6) the extent to which scale-related economies or diseconomies are demonstrated by a given set of institutions depends on variations among them in the scope and variety of the programs and services they offer, the salaries they pay, and the general disposition of their resources. A six-page list of references concludes the document. (SW)

Economies of Scale in Higher Education: Fifty Years of Research

by

Paul T. Brinkman

and

Larry L. Leslie

March 15, 1985

ASHE Association for the Study of Higher Education
The George Washington University/One Dupont Circle, Suite 630/Washington, D.C. 20036
(202) 296-2597

This paper was presented at the Annual Meeting of the Association for the Study of Higher Education held at the Palmer House Hotel in Chicago, Illinois, March 15-17, 1985. This paper was reviewed by ASHE and was judged to be of high quality and of interest to others concerned with the research of higher education. It has therefore been selected to be included in the ERIC collection of ASHE conference papers.

Annual Meeting—March 15-17, 1985—Palmer House
Chicago, Illinois

Economies of Scale in Higher Education: Fifty Years of Research

It has long been held on theoretical grounds that costs are to some extent a function of the size or scale of an operation. Empirical evidence regarding this relationship has been developed over time for numerous industries and sectors of the economy. In higher education interest in the relationship between size and cost goes back at least to the 1920s and 1930s and the pioneering work of John Dale Russell, who laid much of the groundwork for cost analysis in higher education.

The purpose of this paper is to integrate and synthesize the results of empirical studies of the size-cost relationship in higher education. Efforts have increased recently to find better ways of integrating the results of prior work than the conventional literature review. Terms such as research synthesis and meta-analysis describe some of these procedures, although the terminology is not yet consistent. Our intention is to proceed in a meta-analytic function to the extent possible, as comprehensives, standardization, and mathematical integration are emphasized.

Any serious attempt to integrate findings from several studies inevitably must face the challange of dealing with different samples, data structures, and statistical procedures. This analysis is no exception. The situation-specific dimensions will be discussed below, but first some comments on the subject matter itself are in order. For neither "cost" nor "economies of scale" is a clear-cut, unambiguous concept.

There are two problems with respect to costs. First, the concept of cost has several meanings and there are many kinds of cost. Accountants conceive of costs in one way, economists in another. Costs can be direct or indirect, historical or projected, fixed or variable, and so on, to name but a few frequently used catagories. Fortunately, studies dealing with the size-cost relationship generally focus on either direct costs (those immediately related to the cost objective) or full (direct plus overhead) costs that are calculated on a unit basis (average or marginal) and are derived from the historical expenditure records of the provider. On the other hand, these expenditures constitute only the explicit costs incurred by an institution. There are a host of other phenomena that are related to size and that have, or at least may have, an implicit cost for someone. For example, the quality of the instructional program may be affected by size, and the same is true for various social-psychological aspects of collegiate life. These possibilities were of particular concern during higher education's rapid growth phase in the 1960s (see for example, Brown 1969; Chickering 1969; Hodgkinson 1970). They were not addressed in a cost or cost-benefit context, however, and thus will not be discussed here. Nonetheless, they should not be overlooked in any decision context that includes the notion of ideal institutional size.

A second problem is the difficulty of interpreting cost data unambiguously. Ambiguity is present because cost can be a function of many things, including some that are extraneous to the technical requirements of the educational process, such as the amount of revenue available. Although our inability to define and measure fully the outcomes of this process makes it impossible to render a final judgment, it does seem as though higher education costs are as much, or more, a function of what someone decides they will be than of hard, technological constraints. Accordingly, much care is required in interpreting the results of higher-education cost studies.

There are several sources of ambiguity in the notion of economies of scale (EOS). First, the definition of scale is fuzzy. In its classical and most restrictive sense, scale refers to productive capacity. But in practice, perhaps because productive capacity is difficult to measure, scale is almost always represented by the size of an organization or the quantity of its output. Thus, despite the fact that an economics textbook will normally treat EOS as a relationship between productive capacity and average cost (per unit of output), many empirical studies purported to be about EOS actually measure the relationship between the quantity of output and average cost, or even between the quantity of output and the quantity of input (Gold 1981).

Second, it is not always possible to distinguish between manifestations of long-run versus short-run behavior. Technically, EOS has to do with what economists call the long-run, a period long enough to allow an organization to vary the quantity of all inputs. Short-run cost behavior has to do with the way average costs behave when the quantity of output varies but at least some inputs remain unchanged. While the distinction may be relatively clear theoretically, there are times when it is not clear whether observed economies are due to changes in scale or to changes in the utilization of a given scale (productive capacity). As Reichard (1971) has noted, the rate of change in enrollment can be important in this regard. If change occurs rapidly, institutional adjustment to the new enrollment level may lag, thereby creating size-related, short-run effects. That is, for a time the institution may have to deal with the new level of enrollment with essentially the old level of resources. This will drive down unit costs when enrollment is expanding and drive them up when enrollment is shrinking. The expected effect of rapid enrollment growth has been documented for both four-year institutions (Corrallo 1970; Jenny and Wynn 1970; 1972) and for two-year institutions (Marks 1980), but the phenomenon is likely to be a hidden and confounding factor in most cross-sectional studies. As Dickmeyer (1982) shows, the confusion can become acute if one type of institution (in terms of size) is more prone to enrollment declines than another. Cullen and Baker (1984) analyze the problem for longitudinal studies, in the context of administration size in higher education.

Third, there is a lack of consistency in empirical studies of EOS with respect to what is to be held constant when estimating the relationship between scale (or size) and average cost. Of particular concern in this regard are input proportions and input prices, technology, and characteristics of the output. In a strict interpretation, all four would be held constant. The broadest definition of EOS allows for changes in input proportions, output mix, and technology (Reynolds 1983). In a higher education context, the broad interpretation would mean that a set of institutions could legitimately be examined for the presence of size-related economies even though they differed, for example, in the ratio of teaching assistants to professors, in the ratio of graduate to undergraduate students, and in the use of one or more instructional technologies.

Fourth, interpretation is often difficult because "what is seen as EOS can be technological, allocative, pecuniary, or regulatory (rules-based) in origin" (Reynolds 1983). For instance, unit costs can be driven downward, not by technical means, but by an organization achieving a size such that it can negotiate the price of an input. In the case of rules-based EOS, incentives in a regulatory environment can lead to technologies which may not reflect the true cost of production. Public colleges and universities in some formula funding states provide the best example in higher education of instances in which unit cost behavior is essentially rules-based. As Bowen (1980) has noted, some of the revenue generated by a formula may not be needed to provide additional students with the customary level of services, but will likely be spent anyway, thereby enhancing the level of services, increasing faculty salaries, and so on. Unless adjustments are made for these latter expenditures, the effect of increased size on unit costs will likely be underestimated. Conversely, a formula-based adjustment to a lower level of enrollment may or may not be an accurate reflection of underlying costs. Furlong (1983) has attempted to disentangle the separate effects of size and revenue on cost behavior in higher education, while Thompson and Zumeta (1981) explore, both conceptually and empirically, the effects of regulation (as by a state coordinating board) on the relationship between size and unit costs in higher education.

For the most part, it is not possible to avoid these various ambiguities in the higher education studies of EOS, any more than in studies of EOS in other industries. It is possible on occasion to show the effects of holding the output mix or the prices of inputs constant, or it may be obvious that cost behavior at a particular set of institutions is being influenced by rules (as in the example of a formula budget). In many studies, however, the question being asked is not about the independent effects of scale or size on unit costs, but simply whether large institutions spend less per student (or per credit hour) than do small institutions without regard to intervening factors. By and large, that is the question addressed in a major portion of the analysis that follows.

Methodology

There were several matters to consider in developing an appropriate methodology for the task at hand: one, a search strategy with respect to the literature on EOS in higher education; two, a means of standardizing at least a major portion of the results of the EOS studies; and three, one or more procedures for synthesizing, or cumulating, the standardized results.

The literature search included books, dissertations, reports, and journals in education, economics, finance, management, and organizational studies. The search was extended backward in time as far as bibliographic resources would permit. The earliest document found dates from the early 1920s, but almost all of the usable studies were done after 1960. The search was confined to studies dealing with U.S. higher education. References to a number of EOS studies on European higher education can be found in a study done by Verry and Davies (1976), which itself is a comprehensive examination of EOS and other cost-related issues in British universities.

The material covered in the core analysis that follows deals primarily with the the relationship between size (as measured by number of students, number of student credit hours, or number of degrees) and cost (measured in dollars) per unit of size. Not included are studies that relate outputs to inputs, such as Trueheart and Weathersby (1976), Hawley, Boland, and Boland (1965), and Radner and Miller (1975), or those that relate size to the utilization of inputs, such as Hungate, Meeth, and O'Connell (1964), Gerber (1968), and Fiuzat (1973), or that measure cost in terms of physical resources, such as Sengupta (1975), or that focus on the relationship between size and the distribution of resources within an institution, such as Dillon (1980), or that analyze frontier (as opposed to average) behavior, such as Carlson (1976). The primary unit of analysis is the institution. Studies at the departmental or program level are included as well, but those at the individual course level (see Adair 1970; Frisbee 1970; Suver 1973) are not.

No previous reviews were found that attempt to be comprehensive in their treatment of empirical studies. Typically only a handful of studies are discussed, and no attempt is made to standardize the results of the studies that are reviewed. Nonetheless, insightful review commentaries can be found in Dickmeyer (1982), Bowen (1980), Powel and Lamson (1972), and Reichard (1971). Studies of EOS at the primary and secondary levels of education are reviewed in Fox (1981) and Denzau (1975).

Aspects of the relationship between size and cost are reported in several ways in the literature: the shape of average or marginal cost curves, the difference between average and marginal costs, the sign and magnitude of correlation or regression coefficients, or unit costs in relation to size intervals. Average costs by enrollment interval are by far the most frequently reported findings. Also, it is possible on occasion to use reported regression results to calculate predicted costs at various enrollment levels, thus further increasing the number of interval-type data points. In a few instances, studies provide raw data on size and average cost for a sample of institutions in such a way that interval-type data points can be created. Overall, only average costs by enrollment interval were available in sufficient quantity to allow for a meaningful aggregation by statistical means. Thus, standardization efforts were directed toward these findings and they make up the core of what is reported on here. Other types of results are also discussed, but mostly by way of qualification and amplification of the core findings.

The enrollment range can be divided into intervals in a variety of ways. Conventional percentiles are occasionally used, but more often investigators simply create intervals to suit their purposes. For example, one author may choose the interval from 200 to 500 students to represent the smallest institutions in a sample; another may choose the range from 300 to 700. Varying intervals for medium and large institutions are also chosen. In order to provide some degree of standardization, percentage changes in unit cost were calculated on the basis of from three- to four-fold differences in enrollment, using as the starting point whatever interval was provided for the smallest institutions. The midpoints of the respective intervals were used for calculating the extent of enrollment difference. For example, if a study provided average costs by enrollment intervals of 300-500, 501-900, 901-1300, 1301-1700, and 1701-2200 students, the intervals 300-500 and 1301-1700 would be used. The enrollment difference would be 1500 divided by 400, or 3.75. The corresponding percentage change in cost would be calculated on the basis of the average cost experienced by institutions in the interval 1301-1700 as compared to the cost experienced in the interval 300-500. The midpoints of the enrollment intervals used for each study are included in the material tabled. Data for extremely small institutions (less than 200 students) generally were excluded. This constraint led to the exclusion of some of the earliest studies on EOS (for example, Koos 1925). The average value for the midpoint of the small-institution interval was approximately 420 full-time equivalent students for two-year institutions, and 550 for four-year institutions. As a rule, intervals had to contain at least five institutions to be used in calculations for the core analysis.

There are two issues to consider in cumulating the standardized results of the various studies. The first is that the universe of higher education institutions is quite diverse. Most studies deal separately with two-year, four-year, and university-level institutions. That procedure will also be followed here. Investigations which deal collectively with a great variety of institutional types, such as the studies done by Dukiet (1974), Furlong (1983), McLaughlin et al. (1980), and Russell and Reeves (1935), are not included in the analysis. Also excluded are several early studies on junior colleges, such as Webb (1934), that mix free-standing institutions with high school based programs. An account of these latter studies can be found in Martin (1949). There is also diversity among the cost objectives in higher education. For example, costs can aggregated by function, such as administrative costs, or by object of expenditure, such as personnel compensation. Most studies provide data by functional area, so that procedure was followed here. For purposes of the core analysis, there were sufficient data points for two-year and four-year institutions for the following functions: educational and general, instruction, administration, operation and maintenance of the plant, and library (four-year only). Most of the studies of EOS at universities dealt with instructional costs only. Almost all of the studies that did not fall into these expenditure categories analyzed some form of total operating costs. These studies are discussed in the text in connection with the findings for educational and general expenditures.

The second issue concerns the kind of statistical measures that can properly be used as a means of synthesizing the standardized results. As indicated above, the results of studies in the core analysis are presented in terms of percentage changes in cost per student, or on occasion, cost per credit hour. We calculate ranges, means, weighted means (by sample size), medians, and standard deviations for the set of such changes for two-year and four-year institutions. There were not enough data points for research universities to warrant mathematical cumulation. Because of a lack of data, it was necessary to ignore inter-study differences in the variance among the unit-cost values lying within enrollment intervals. Without variance measures, it is not possible to calculate the so-called d-statistic (mean value for the treatment group minus the mean value for the control group, divided by the control- or within-group standard deviation) that some meta-analysts use to standardize effect scores (Glass, McGaw, and Smith, 1981; Hunter, Schmidt, and Jackson, 1982). Occasional data, as well as what is generally known about unit costs in higher education, suggest that the variance is likely to be substantial in all of the studies. That is, costs per student or per credit hour are likely to vary widely among institutions of similar size. Thus, great care must be taken in generalizing the cumulative results to specific situations.

Finally, there is the matter of differences among EOS studies with respect to the controls they impose on institutional behavior. Types and means of control vary. For example, in descriptive studies control may be exerted over output mix by weighting the number of students by level of instruction. In studies in which cost is regressed on enrollment, control may be gained by using additional variables in the estimating equation. For example, holding faculty salaries constant at the mean would control an important segment of input prices. In a rather different vein, the choice of functional form in a regression analysis can impose important restrictions on the estimated size-cost relationship. For example, a regression equation may be constructed in such a way that only a linear relationship between enrollment and average cost can be estimated. The choice of statistical procedure can itself impose similar restrictions. For instance, calculating a Pearson product-moment, a frequently used correlation coefficient in these studies, entails estimating a linear relationship regardless of the nature of the actual relationship.

These differences in control, or, one might say, in the questions being asked, have considerable bearing on the possibilities for both standardization and cumulation of results across the various studies. A modest step in dealing with the problem is taken by grouping the studies in accord with institutional mission (two-year, four-year, and university). In addition, the confounding effects of specific disparities in control can be diminished somewhat by simply acknowledging them in appropriate instances. We have done that in the text to some degree, and, more systematically, in the Appendix (Table 1A). More importantly, however, it turns out that for the core analysis for two-year and four-year institutions most of the studies are similar in terms of controls. They are at the minimum level, controlling only for institutional type and sector. Thus, a number of meaningful generalizations are possible, even though there is no satisfactory solution available for the entire set of studies.

Results for Two-Year Colleges

Table 1 shows the results of the core analysis for two-year colleges. On a percentage basis, scale-related economies are greatest for administrative expenditures (ADM). Across 14 data points, unit costs at the larger institutions were, on average, 34 percent lower than at smaller institutions (based on three- to four-fold differences in enrollment). By contrast, the corresponding difference in instructional costs (INS) was only 15 percent. Measured in similar fashion, economies in the operation and maintenance of the physical plant (O&M) came to about 28 percent, just over the figure (25 percent) for educational and general (E&G) expenditures (the sum total of all

Table 1. Two-Year Colleges: Percentage Decreases in Unit Costs Associated with Three- to Four-Fold Increases in Enrollment

Author	Year	S*	--Expenditure Category-- E&G	ADM	INS	O&M	Sample Size	Enrollment Interval Midpoint**	
Martin	1949	P	17%	42%	9%	22%	34	370	1385
Metz	1964	M	27	40	14	26	51	250	750
Jordan	1965	P		29	-4	21	23	292	1176
Ostrom	1968	P	24		19	27	16	700	2200
Scales	1969	I	25	34	21	27	22	286	882
Scales	1969	P	25	32	16	32	26	583	1957
Corrallo	1970	M	29				54	350	1150
Maynard	1971	P	25				30	500	2000
Carnegie	1972	P	26	41	17	23	50	300	1125
Carnegie	1972	I	36	28	34	44	50	300	1125
Millett	1980	P	30				18	405	1555
Dickmeyer	1980	P	21	39	8	27	134	500	1945
Mullen	1981	P	26	28	21	23	569	350	1250
Brinkman	1981	P			12		225	350	1400
Dickmeyer & Cirino	1981	P	27	38	24	32	211	525	2100
Dickmeyer & Cirino	1982	P	21	27	15	23	221	525	2100
Dickmeyer & Cirino	1983	P	23	30	18	28	224	525	2100
Dickmeyer & Cirino	1984	P	17	27	11	22	280	620	2400
Southern Assoc.	1984	M	26	37	6	36	176	750	2685
Brinkman	1985	P	25		18		330	400	1600
Cumulative Statistics:									
Minimum			17	27	-4	12	16	250	750
Maximum			36	42	34	44	569	750	2685
Mean			25	34	15	28	137	438	1645
Median			25	33	16	27			
Weighted Mean			24	31	16	26			
St. Dev.			4.3%	5.4%	8.1%	6.1%			
Mean/St. Dev.			5.8	6.2	1.9	4.5			
N of Cases			18	14	17	15			

*P = public, I = independent, M = mixed by sector

**For most studies, figures shown are our estimates of the midpoints of enrollment intervals used as the basis for percentage calculations.

operating expenditures except those related to non-educational activities such as auxiliary enterprises). There is, of course, some dispersion around these averages, as indicated by the standard deviation. Nonetheless, given the prospects for measurement error, differences in the intervals, and differences among institutions in unit costs, the amount of congruence in the data is encouraging. The measures of central tendencies do not appear to be misleading. Of the studies listed in Table 1, only those by Brinkman (1981b; 1985) and Jordan (1965) include direct controls (on output mix, input prices, and so on) as a means of obtaining the independent effects of size. As noted earlier, the specific controls used are noted in the Appendix.

The data shown in Table 1, especially the cumulative statistics, represent the primary findings for two-year colleges. Some additional data will now be presented in narrative form. In some instances, these data will serve to reinforce what has already been shown, but their main purpose is to add complimentary perspectives and widen the context within which the primary findings can be understood.

A study by Keene (1963), which was not included in the table because of the expenditure category he examined (total current funds), perhaps best illustrates how controls can be used to address important issues. Keene calculated a percentage decline of 28 percent in unit expenditures as the result of comparing institutions with 400 students with those that have 1400 students, under the assumption that the smaller institutions provide the same richness of educational opportunity as do institutions with 600 to 700 students. The Florida community colleges that he examined exhibited little relationship between size and unit cost until he equalized (rather conservatively) the services provided among the institutions.

Similarly, examining total operating costs and enrollment in California community colleges, Thompson and Zumeta (1981) show that cost per student declines at a decreasing rate as student demand increases, if service levels are held constant. These authors also show, however, that if aggregate student demand (as represented by the surrounding eligible population) is held constant, an increase in enrollment will be associated with an increase in cost per student. In other words, the effect that additional students have on unit costs is a function of how hard an institution must work to attract those additional students.

Two studies examined the behavior of total operating expenditures. For two-year colleges, these expenditures should behave much as E&G expenditures do, and that was the finding in both studies. Kress (1978) looked at 68 community college districts in California and found that a 23 percent decrease in average cost per student accompanied a four-fold increase in enrollment. Marks (1980) did a time series analysis of changes in a sample of 134 community colleges during the period from 1972 to 1977. After controlling for inflation, he found that a nearly three-fold growth in enrollment was accompanied by a 29 percent decline in average cost per student.

Two studies estimated the difference between average and marginal costs. Their findings are in accord with those from the interval studies. Shymoniak and McIntyre (1980) report average costs exceeded marginal costs by 28, 14, and 10 percent for administrative, E&G, and instructional expenditures, respectively, at mean enrollment. The figure for instruction is identical to that found by Brinkman (1981b). Of course, the more that average costs exceed marginal costs, the greater the potential for economies of scale. These findings, then, appear to confirm at least the relative magnitude of the changes across expenditure categories indicated by the core analysis.

Studies that calculate correlation coefficients offer modest supporting evidence for the presence of economies of scale. Wallhaus (1981) reports coefficients of -.30 and -.33 for enrollment correlated with instructional and O&M unit costs, respectively. Looking at the same population, public community colleges in Illinois, but a decade earlier, Oborn (1971) found a -.19 correlation between total expenditures per student credit hour (SCH) and the total number of SCH by institution. For nine departments in Florida's public community colleges, Fickett (1977) reported an average correlation of -.31 between direct instructional costs per SCH and the total number of SCH. By contrast, Cage and Manatt (1969) reported a correlation of -.72 between cost per SCH and enrollment by program for Iowa's public two-year colleges. The difference in the two coefficients may represent a difference in state funding procedures and strategies.

Several regression studies demonstrate some of the confounding influences on measures of EOS. In a study of public community colleges in Texas, Jordan (1965) found no significant inverse relationship between total institutional expenditures per student and enrollment until he controlled for the scope and variety of courses offered. In a study of Florida's public community colleges, Hackett (1981) found a strong relationship between size and unit costs for the occupational curriculum, support functions, and O&M only when he controlled for faculty salaries. Similarly, in a large national sample, Brinkman (1985) found that unit costs are likely to be lower at small institutions than at medium size institutions unless faculty salaries are held constant across the two groups, in which case a fairly typical pattern of EOS emerges. Corrallo (1970) regressed educational operating expenditures per student on enrollment for separate samples of public and private two-year colleges. The coefficent on enrollment for public colleges was .01, with no effect on explained variance, while the coefficient for private colleges was -.54, with a strong effect on explained variance. The difference could be due to the influence of funding formulas in the public sector, which especially during the 1960s tended to be based on and perpetuate constant average costs. In addition, the private school sample included very small institutions (200 to 400 students) and the public school sample did not.

The data presented above in Table 1 pertain to the behavior of average costs at the low end of the enrollment range. There were insufficient data points to do a comparable analysis for the high end of the enrollment range, but cost behavior in this range has been examined by a number of authors. What follows is an overview of their findings.

There is some agreement in the literature that the largest portion of any scale-related economies for E&G expenditures at two-year colleges are typically realized by the time institutional enrollment is in the range of 1,000 to 1,500 FTE students (Carnegie Commission on Higher Education, 1971; Kress, 1977; Mullen, 1981). It is likely that instructional economies are experienced primarily at the low end of that range, while substantial administrative economies probably extend to the 1,250-1,500 area (Mullen, 1981). There is less agreement about unit costs at the largest two-year colleges. The results of several studies (Brinkman 1985; Bowen 1980; Dickmeyer 1980; Dickmeyer and Cirino 1983; Dukiet 1974; Maynard 1971; and Mullen 1981) suggest that instructional unit costs probably do begin to rise again, but in other studies (Brinkman 1981b; Carlson 1972; Dickmeyer and Cirino 1981; Dickmeyer and Cirino

1982; Dickmeyer and Cirino 1984), the results suggest either no increase in unit costs or even a continuing, albeit very gradual, decrease. Apparently, if unit costs in one or more expenditure areas do tend to change as institutions reach the upper end of the enrollment range, the changes are quite small. Again, the confounding influences make definitive conclusions difficult to attain. The very large two-year colleges are located in highly urbanized areas, which often entails high salaries and a high proportion of part-time students. Both phenomenon have been shown to affect unit cost behavior, although in opposite directions (Brinkman 1985). States that create rules-based EOS at the low end of the enrollment range may be less likely to do so at the high end. Most of the studies mentioned exert little if any control over these various influences, and thus take the calculated relationship between size and cost at face value.

Results for Four-Year Institutions

The pattern of scale-related economies for four-year institutions resembles that for two-year institutions. As Table 2 indicates, the largest EOS occurs in administrative expenditures. In association with a three- to four-fold increase in enrollment, the average percentage decrease in administrative cost per student was about 34 percent, which is the same as the comparable figure for two-year institutions. The decreases for instructional and O&M costs, 16 and 25, respectively, are also close to the results for two-year colleges. At 22 percent, E&G costs decrease three percentage points less at the four-year schools. Across 15 data points, library expenditures per FTE student declined 21 percent. As measured by the standard deviation, the dispersion among the findings was greatest for library costs and least for E&G and instructional costs. Despite the considerable overlap in the findings from the various

Table 2. Four-Year Colleges: Percentage Decreases in Unit Costs Associated with Three- to Four-Fold Increases in Enrollment

Author	Year	TS*	---Expenditure Category--- E&G	ADM	INS	O&M	LIB	Sample Size	Enrollment Interval Midpoint**	
Millett	1952	BI	%	30%	%	%	%	40	575	2200
NACUBO	1956	BI	27	46	19	35	14	30	350	1200
NACUBO	1960	BI	11	31	5	19	-4	22	350	1200
Metz	1964	BM	25	38	16	14	24	85	400	1200
Metz	1964	CM	29	38	17	15	23	58	600	1800
D'Angelo	1970	BI	24					300	500	2000
Corrallo	1970	BM	23					46	700	2400
Jenny & Wynn	1970	BP	23	37	14	23	27	22	586	1681
Maynard	1971	BP	20					60	500	2000
Columbia Research	1971	CM			20			31	733	2690
Jenny & Wynn	1972	BP	20	35	18	16	24	15	811	2445
Carnegie (LA1)	1972	BI	28	44	24	12	38	30	400	1375
Carnegie (LA2)	1972	BI	13	24	7	13	13	100	500	1750
Carnegie	1972	CI	20	21	16	19	8	27	1017	4000
Carnegie	1972	CP	23	25	18	40	31	53	800	2750
Ven Hoerst & Henkhaus	1973	BI				34	29	32	650	1950
Meeth	1974	BI	20					44	325	1250
Brinkman	1981	BP			20			60	400	1400
Brinkman	1984	CI	27	30	19	42	33	40	400	1200
Brinkman	1984	CP	27	38	19	34	34	40	400	1200
Southern Assoc.	1984	BM	25	42	7	33	10	120	1000	3250
Southern Assoc.	1984	CM	18	32	13	22	32	35	1000	3750
Cumulative Statistics:										
Minimum			11	21	5	12	-4	15	325	1200
Maximum			29	46	24	42	38	300	1017	4000
Mean			22	34	16	25	21	59	540	2030
Median			23	35	18	22	24			
Weighted Mean			23	34	14	25	17			
St. Dev.			4.8%	7.3%	5.2%	10.1%	11.3%			
Mean/St. Dev.			4.7	4.7	3.0	2.4	1.8			
N of Cases			18	15	16	15	15			

*B = baccalaureate, C = comprehensive (baccalaureate and masters), P = public, I = independent, M = mixed by sector

**For most studies, figures shown are our estimates of the midpoints of enrollment intervals used as the basis for percentage calculations.

studies, it must again be emphasized that cost differences among similar-sized institutions in these studies is typically large; therefore, what we are observing in Table 2 are nothing more than general tendencies which may or may not be evident in the expansion path of any given institution. Again, as was true for the two-year institutions, most of the studies imposed only the mimimum control inherent in sample selection.

The data in Table 2 represent the primary findings for four-year institutions. Again, however, there are other data that are worth presenting in narrative form for the additional perspectives they provide.

There are four additional studies that yielded interval-type data but did not fit the restrictions imposed in creating Table 2. In an early study of 34 liberal arts colleges (Reeves, Russell, Gregg, Brumbaugh, and Blauch 1932), it was found that for a four-fold increase in enrollment "educational costs" per student declined only 12 percent while "non-educational costs" per student declined nearly 50 percent. In a study of 145 liberal arts colleges Calkins (1963) found that E&G revenues per student declined 28 percent in conjunction with a three-fold increase in enrollment. Since institutions spend most of their E&G revenue, this finding is roughly comparable to the E&G expenditure data in Table 2. Also roughly comparable are the results of an analysis of total expenditures in 17 California state colleges (California Coordinating Council for Higher Education 1969). On the basis of a fitted cost curve, costs per student at an institution with 12,000 FTE students were 22 percent lower than at an institution with 4000 FTE students. In a study of just six New Mexico public four-year institutions, Russell and Doi (1955) found that a 34 percent decrease in administrative costs accompanied a four-fold increase in enrollment.

The ratio of marginal to average costs for instructional expenditures at both public comprehensive and baccalaureate colleges was estimated by Brinkman (1981b) to be about .82. In a later study of public and private baccalaureate institutions, virtually the same ratio (.81) was again recorded for instructional costs at both types of institutions (Brinkman 1984). The marginal- to average-cost ratios were somewhat smaller for E&G (public .68; private .72), administrative (public .48; private .67), O&M (public .62; private .51), and library (public .66; private .68) expenditures. These ratios suggest that substantial scale economies were realized in the samples studied. (The public institutions ranged in size from 1,350 to 5,000 FTE students, and the privates from 950 to 4650.)

In a study of private liberal arts colleges at the departmental level of analysis, Tierney (1980) found that marginal- to average-cost ratios averaged a low .38 across seven departments. There was considerable difference by department: English had the highest estimate at .66, physics had the lowest at .19. The study, a carefully designed, pooled cross section of 40 institutions over four years, was meant to be an analysis of long-run cost behavior. Assuming a correct specification of the estimating equation, the very low ratios suggest perhaps that the results are more a reflection of short-run costs. The homogeneity of the sample and the (presumably) limited extent of enrollment variation may mean that the ratios represent a good deal of underutilized capacity (at a given scale), rather than cost behavior related to differences in scale. On the other hand, the low marginal- to average-cost ratios may be due to the fact that by focusing on costs by department in baccalaureate institutions the study effectively eliminates much of the curriculum proliferation that can negate scale-related economies.

Using different samples of liberal arts colleges, Calkins (1963) and Corrallo (1970) estimated identical coefficients, -.28, regressing, respectively, E&G revenues per student and E&G expenditures per student on enrollment, with several different control variables present in their respective models. These coefficients can be interpreted as meaning that both revenues and expenditures per student decline $.28 (in then current dollars) for each additional student over some range of enrollment about the mean. Corrallo's estimate was for colleges with religious affiliations. He also estimated coefficients for non-sectarian private liberal arts as well as public baccalaureate institutions. The results, -.05 and .03, respectively, added little to explained variance. There were no small institutions (less than 900 students) in either sample, however, in sharp contrast to the sample of religiously affiliated institutions. In a much older study, Magee (1931) regressed instructional expenditures on student credit hours. With no controls in the equation, the estimated coefficient was -.24, whereas, when holding curriculum diversity constant, the estimate jumped to -.64. The direction and magnitude of the change is similar to those reported by Jordan (1965) for two-year colleges. These results suggest that institutions which become larger but not more complex are quite likely to manifest far greater economies of scale than those which do become more complex as they grow in size (more evidence to this effect can be found in Blau 1973, Brinkman 1981a, Marks 1980, and McLaughlin et al. 1980).

Apart from rapidly declining costs in the very low enrollment range, the evidence regarding the shape of the average cost curve is inconclusive. There is some reason to think that liberal arts, or baccalaureate, colleges typically achieve most of their scale-related economies by the time enrollment reaches 1,500 to 2,000 FTE students (Brinkman 1981b; Corrallo 1970), if not sooner

(Carnegie Commission on Higher Education 1972). The comparable range for more comprehensive colleges is probably 3,000 to 4,000 students (Brinkman 1981b; California Coordinating Council for Higher Education 1969; Maynard 1971), if not sooner (Carnegie Commission on Higher Education 1972). The findings of some studies, such as those by Jenny and Wynn (1970) and Maynard (1971), suggest that relatively large four-year institutions experience higher unit costs than mid-sized institutions, or, in other words, that the cost curve is somewhat U-shaped. Other studies such as Brinkman (1981b; 1984), California Coordinating Council for Higher Education (1969), Carlson (1972), Metz (1964), and Reeves et al. (1932) suggest that after its initial decline the average cost curve tends to remain essentially flat as institutions become very large. In the Carnegie Commission study (1972), the largest institutions typically did not have the lowest costs per student across the various expenditure categories, but there was no clear cost-size relationship evident for size levels beyond the middle ranges. Similarly, Bowen (1980) found that among liberal arts colleges and public comprehensive institutions the interval containing the second largest institutions recorded the lowest educational costs per student, while for private comprehensive institutions the largest institutions experienced the lowest unit costs.

Results for Research Universities

Few comparable data points are available to assess the relationship between size and cost at research universities. While 17 studies were found that dealt with the issue empirically, only a portion of them provided usable results; and within the latter group virtually none of the studies addressed the same aspects of the basic issue. In addition, research universities present a more difficult subject to analyze. They engage in diverse activities, not all of which relate to enrollment. The sponsored, or separately budgeted, research component of their E&G expenditures, for example, is substantial, but it seems to bear no particular relationship to the number of students enrolled. Consequently, studies which provide data on E&G expenditures per student, but do not control for this research component, are of questionable value. The same can be said for the portion of administrative and O&M expenditures that relates to the research effort. Also, from a cost perspective the range of students is very great. Doctoral students are far more more expensive to educate than lower division undergraduates. Clearly, the effect of a change in enrollment on overall average cost will depend on the mix of students involved.

With those caveats in mind, it can be said that the available evidence indicates that EOS typically will be experienced by a representative group of private research universities, but not by their public counterparts. In the Carnegie study (1972), private research universities show a 25 percent decline in instructional cost per student comparing institutions in the 3,000 to 4,999 FTE enrollment interval to institutions with 7,000 to 9,999 students. For the same range, but using a weighted student count (each graduate student multiplied by three), the decline in cost is 20 percent. In that same Carnegie study, however, the data also suggest that the average cost curve for private research universities is saw-toothed. The very small institutions and those with enrollments in the 10,000 to 15,000 range experienced the highest costs. Similarly, Corrallo (1970) found that the lowest unit costs were achieved by research universities, public and private, at enrollment levels of 6,000 to 10,000 and 14,000 to 18,000. Lyell (1979) found that, over a 23-year period, a public research university experienced increasing costs per student in growing from 10,000 to nearly 16,000 students, and then nearly flat costs thereafter in growing to just over 20,000 students. Bowen's (1980) analysis of educational costs (a broader category than instruction, but much narrower than E&G) also indicate an uneven pattern. Using an enrollment range divided into quintiles, the public institutions show very modest differences, with the smallest, middle, and largest institutions having the highest educational costs per weighted student (by level). The private institutions show large differences, with the smallest and next to largest institutions having the highest costs. In a regression study of instructional costs at public research universities, Brinkman (1981b) found that changes in unit costs were negligible over most of the enrollment range, provided that the proportion of students by level remained constant. There were substantial scale-related economies available at the graduate and upper-division levels, provided these enrollments were allowed to increase independently. Broomall, Mahan, McLaughlin, and Patton (1978) found no evidence for EOS in a sample of 22 major public universities, regressing expenditures in various categories on total full-time equivalent enrollment with no controls. Controlling for the proportion of graduate students, curriculum complexity, and research emphasis, Brinkman (1980) also found no evidence for EOS in instructional costs among 25 public research universities but considerable evidence for EOS in a combined sample of 50 public and private universities.

Some additional insight into size-related cost behavior at research universities can be obtained from several studies that have examined departments, programs, or colleges within universities. These studies are shown in Table 3. They are too diverse to cumulate mathematically, but the patterns they reveal, or at least suggest, seem to be plausible. For instance, we might expect that declines in average cost would be somewhat higher typically in these studies than in those that cover the instructional function as a whole, on the presumption that individual units will be less subject to

Table 3. Indicators of Economies Related to Size for Instructional Segments within Research Universities

Author/Yr	Cost Objective	Size of Large Segment/ Small Segment	Percentage Decrease in Average Cost	Marginal/ Average Cost
Borgmann & Bartram (1969)	weighted degrees			
	all engineering	4	29%	
	mineral engineering	3.5	45	
	(14 institutions)			
Brovender (1974)	SCH by program:			
	humanities	3	34	.49
	natural science	3	32	.53
	social science	3	19	.72
	(model 1);			
	humanities	3	23	.66
	natural science	3	23	.66
	social science	3	13	.81
	(model 2)			
	(1 institution)			
Buckles (1978)	SCH by department (1 institution)	3	28	
Butter (1966)	Ph. D. degrees:			
	physics	3	62	
	sociology	3	69	
	english		none	
	zoology		none	
	(12 institutions)			
Gibson (1968)	SCH by department:			
	lower division	3	40	
	upper division	3	36	
	graduate	3	30	
	(1 institution)			
Razin & Campbell (1972)	SCH by college:			
	undergraduate	3	28	.58
	(1 institution)			
Terman (1969)	SCH in engineering:			
	all levels	3.5	29	
	(19 institutions)			

the sort of diversification that absorb scale-related economies. The comparative results in Brovender's study are reasonable if one assumes that it is short-run cost behavior. His data are for the late 1960s, a time when enrollment in the social sciences was high. Having less capacity going unused than in the other areas, the social sciences would be expected to have higher marginal- to average-cost ratios. The extremely large predicted changes in the cost of doctoral degrees in physics and sociology suggests that underutilization was the operative factor, although the difficulty of estimating relationships at the doctoral level (especially for the cost of a degree) cannot be overstated.

In another study in the same vein (not shown in Table 3), Smith (1978) used a regression model to analyze instructional costs at Michigan's public colleges and universities. He examined six discipline areas at four student levels and found a complex mixture of size and interaction effects. Overall, there was considerable evidence for EOS at the undergraduate levels and for both EOS and diseconomies of size at the graduate levels. Size effects were more dramatic at lower enrollment ranges. Evaluated at mean enrollment, marginal costs were less than average costs in 17 out of 24 instances. Several interaction terms (among the student levels) were significant in all disciplines except engineering. Similarly, in a time series analysis of cost behavior at the University of Oregon, Siegel (1967) found that scale effects could be detected in each of the curricular areas (and three levels of instruction) which he examined. In the great majority of instances, larger size resulted in lower unit costs.

Other Studies

This review would be incomplete without brief comments on a number of studies that could not be included in the core analysis. With few exceptions, these additional studies tend to confirm the general results discussed above. For instance, the data in Tables 1 and 2 indicate that the administrative area is particularly prone to scale economies. Studies by Blau (1973) and by Hawley, Boland, and Boland (1965) reinforce that finding by showing that at four-year institutions the ratio of administrators to faculty declines as the number of faculty increases. In the latter study, this is true only when comparing small to medium-size institutions. The ratio is constant across medium to large-size institutions. There is evidence for EOS in instruction as well. Using a large national sample, Radner and Miller (1975) found that the student-faculty ratio increases moderately for various types of institutions as those institutions become larger. Similarly, Gerber (1968) found that average class size at public two-year colleges in Minnesota increased as institutional enrollment increased, and Hungate, Meeth, and O'Connell (1964) and McGrath (1964) found the same phenomenon occurring at private liberal arts colleges. In the Hungate et al. study, the relationship between class size and enrollment levels off beyond about 2000 FTE students. For public research universities, however, Sengupta (1975) found that in percentage terms the number of senior faculty increased faster than enrollment, which again indicates the apparent absence of overall instructional EOS in representative samples of this type of institution. Carlson (1972), in a study using many controls (curricular mix, student mix, and so on), found evidence for EOS at various types of institutions that were shown to be relatively efficient. These so-called "frontier" institutions experienced EOS to a lesser degree than did institutions not on the efficient surface, but like the latter institutions, they experienced EOS only over the range from small to moderate levels of institutional size. Trueheart and Weathersby (1976), in a study employing few controls, found no evidence of economies of scale for a sample of relatively efficient, traditionally black four-year institutions.

Discussion

The results of research on economies of scale in higher education can be summarized as follows: 1) two-year and four-year colleges, on average, do experience positive returns to size; 2) substantive size-related economies are most likely to occur at the low end of the enrollment range; 3) the enrollment range over which such economies are likely to be found differs by type of institution; 4) the extent of such economies differs by function, with the administrative area typically experiencing the greatest reduction in unit cost and instruction the least; 5) for educational and general expenditures, the broadest category, a three- to four-fold difference in enrollment among small institutions is accompanied by a difference in cost per student, at the mean, of 25 percent for two-year institutions and 23 percent for four-year institutions; and 6) the extent to which scale-related economies or diseconomies are demonstrated by a given set of institutions depends on variations among them in the scope and variety of the programs and services they offer, the salaries they pay, and the general disposition of their resources. In general, an increase (decrease) in the number of students enrolled in an institution (or unit thereof) is only one of many factors that can influence unit costs, and its influence is subtle and often obscured by the effects of more powerful and directly influential factors. This appears to be especially true for medium and large-sized institutions whereas, for small institutions, size effects are typically strong enough to be noticeable although sometimes only when steps are taken to isolate those effects.

With respect to the materiality of the findings assembled here, it would appear that, in terms of overall institutional size, only small institutions (or state systems with such institutions) need be concerned with the possible effects of scale on unit costs. It is difficult, as we have seen, to establish the precise enrollment range that would best characterize smallness in this context. If, for the sake of argument, we use the figure of 1000 FTE students as the upper end of that range, then the number of small institutions is considerable. Based on data from the fall of 1982, about 1500 of the nation's 3350 accredited colleges and universities have fewer than 1000 students. However, not all of those 1500 institutions are equally vulnerable to the effects of size on unit costs. About half of them are specialty schools, whose highly focused curricula should in most instances be advantageous from a cost perspective. On the other hand, there are some additional institutions that have enrollments well beyond 1000 students, yet are small enough, relative to their mission, to be at a disadvantage from a cost perspective. Enrollment declines in the near term could pull additional institutions into this category.

As for the unit-cost disadvantage typically experienced by these small institutions, our best estimate is that it is on the order of 25 percent, on average, for educational and general expenditures. The figure may be both comforting and threatening to the institutions in question. It would seem to be too small to prohibit them from competing with their larger counterparts, but it is too large, when viewed from the perspective of tuition rates or state funding formulas, to simply ignore.

The amount of data on departments, programs, or schools within universities is not large, but it is sufficient to warrant concern about the effects of size on unit costs. Differences in per student costs of 25 to 40 percent are common among the available data points. The simple assumption of linearity, then, is questionable when used as the basis for resource allocation within institutions. Unfortunately, the effect of size on unit costs differs substantively by both level and program of instruction. This suggests that procedurally, and perhaps politically as well, it may be difficult to develop strategies for intra-institutional resource allocation that adequately account for differences in size among academic units

APPENDIX

Table 1A. Additional Details on Individual Studies for which Percentage Change Data Could Be Calculated

(1)	(2/3)	(4/5)	(6/7)	(8/9)
	Year of Data	Source	Data Source	Type of Control
Author(s), Year	Population	CS/TS	Level	Statistics
Borgmann & Bartram, 1969	1968-89 76 depts in 2 I RU & 12 P RU/DU/S	R CS	AS D	CC,SL raw data
Brinkman, 1985	1979-80 779 P CC	J CS	HEGIS,O I	IT,IS,CC,FS,CL regression
Brinkman, 1984	1981-82 80 P, 80 I CU/BC	R CS	HEGIS,O I	IT,IS,CC,FS,CL, Q,SL regression
Brinkman, 1981a	1976-77 50 P/I RU	J CS	HEGIS I	IT,IS,CD,CL,SD, IP,SL,RE,FS regression
Brinkman, 1981b	1977-78 119 P BC, 585 P CC	D CS	HEGIS,O I	IT,IS,CD,CL,FS, SL regression
Brovender, 1974	1968-69 1 P RU	J CS	IR P	IT,SL,IS,LF regression
Buckles, 1978	1963-64 thru 1969-70 1 P RU	J TS/CS	IR D	IT,IS,FS,FL,CS regression
Butter, 1966	1964-65 12 P/I RU	R CS	AS D	IT,SF,FS,RE,CD,LF regression
California Coordinating Council, 1969	1966-67 17 P CU	R CS	SR I	IT,IS descriptive
Carnegie Commission, 1972	1967-68 1550 P & I RU/DU, CU,BC,LA,CC	R CS	HEGIS I	IT,IS descriptive
Columbia Research Associates, 1971	1967-68 thru 1969-70 50 P/I CU/BC	R CS,TS	AS I	IT,IS raw data
Corrallo, 1970	1963-64 362 P & I RU/DU, CU/BC,LA,CC	D CS	NCES I	IT,IS,Q,SD,SL raw data
Dickmeyer, 1980	1978-79 184 P CC	R CS	AS I	IT,IS descriptive*

D'Angelo, 1970	1966-67 398 I CU/BC	D CS	O I	IT,IS,SF regression
Dickmeyer & Cirino, 1981	1979-80 403 P CC	R CS	AS I	IT,IS descriptive*
Dickmeyer & Cirino, 1982	1980-81 420 P CC	R CS	AS I	IT,IS descriptive*
Dickmeyer & Cirino, 1983	1981-82 442 P CC	R CS	AS I	IT,IS descriptive*
Dickmeyer & Cirino, 1984	1982-83 520 P CC	R CS	AS I	IT,IS descriptive*
Gibson, 1968	1964-65 41 depts in 1 P RU	D CS	IR S	IT,IS,SL regression
Jenny & Wynn, 1970	1959-60 48 LA	R CS	AS I	IT,IS raw data
Jenny & Wynn, 1972	1967-68 48 LA	R CS	AS I	IT,IS raw data
Jordan, 1965	1962-63 31 P CC in TX	D CS	AS I	IT,IS,CD regression
Keene, 1963	1957-58 thru 1961-62 23 P CC in FL	D CS	AS I	IT,IS,CC,CD regression
Kress, 1978	1975-76 68 P CC districts in CA	D CS	SR district	IT,IS,CD,SD regression
Marks, 1980	1971-72 thru 1976-77 134 P CC	D TS,CS	HEGIS I	IT,IS descriptive
Martin, 1949	1947-48 34 P CC	D CS	AS I	IT,IS descriptive
Maynard, 1971	1967-68 123 P CU/BC,CC	B CS	AS I	IT,IS regression
Meeth, 1974	1970-71 66 LA	B CS	AS I	IT,IS descriptive
Metz, 1964	1963-64 404 P CU,BC,CC	R CS	AS I	IT,IS descriptive
Millet, 1952	1948-49 80 LA	B CS	AS I	IT,IS descriptive
Millet, 1980	1977-78 18 P CC in MN	R CS	SR I	IT,IS raw data

Mullen, 1981	1976-77 900 P CC	D CS	HEGIS I	IT,IS regression
NFCUBOA, 1956	1953-54 60 LA	R CS	AS I	IT,IS descriptive
NFCUBOA, 1960	1957-58 56 LA	R CS	AS I	IT,IS descriptive
Ostrom, 1968	1966-67 48 P CC in CA	D CS	AS I	IT,IS raw data
Razin & Campbell, 1972	1964-65 thru 1968-69 1 P RU	J TS/CS	IR C(U)	IT,IS,SL regression
Reeves, Russell, et al, 1932	1929-30 34 LA	B CS	AS I	IT,IS descriptive
Russell & Doi, 1955	1954--55 6 P CU/BC in NM	J CS	I SR	IT,IS descriptive
Scales, 1969	1966-67 72 P, 55 I CC in the South	R CS	S I	IT,IS raw data
Southern Association, 1984	1983-84 324 P/I CC, 160 P/I BC, 136 P/I CU in the South	R CS	AS I	IT descriptive
Terman, 1969	1966-67 36 P/I RU/DU/CU	J CS	AS C(U)	IT,CC,Q,SL raw data
Ven Hoerst & Henkhaus, 1973	1972-73 65 LA	J CS	AS D	IT,IS descriptive

Symbols, by column

(3) RU = research university, DU = doctoral university, CU = comprehensive university or college, BC = baccalaureate college, LA = private liberal arts college, CC = community or junior college, S = special, P = public, I = independent, / between symbols = grouped together

(4) B = book, D = dissertation, J = journal, R = report

(5) CS = cross section, TS = time series

(6) S = survey, AS = author survey, IR = institutional records, SR = state records, O = other

(7) D = department, I = institution, P = program, C(U) = college within a university

(8) CC = curriculum content, CD = curriculum diversity, CL = cost of living, CS = class size, F = number of faculty, FL = faculty load, FS = faculty salaries or compensation, IS = institutional sector, IT = institutional type, Q = quality, RE = research expenditures, SD = student demographics, SF = student faculty ratio, SL = student level, LF = linear relationship assumed

(9) Descriptive = interval data provided directly, regression = interval data was created from regression results for purposes of present analysis, raw data = interval data created from raw data (on enrollments and average cost per student by institution)

* A special note is in order for the Dickmeyer and Cirino studies, because they comprise a substantial portion of all the studies shown in Table 1. It should also be emphasized that these ongoing, annual studies are an extremely important resource for information on the finances of public community colleges. In these studies, data on median cost per FTE student is provided for the following groups of institutions: 1) total head count (HC) enrollment is less than 5000; 2) total HC enrollment is between 5,000 and 15,000; 3) total HC is greater than 15,000; and 4) total FTE enrollment is less than 1000. HC enrollment includes credit and non-credit enrollment. Using HEGIS data, we examined the reported FTE enrollments of the institutions included in the 1982-83 study. Such data existed for about 90 percent of the institutions. We determined that, on an FTE credit enrollment basis, comparing median figures for group 2 and group 4 would provide the roughly four-to-one enrollment difference (for the midpoint of the enrollment intervals) that was needed for inclusion in the core analysis.

References

Adair, C. D. (1970). Cost analysis of instruction at the University of Arkansas in 1968. Ed.D. dissertation, University of Arkansas.

Blau, P. M. (1973). The organization of academic work. New York: John Wiley and Sons.

Borgmann, C. W., & Bartram, J. W. (1969). Mineral engineering education in the West. Boulder, Colo.: Western Interstate Commission for Higher Education.

Bowen, H. R. (1980). The costs of higher education: how much do colleges and universities spend per student and how much should they spend? San Francisco: Jossey-Bass.

Brinkman, P. T. (1981a). Factors affecting instructional costs at major research universities. The Journal of Higher Education, 52, 265-279.

Brinkman, P. T. (1981b). Marginal costs of instruction in public higher education. Ph.D. dissertation, University of Arizona.

Brinkman. P. T. (1984). A comparison of expenditure patterns in four-year public and private institutions. Boulder, Colo.: National Center for Higher Education Management Systems.

Brinkman, P. T. (1985). The financial impact of part-time enrollments in two-year colleges. Journal of Higher Education, 56, (in press).

Broomall, L. W., Mahan, B. T., McLaughlin, G. W., & Patton, S. S. (1978). Economies of scale in higher education. Blacksburg, Va.: Virginia Polytechnic Institute and State University, Office of Institutional Research. (ERIC Document Reproduction Service No. ED 162604)

Brovender, S. (1974). On the economics of a university: toward the determination of marginal cost of teaching services. Journal of Political Economy, 82, 657-664.

Brown, J. D. (1969). The liberal university: an institutional analysis. New York: McGraw-Hill.

Buckles, S. (1978). Identification of causes of increasing costs in higher education. Southern Economic Journal, 45, 258-265.

Butter, I. H. (1966). Economics of graduate education: an exploratory study. Ann Arbor: The University of Michigan Department of Economics. (ERIC Document Reproduction Service No. ED 010639)

Cage, B. N., & Manatt, R. D. (1969). Cost analysis of selected educational programs in the community colleges of Iowa. The Journal of Educational Research, 63, 366-370.

California Coordinating Council for Higher Education. (1969). Meeting the enrollment demand for public higher education in California through 1977--the need for additional college and university campuses. Sacramento: Coördinating Council for Higher Education.

Calkins, R. N. (1963). The unit costs of programmes in higher education. Ph.D. dissertation, Columbia University.

Carlson, D. E. (1972). The production and cost behavior of higher education institutions. Ford Foundation Program for Research in University Administration. Berkeley: University of California. (ERIC Document Reproduction Service No. ED 081 375)

Carnegie Commission on Higher Education. (1972). The more effective use of resources. New York: McGraw-Hill.

Carnegie Commission on Higher Education. (1971). New students and new places. New York: McGraw-Hill.

Chickering, A. W. (1969). Education and identity. San Francisco: Jossey-Bass.

Columbia Research Associates (1971). The cost of college. Cambridge, Ma.: Columbia Research Associates.

Corrallo, S. B. (1970). An analysis of instructional expenditures for institutions of higher education in the northeast United States. Ph.D. dissertation, State University of New York at Buffalo.

Cullen, J. B., & Baker, D. G. (1984). Administration size and organizational size: an examination of the lag structure. Academy of Management Journal, 27, 644-653.

D'Angelo, R. D. (1970). Variations in instructional and general expenditures associated with seven administrative factors in private liberal arts colleges for the academic year, 1966-67. Ph.D. dissertation, Ohio University.

Denzau, A. T. (1975). An empirical survey of studies on public school spending.", National Tax Journal, 28, 241-249.

Dickmeyer, N. (1980). Comparative financial statistics for community and junior colleges, 1978-1979. Washington, D.C.: National Association of College and University Business Officers.

Dickmeyer, N. (1982). Small independent colleges and economies of scale. Research in Higher Education, 17, 51-67.

Dickmeyer, N., & Cirino, A. M. (1981). Comparative financial statistics for public community and junior colleges, 1979-80. Washington, D.C.: National Association of College and University Business Officers.

Dickmeyer, N., & Cirino, A. M. (1982). Comparative financial statistics for public community and junior colleges 1980-81. Washington, D.C.: National Association of College and University Business Officers.

Dickmeyer, N., & Cirino, A. M. (1983). Comparative financial statistics for public community and junior colleges 1981-82. Washington, D.C.: National Association of College and University Business Officers.

Dickmeyer, N., & Cirino, A. M. (1984). Comparative financial statistics for public community and junior colleges 1982-83. Washington, D.C.: National Association of College and University Business Officers.

Dillon, C. E. (1980). The rising costs of higher education. Ph.D. dissertation, Claremont Graduate School.

Dukiet, K. (1974). The cost of higher education 1973-74. College Management, 9, 8-18.

Fickett, A. G. (1977). An analysis of selected factors related to instructional costs and the allocation of instructional resources to public community junior colleges in Florida. Ph.D. dissertation, The Florida State University.

Fiuzat, Y. (1973). Physical productivity trend of Missouri and Illinois public junior colleges and its relationships with selected institutional attributes, 1968-72. Ph.D. dissertation, Columbia University.

Fox, W. F. (1981). "Reviewing economies of size in education." Journal of Education Finance, 6, 273-296.

Frisbee, J. (1970). Analysis of instructional program costs in a small liberal arts college. Ed.D. dissertation, University of Tennessee.

Furlong, R. B. (1983). Expenditure patterns in Alabama's public universities. Ph.D. dissertation, Auburn University.

Gerber, C. R. (1968). Faculty workload and unit cost of instruction in Minnesota state junior colleges. Ph.D. dissertation, University of Minnesota.

Glass, G. V., McGaw, B., & Smith, M. L. (1981). Meta-analysis in social research. Beverly Hills: Sage Publications.

Gold, B. (1981). Changing perspectives on size, scale, and returns: an interpretive survey. Journal of Economic Literature, 19, 5-33.

Hackett, E. R. (1981). An analysis of the economy of scale assumption in the state level allocation formula of colleges. Ph.D. dissertation, Florida State University.

Hawley, A. H., Boland, W., & Boland, M. (1965). Population size and administration in institutions of higher education. American Sociological Review, 30, 252-255.

Hodgkinson, H. (1970). Ideal governance structure would be large and smaller simultaneously. College and University Business, 48, 65-68.

Hungate, T. C., Meeth, R., & O'Connell, W. R., Jr. (1964). The quality and cost of liberal arts college program. In E. J. McGrath (Ed.) Cooperative, Long Range Planning in Liberal Arts Colleges. New York: Columbia University.

Hunter, J. E., Schmidt, F. L., & Jackson, G. B. (1982). Meta-analysis: cumulating research findings across studies. Beverly Hills: Sage Publications.

Jenny, H. H., & Wynn, R. G. (1970). The golden years: a study of income and expenditure growth and distribution of 48 private four year liberal arts colleges 1960-1968. Wooster, Ohio: The College of Wooster.

Jenny, H. H. & Wynn, R. G. (1972). The turning point: a study of income and expenditure growth and distribution of 48 private four year liberal arts colleges 1960-1970. Wooster, Ohio: The College of Wooster.

Jordan, T. E. (1965). An exploration of the relationship among size, cost, and selected educational opportunities in certain Texas public junior colleges. Ed.D. dissertation, University of Houston.

Keene, T. W. (1963). Foundation program cost differentials for community junior colleges. Ed.D. dissertat , University of Florida.

Koos, L. V. (1925). The junior-college movement. Boston: Ginn and Company.

Kress, S. (1977). Economies of scale and the form of expenditure functions in education. (Ph.D. dissertation, University of California, Berkeley.)

Leslie, L. L. & Brinkman, P. T. (1980). Instructional cost at research universities. In L. L. Leslie and H. L. Otto (Eds.) Financing and Budgeting Postsecondary Education in the 1980's, Tucson: University of Arizona.

Lyell, E. H. The cost structure of higher education: implications for governmental policy in steady state. Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, April, 1979. (ERIC Document Reproduction Service No. ED 172634)

Magee, H. J. (1931). Unit costs of teachers' college and normal schools. New York: Columbia University Teachers College.

Marks, J. L. (1980). Forces shaping the humanities in public two-year colleges. (Ph.D. dissertation, University of Arizona).

Martin, A. B. (1949). Cost of administration, instruction, and maintenance of public junior colleges in the United States. Ph.D. dissertation, University of Texas at Austin.

Maynard, J. (1971). Some microeconomics of higher education. Lincoln: University of Nebraska Press.

McLaughlin, G. W., Montgomery, J. R., Smith, A. W., & Broomall, L. W. (1980). Size and efficiency. Research in Higher Education, 12, 53-66.

Meeth. R. L. (1974). Quality education for less money. San Francisco: Jossey-Bass.

Metz, G. E. (1964). Current fund expenditures. Altanta: Commission on Colleges Southern Association of Colleges and Schools.

Millett, J. D. (1952). Financing higher education in the United States. New York: Columbia University Press.

Millett, J. D. (1980). Report on enrollment and costs in the Minnesota community college system. St. Paul: Academy for Educational Development.

Mullen, J. M. (1981). Minimum institutional size and resource requirements: an analysis of the economic factors for two year public colleges. Ed.D. dissertation, University of Virginia.

National Federation of College and University Business Officers Associations (1955). A study of income and expenditures in sixty colleges year 1953-1957. Washington, D.C.: NFCUBOA.

National Federation of College and University Business Officers Associations (1960). The sixty college study . . . a second look. Washington, D.C.: NFCUBOA.

Oborn, D. S. (1971). Optimum size of Illinois public junior college campuses relative to selected costs. Ed.D. dissertation, Illinois State University.

Ostrom, W. A. (1968). The relationship of size to current expense of education in California single-college public junior college districts. Ed.D. dissertation, University of Southern California.

Powel, J. H., Jr., & Lamson, R. D. (1970). Elements related to the determination of costs and benefits of graduate education. Washington, D.C.: The Council of Graduate Schools.

Radner, R., & L. S. Miller. (1975). Demand and supply in U.S. higher education. New York: McGraw-Hill.

Razin, A., & Campbell, J. (1972). Internal allocation of university resources. Western Economic Journal, 10, 308-320.

Reeves, F. W., Russell, J. D., Gregg, H. C., Brumbaugh, A. J., & Blauch, L. E. (1932). The liberal arts college. Chicago: The University of Chicago Press.

Reichard, D. J. (1971). Campus size: a selective review. Atlanta: Southern Regional Education Board.

Reynolds, R. L. (1983). Policy choices and economies of scale. Journal of Economic Issues, 17, 1067-1074.

Russell, J. D. & Doi, J. I. (1955). Analysis of expenditures for administrative and general purposes. College and University Business, 19, 39-41.

Russell, J. D., & Reeves, F. W. (1935). Finance. Vol. 7 of The Evaluation of Higher Institutions. Chicago: University of Chicago Press.

Scales, E. E. (1969). Current operating costs of two-year colleges in the South. Atlanta: Commission on Colleges Southern Association of Colleges and Schools.

Sengupta, J. K. (1975). Cost and productivity functions in the university education system: an econometric analysis. In H. Correa (Ed.) Analytical Models in Educational Planning and Administration. New York: David McKay.

Shymoniak, L., & McIntyre, C. (1980). Incremental cost study. Sacramento: California Community Colleges Office of the Chancellor. (ERIC Document Reproduction Service No. ED 188687)

Smith, N. S. (1978). An economic analysis of the costs of instruction in the Michigan system of higher education. Ph.D. dissertation, Michigan State University.

Siegel, B. N. (1967). Costing students in higher education--a case study. ERIC Document No. ED 014143.

Southern Association of Colleges and Schools. (1984). Educational and general expenditures of member institutions. Atlanta: SACS.

Suver, J. A. (1973). An analysis of instructional costs and their relationship to certain variables included within the instructional budget category for selected colleges of Washington state. Ph.D. dissertation, University of Washington.

Terman, F. E. (1969). Economic factors relating to engineering programs. Journal of Engineering Education, 59, 510-514.

Thompson, F., & Zumeta, W. A regulatory model of governmental coordinating activities in the higher education sector. Economics of Education Review, 1, 27-52.

Tierney, M. L. (1980). An estimate of departmental cost functions. Higher Education, 9, 453-468.

Trueheart, W. E., & Weathersby, G. B. (1976). Production function analysis in higher education: general methodology and application to four year black colleges. Cambridge, Ma.: Harvard University.

Ven Hoerst, S. M., & Henkhaus, E. J. (1973). Nonacademic operating costs: how small colleges compare. College and University Business, 55, 24-26.

Verry, D., & Davies, B. (1976). University costs and output. Amsterdam: Elsevier.

Wallhaus, P. (1981). An analysis of the factors which affect instructional unit cost in the public community colleges of Illinois. Springfield: Illinois Community College Board. (ERIC Document Reproduction Service No. ED 198848)

Webb, P. E. (1934). Interrelations of size, cost, and curriculum in junior colleges. Ph.D. dissertation, Yale University.