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Instructional Costs per Student Credit Hour: Differences by Level of Instruction

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COST BY LEVEL

The variation of unit costs by level of instruction, on either a per-student or per-student-credit-hour basis, is a traditional issue in the economics and finance of higher education. Funding formulas, for either requesting or allocating funds, often include recognition of an institution's effort by level of instruction. The same is likely to be true for internal budgeting among departments and programs, and for many kinds of program planning. In recent times, the growing interest in differential pricing schemes, in which tuition is established on the basis of the different costs of programs (or courses) taken by students, has added another reason for higher education administrators to be cognizant of cost differences associated with levels of instruction.

Researchers have examined these costs from the perspective of equity issues,¹ of productivity in higher education,² or the university as a firm.³ In addition, as the authors of *Involvement in Learning*⁴ have emphasized, costs by level are one indication of whether too few resources may be flowing to the early (lower-division) years of the collegiate experience, thereby exacerbating problems such as high attrition rates and inadequate preparation in basic knowledge and skills.

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1. Estelle James, "Product Mix and Cost Disaggregation: A Reinterpretation of the Economics of Higher Education," *The Journal of Human Resources* 13 (1978): 157-86.

2. June O'Neill, *Resource Use in Higher Education* (Berkeley: Carnegie Commission on Higher Education, 1971); Roy Radner and Leonard S. Miller, *Demand and Supply in U.S. Higher Education: A Report Prepared for the Carnegie Commission on Higher Education* (New York McGraw-Hill, 1975); and C. L. Skoro and G. Hryvniak, "The Productivity of U.S. Higher Education, 1967-1977" *Research in Higher Education* 13 (1980): 147-87.

3. Lawrence Southwick, Jr., "The University as a Firm," *Carnegie Review* (October 1967): 3ff; and Donal Verry and Bledwyn Davies, *University Costs and Outputs* (New York: Elsevier, 1976).

4. Study Group on the Conditions of Excellence in American Higher Education, *Involvement in Learning: Realizing the Potential of American Higher Education* (Washington, DC: National Institute of Education, 1984).

The determination of costs by level of instruction is sufficiently complex that such data are not routinely gathered by all, or even most, institutions. Thus, while such data are important, they are not as available as they ought to be. Furthermore, when these data are gathered only locally, they are subject to the vagaries of all cost data, and may reflect local idiosyncrasies more than general, underlying tendencies with broad applicability.

The objective of this study, then, is to provide data about costs by level of instruction in such a way as to be useful for the many purposes mentioned earlier. The results of a large number of cost studies that have calculated costs by level will be used to determine what the ratios are, on average, between the unit costs of providing instruction at the lower-division versus upper-division versus graduate level (distinguishing when possible between master's and doctoral work).

The investigation will focus primarily on the direct costs of instruction, as opposed to other, indirect costs, such as those for general administration, student services, the physical plant, and so on, that have only an indirect relationship to instruction. Nonetheless, data on full costs (which include both indirect and direct costs) will be provided in instances where they are available. The results will be disaggregated by type of institution and by type of instructional program (i.e., by discipline). All of the results reported in tables are based on data derived from cost accounting procedures.

PRODUCTION ISSUES

Several types of direct cost, institutional resources contribute to the provision of instructional services: personnel, supplies and equipment, classroom and laboratory space, communication (e.g., printing, telephone), and travel. The largest single component of the direct cost of instruction is faculty compensation (salaries and fringe benefits). It is not uncommon for faculty compensation to constitute 70 to 80 percent or more of total direct instructional expenditures. The other cost components tend to follow faculty costs. For example, the greater the number of faculty, the higher the cost for telephones, supplies, travel, and so on. Accordingly, a major issue in any study of costs by level of instruction is how to allocate faculty compensation across levels of instruction. This issue will be discussed in the next section.

The data to be examined reveal the extent to which costs on a per-student-credit-hour basis are less for lower-division than for upper-division or graduate instruction. The reasons why this is so are straightforward. On average, the student-faculty ratio is

higher at the lower-division level. Also, proportionately more junior faculty (assistant professors, instructors and teaching assistants) are used in lower-division courses, leaving a disproportionate number of senior faculty, with their higher salaries, to teach at the upper-division and graduate levels. In addition, it appears that fewer supplies and equipment are used on a per-credit-hour basis at lower instructional levels.

Differences in available resources by type of institution, resource prices, and resource utilization lead to differences in the cost ratios between levels of instruction. For instance, institutions that provide doctoral-level instruction will be able, if they so choose, to use their doctoral students as instructors at the lower-division level. Since the pay rates for these individuals are relatively low, the relative cost for lower-division instruction is likely to be less at doctoral institutions than at four-year institutions that must rely more heavily on regular faculty. Of course, the presence of part-time faculty (who are not graduate students) in virtually all types of institutions adds complexity to the situation and makes it more difficult to predict the outcome by type of institution.

Scale-related effects also add complexity to the underlying phenomenon. As a rule, the smaller the scale of operation (that is, the lower the enrollment), the higher the costs per credit hour or per student, and vice versa. Thus, institutions that provide services at the graduate level to small numbers of students may have exceptionally high cost ratios, comparing graduate to lower-division instruction. Similarly, institutions that have small upper-division enrollments, perhaps due to high attrition rates, are likely to experience high cost ratios comparing upper to lower-division instruction. Institutions that can maintain large class sizes can keep their unit costs relatively low at any level of instruction. Scale-related effects can be especially strong at the program- or discipline-level of analysis, where extremely small enrollments sometimes occur. Gibson⁵ analyzes these effects for average costs by discipline by level of instruction, and Brinkman⁶ does the same for marginal costs by institution by level of student.

ALLOCATION ISSUES

As noted earlier, determining direct costs by level of instruction inevitably involves allocation procedures focusing on faculty

5. Thomas Taylor Gibson, "Unit Costs of Higher Education: A Study of the University of Colorado" (Ph.D. diss., University of Colorado, 1968).

6. Paul T. Brinkman, "Marginal Costs of Instruction in Public Higher Education" (Ph.D. diss., University of Arizona, 1981).

time. Essentially two allocation procedures, or variations thereof, are used. The simplest procedure is to base the allocation of faculty costs on faculty teaching assignments. For example, if a faculty member teaches one-third of his or her courses at the lower-division level, then one-third of that individual's compensation (salary plus fringe benefits) for instruction would be allocated to the costs of lower division.

The other procedure is more complicated, as it attempts to take into account both the intensity of faculty effort (i.e., how much time faculty actually spend in teaching a course) and the full range of faculty activities (i.e., lecturing in a classroom, conducting seminars, advising majors, directing dissertations, serving on committees, and so on). With respect to teaching, for example, more preparation may be required for an upper-division course than for a course at the lower-division level. If so, then more faculty compensation would be allocated to upper-division costs than would be called for by basing the allocation on course assignments alone, other things being equal. Typically, this more complex procedure is based on a faculty activity survey wherein faculty are asked to indicate how much time they spend on each of their duties.

Of the 225 data points in the core analysis to be reported on below, roughly 80 percent are based on a faculty assignment procedure, 14 percent on a faculty activity survey, and 6 percent on procedures not disclosed. Preliminary analysis revealed that distinguishing between the allocation approaches had no material effect on the results, so the results reported below are not disaggregated on this dimension.

A thorough analysis of how faculty costs can and should be allocated, with respect to determining the cost of a course, is found in Crothers.⁷ He concluded that the true costs of instruction can best be determined only by means of a faculty analysis survey. Crothers also discovered that about 45 percent of a faculty member's time, on average, was spent on non-instructional activities, whose costs are difficult to quantify. Fortunately, in light of the available data, the critical issue for the present study is not the true cost of instruction, but the relative costs by level of instruction. Crothers' finding that there is little correlation between course level and faculty time spent on the course lends credibility to allocating faculty costs by course assignment. However, the

7. William Clark Crothers, "A Multiple Correlation and Regression Analysis Comparing Faculty Activity Survey with Other Methodologies for Allocating Costs to Courses" (Ph.D. diss., Michigan State University, 1973).

tendency of senior faculty to devote somewhat more of their time to non-instructional activities will tend to bias upwards the relative costs of upper-division and graduate instruction when costs are allocated solely on the basis of course assignments. A bias in the same direction is likely to be present if no adjustment is made for differences in class size.

Other direct instructional expenditures, such as office supplies, telephone, and travel, that cannot be directly associated with particular courses, typically are allocated to levels of instruction on the basis of faculty assignment or effort by level. The same is apparently true for allocating the cost of support staff, although frequently one can only guess how these costs were actually distributed.

As noted earlier, studies will occasionally include data on full costs (direct plus indirect). Various procedures can be used to allocate indirect costs, such as expenditures for general administration, student services, the library, and the operation of the plant, to the instructional function, and then, within that function, to levels of instruction. (A useful discussion can be found in NACUBO-NCHEMS.)⁸ Variations in procedures will be ignored in reporting full cost figures below. Examination of the full-cost data shows that they move quite consistently with direct-cost data, indicating that they probably have not been materially affected by differences in allocation procedures.

METHODOLOGY

This study is a research synthesis, or secondary analysis. The aim of the study is to derive central tendencies from the results of a large number of studies. The main advantage of this approach is that it overcomes a problem that plagues virtually any primary analysis of costs, which is the vulnerability of any one set of cost data to local idiosyncrasies. Such idiosyncrasies can be the result of peculiarities in accounting, in the actual structure of the processes being analyzed, or in critical aspects of the environment surrounding the process (such as the availability of a particularly large or small amount of revenue per unit of activity). In the latter two cases, the costs may be correctly stated, but they will not be representative of the typical institution's experience. By contrast, integrating the findings of many studies leads to results that

8. National Center for Higher Education Management Systems, *Procedures for Determining Historical Full Costs*, National Center for Higher Education Management Systems, National Association of College and University Business Officers Technical Report 65 (Boulder, Colo.: The Center, 1977).

can serve as benchmarks against which a given institution or system of institutions can evaluate its own costs.

The mode of synthesis followed here is in the spirit of the meta-analytic approach as developed in Glass, McGaw, and Smith;⁹ Hunter, Schmidt, and Jackson;¹⁰ and others. In essence, this means that an effort has been made to include data from a very wide set of studies, to standardize the data from these studies to the extent possible, and to integrate and present the standardized data using conventional statistics (as opposed to reporting the results in the serial fashion of the typical literature review).

There are three primary sources of data on costs by level of instruction. One source consists of the reports of state coordinating or governing boards that require data of this sort from the institutions within their purview. Examples of states that produce such reports include Florida, Kansas, Idaho, Illinois, Minnesota, Mississippi, Oregon, Tennessee, Virginia, and Wisconsin. The reports from a state, such as Kansas, that depends heavily on benchmark data from institutions outside the state can be an especially good source of data (i.e., it will contain many data points generated in a consistent manner). Higher education agencies in states that do not produce periodic reports of this kind may have pertinent data available from onetime special studies (as is true for Kentucky, for instance). Still other states, such as Ohio and Louisiana, can provide formula funding factors that either generate, or are based on, costs by level of instruction.

A second source of data consists of various studies conducted by individuals working on dissertations or engaged in research as staff members of an institution or system office. Some system offices, such as the one for the University of Colorado, have these studies done annually.

A third source of data is a set of studies conducted by the National Center for Higher Education Management Systems (NCHEMS) during the early 1970s. These studies, of which thirty could be used in the present investigation, were part of an effort to develop costing and interinstitutional data sharing models. These studies are especially valuable for comparative purposes because they employed a consistent methodology. A particular report or study may provide data by discipline, by groups of disciplines, by institution, or by groups of institutions. The

9. Gene V. Glass, Barry McGaw, and Mary Lee Smith, *Meta-Analysis in Social Research* (Beverly Hills: Sage Publications, 1981).

10. John E. Hunter, Frank L. Schmidt, and Greg B. Jackson, *Meta-Analysis: Cumulating Research Findings Across Studies*, American Psychological Association Studying Organizations: Innovations in Methodology no. 4 (Beverly Hills: Sage Publications, 1982).

NCHEMS studies, in addition to providing data by discipline, also provide data by student major (that is, cost data based on actual course-taking patterns of students with various majors). Altogether, the data that could be found make it possible to report results by institutional type, at institutional and disciplinary levels of analysis.

Organizing data by institutional type and by discipline were only two of a number of steps taken to standardize the available data. As mentioned in the previous section, some studies provide data on direct costs, some on full costs, and some on both. Direct cost results are reported separately from full cost results in the analyses that follow. A few studies provide data by level of student; these were not used. All results reported here refer to costs by level of instruction. Similarly, some studies report costs on a per-student basis, but most report costs on a per-credit-hour basis. This difference is not important when comparing lower-division to upper-division, because the typical credit-hour load tends to be roughly the same at the two levels. However, the course load of a typical graduate student is usually less than that of the typical undergraduate. Thus cost ratios between graduate and lower-division will be higher, on average, when reported on the basis of credit hours than on the basis of full-time-equivalent students. All of the cost ratios reported in the tables below are based on per-credit-hour costs.

Data from fifteen cost accounting studies were not included in deriving the results shown below. The primary reasons for excluding these data are as follows: the type of institution represented by the data could not be determined, the type of cost (direct versus full) could not be determined, the data were too old (pre-1950), or the data had to do with a subset of an institution (such as a college within a university) that did not correspond with the structure adopted for reporting on disciplines. In addition, data from several studies that report results based on statistical estimates rather than cost accounting procedures were not used to develop the tabled material because cost ratios were developed by level of student rather than by level of instruction.

RESULTS BY INSTITUTION

In classic cost and productivity studies that depend on ratios of costs by level, as in O'Neill¹¹ and Bowen,¹² it has been customary

11. O'Neill, *Resource Use*.

12. Howard R. Bowen, *The Costs of Higher Education: How Much Do Colleges and Universities Spend Per Student and How Much Should They Spend?* (San Francisco: Jossey-Bass Publishers, 1980).

to assume that the same ratios would hold for any type of institution. Yet, reflecting on the underlying mechanisms (differences in class size, the presence or absence of teaching assistants, a research emphasis that might drive up the salaries of certain faculty, and so on), one might well conclude that the cost ratios ought to vary by institutional type. Specifically, it would be reasonable to expect that the larger, more-complex institutions (in terms of degree levels and emphasis on research) would experience greater differences in costs by level. This turns out to be the case.

As shown in Table 1, there are systematic differences in the cost ratios by type of institution.¹³ The differences are quite modest comparing upper to lower division, but more substantial comparing graduate to lower division. With a few exceptions, the larger and more complex the institution, the larger the cost ratios. One exception is the high figure for G2:L at doctoral institutions

13. The criteria used in classifying institutions by the categories shown in Tables 1-3 are as follows:

Research Universities: These institutions are characterized by a significant level of activity in and commitment to doctoral-level education as measured by the number of doctorate recipients and the diversity in doctoral program offerings and by a significant level of research activities. To be classified as a research university, an institution must grant a minimum of thirty doctoral-level degrees in three or more doctoral-level program areas on an annual basis or, alternatively, have an interdisciplinary program at the doctorate level. Included in the counts of doctoral degrees are the first professional degrees (M.D., D.D., D.V.M., D.D.S.). In addition to meeting the criteria on degrees, a research university must rank among the top seventy-five institutions in the country in research expenditures. For this study, exceptions have been made to include Rockefeller University and Georgia Institute of Technology Main Campus in this category because of their doctoral program emphasis and substantial level of research.

Universities: These institutions meet all of the criteria stated above, except they are not as extensively involved in research activities as the research universities.

Comprehensive Institutions: These institutions are characterized by a strong, diverse post-baccalaureate program (including first professional), but do not engage in significant doctoral-level education. Specifically, this category includes institutions not considered major doctoral schools in that the number of doctoral-level degrees granted is less than thirty or in that fewer than three doctoral-level programs are offered. In addition, these institutions must grant a minimum of thirty post-baccalaureate degrees and either grant degrees in three or more post-baccalaureate programs, or alternatively, have an interdisciplinary program at the post-baccalaureate level.

General Baccalaureate Institutions: These institutions have, as their primary emphasis, general undergraduate, baccalaureate education. They are not significantly engaged in post-baccalaureate education. Included are institutions not considered specialized institutions, in which the number of post-baccalaureate degrees granted is less than thirty or in which fewer than three post-baccalaureate-level programs are offered, but either (a) grant baccalaureate degrees and grant degrees in three or more baccalaureate programs, or (b) offer a baccalaureate program in interdisciplinary studies. Additionally, over 25 percent of the degrees granted must be at the baccalaureate level or above.

compared to that at research universities. This is likely the result of extreme diseconomies of scale in some of the programs at the doctoral institutions. As the ranges indicate, there are considerable variations from one institution to another within institutional types. A variety of unique circumstances are the reason, no doubt, and they need to be kept in mind, as in any cost study, in thinking of the normative value of these data.

As the results indicate, the full-cost ratios without exception are less than the direct-cost ratios. This is to be expected, because most of an institution's indirect costs have little if anything to do with levels of instruction. Thus, with respect to the unit costs of instruction, they tend to be distributed (allocated) relatively evenly across the levels, thereby diminishing the cost ratios.

How do these results compare to figures used in the classic studies mentioned above, wherein cost ratios by level are an integral part of various kinds of cost and productivity analyses? The answer is surprisingly complicated. If we turn first to O'Neill's¹⁴ longitudinal analysis of productivity in higher education, we find the following cost ratios being used: 1.5 to 1, for upper to lower division; and 3.75 to 1 for graduate to lower division. These ratios are taken as representing differences in costs per credit hour, as measured on a full-cost basis. Actually, her cost data are full operating costs plus capital costs, or more inclusive than the full-cost data in Table 1 that refer to operating costs only. As one can see, some of the data in Table 1 are quite similar to O'Neill's. The combined graduate ratio (G:L) for full costs is just over 4 to 1 (for doctoral and research institutions), compared to her 3.75 to 1. Her 1.5 to 1 ratio for upper to lower division is very close to the average of the full-cost mean values for the various types of institutions in Table 1.

The picture is complicated by the fact that O'Neill's data source for the cost ratios was a set of studies done in Michigan during the 1960s, which provided data on direct costs, not full costs. In noting this, O'Neill suggests that the ratios she uses may be biased upwards, given that indirect costs "are more equitably distributed by grade level" and thus will depress cost ratios when added to direct costs. It is difficult to judge from the data in Table 1 whether her concern was as justified in practice as it is in principle. For the most part the data in the table reflect conditions during the 1970s and early 1980s. James¹⁵ provides evidence that the cost ratios have been getting larger over the past several dec-

14. O'Neill, *Resource Use*.

15. James, "Product Mix."

TABLE I
COST RATIOS PER CREDIT HOUR BY
LEVEL OF INSTRUCTION

	Direct Costs				Full Costs			
	U:L	G1:L	G:L	G2:L	U:L	G1:L	G:L	G2:L
A. Baccalaureate								
Min	1.06	1.30			1.10	1.30		
Max	2.62	3.00			1.99	2.80		
Mean	1.60	1.92			1.49	1.94		
S.D.	0.39	0.52			0.28	0.55		
Cases	29	7			15	5		
B. Comprehensive								
Min	1.20	1.26		3.69	1.20	1.25		2.05
Max	2.28	6.10		5.23	1.70	5.90		4.19
Mean	1.57	2.80		4.46	1.39	2.59		2.99
S.D.	0.21	0.79		0.60	0.14	1.11		0.81
Cases	80	80		4	20	20		4
C. Doctoral								
Min	1.18	2.63	2.23	3.67	1.16	2.84	2.00	3.23
Max	2.00	4.63	6.25	13.40	1.90	4.71	5.83	6.45
Mean	1.64	3.79	4.54	9.12	1.52	3.30	4.07	4.46
S.D.	0.19	0.45	1.20	2.92	0.21	0.58	1.66	1.04
Cases	25	19	12	13	14	8	6	8
D. Research								
Min	1.28	2.81	2.94	3.48	1.47	2.58	2.91	3.84
Max	2.23	4.93	7.16	11.26	2.00	3.08	5.10	4.71
Mean	1.83	3.87	4.97	8.45	1.74	2.83	4.11	4.28
S.D.	0.23	0.73	1.09	2.30	0.15	0.25	0.68	0.43
Cases	46	24	22	24	8	2	6	2
E. Doctoral & Research								
Min	1.18	2.63	2.23	3.48	1.16	2.58	2.00	3.23
Max	2.23	4.93	7.16	13.40	2.00	4.71	5.83	6.45
Mean	1.76	3.61	4.78	8.56	1.61	3.21	4.08	4.42
S.D.	0.24	0.69	1.16	2.54	0.22	0.56	1.27	0.95
Cases	71	43	34	37	22	10	12	10

*L = lower-division costs, U = upper-division costs, G1 = masters-level costs, G2 = doctorate-level costs, G = combined graduate costs.

Sources: See list in footnote 19.

ades, at least for research universities. It may be, then, that O'Neill's data were upward biased with respect to the analysis she was undertaking at that time. Those same estimates, however, would be downward biased at the present time, if the broadly based figures in Table 1 are to be believed. And, to complete the picture, the same ratios (3.75:1 and 1.5:1) were used in the work done by Skoro and Hryvniak¹⁶ that extended O'Neill's longitudi-

16. Skoro and Hryvniak, "The Productivity of U.S. Higher Education."

nal analysis another ten years through 1977. In this instance, the estimated ratios were very much on target except for comprehensive institutions, where most graduate instruction is at the master's level.

Another important use of cost ratios occurs in Bowen's 1980 work on the costs of higher education. The ratios are used to construct an artificial student unit that in turn is used to derive cost-per-student data. Differences among institutions in costs per student, which Bowen shows to be quite large, are to some extent a function of the ratios adopted. Based on his analysis of some fifteen studies in which costs by level are reported, Bowen uses the following ratios: 1.5 to 1, upper to lower division: 2.1 to 1, master's to lower division: and 3 to 1, for "beyond first year" graduate students to lower division. To compare these ratios with those in Table 1, one must keep in mind that they are for full costs, expressed in per-student rather than per-credit-hour terms, and refer to costs by level of student rather than level of instruction.

It is difficult to determine how best to convert cost ratios based on credit hours to ratios based on students. The available data on master's students in particular is ambiguous. One the other hand, the ratio data gathered as part of this study indicate that little or no adjustment is needed. For instance, at comprehensive institutions the student-based cost ratio was 2.96 for direct costs (26 cases) and 2.27 for full costs (20 cases) compared to 2.8 and 2.59, respectively, in Table 1. At research institutions, the corresponding values were 4.32 (5 cases) and 3.26 (6 cases), compared to 4.05 and 3.22, respectively, in Table 1. The correspondence was similar for doctoral institutions, but all five cases were from the same state. On the other hand, in two states (Idaho and Wisconsin) where cost ratios are calculated in both per-credit-hour and per-student terms, the per-student ratio for master's to lower division is about 20 to 30 percent below that for the per-credit hour ratio. Data from the Higher Education General Information Surveys (HEGIS), when the surveys still contained data on student credit hours by level, show that the full-time equivalent of first-year graduate students (a reasonable surrogate for a master's student) take about 11.5 credits on average for all types of institutions offering instruction at that level, compared to about 15 credits for undergraduates. This would argue for a 23 percent adjustment, i.e., for multiplying the Gl:L values in Table 1 by 11.5/15, or 0.77, to move from per-credit-hour to per-student ratios.

For doctoral-level instruction, a heavier adjustment is required. For full costs, a figure of 30 percent is not unreasonable.

That would put the estimated per-student ratio for doctoral and research universities combined at about 3.1, i.e., 0.7 times 4.42. For direct costs, if it is assumed that doctoral students take 8 credits on average, compared to 15 for lower-division students, then the multiplier is 0.53. It yields an estimated per student cost ratio of 4.57 at doctoral and research institutions combined.

To adjust the data in Table 1 to reflect cost ratios per student by level of student, the data must first be transformed, in the manner just described, from per-credit-hour to per-student cost ratios. Then the per-student ratios can be converted from level of instruction to level of student by multiplying the per-student ratios by some number that is greater than zero but less than one. Because students at one level occasionally take courses at other levels, the cost ratios by level of student must be less than the ratios by level of instruction. Gibson,¹⁷ for instance, found differences of 12 percent and 25 percent for upper-division and graduate cost ratios, respectively, between level-of-instruction and level-of-student ratios at a research university. By contrast, across eleven public universities in Ohio in 1983-84 upper-division students took 17 percent of their credit hours at the lower-division level of instruction, while graduate students took only 4.5 percent of their credits at the undergraduate level,¹⁸ suggesting rather different adjustment factors than those indicated by Gibson's analysis.

No broadly based measures of average behavior in this regard could be assembled. The few available data sources suggest that the patterns differ considerably from one institution or state to the next.

While recent data predominate in the studies included in Table 1, there is enough of a temporal spread in the data to provide confirmation of James' notion that the ratios (per-credit-hour by level of instruction) have become larger at institutions that are heavily committed to graduate education and research. Comparing the period from 1953 to 1974 to the period from 1978 to 1985, the increases were about 12, 28, and 44 percent, for upper-division, master's, and doctoral cost ratios, respectively, at research universities. At other types of institutions, the ratios have stayed about the same, as measured by the data gathered for this study.

17. Gibson, "Unit Costs."

18. Rosemary Jones, personal communication from Ohio Board of Regents, Columbus, Ohio, June 25, 1985.

RESULTS BY DISCIPLINE

There are two primary factors that could be expected to create differences in the costs ratios by discipline. The fundamental factor would be the underlying production relationships that are required (more or less) by the various disciplines. A relatively heavy reliance on laboratory courses, for instance, would be one such relationship. The need for relatively small classes, as in a writing program, would be another. The second factor is the differing effects of scale. A discipline that is undersubscribed relative to the capacity (mostly in the form of faculty) that must be maintained to assure a quality program is likely to have relatively high costs. There could be some changes in the rankings among disciplines over time, then, in accord with changes in student demand for various programs.

Table 2 shows cost ratios for a selected set of disciplines. The first portion of the table provides ratios for comprehensive institutions that have substantial master's-level programs. The second portion of the table provides data on institutions that are heavily engaged in doctoral-level instruction. Note that all ratios are expressed in per-student-credit-hour terms.

TABLE 2
COST RATIOS BY SELECTED DISCIPLINES

Comprehensive Institutions					
Upper Division to Lower Division					
	Mean	S.D.	Min	Max	N
Biology	2.26	1.11	1.00	7.34	50
Psychology	2.20	1.16	0.69	7.79	48
Physical Science	2.12	1.19	1.04	7.22	50
Social Science	2.04	0.51	1.38	3.88	50
Mathematics	1.99	0.70	0.60	4.13	50
Letters	1.75	0.48	0.94	2.75	50
Art and Music	1.72	0.50	0.81	3.35	49
Computer Science	1.52	0.78	0.81	4.05	26
Education	1.29	0.48	0.68	3.56	44
Business	1.28	0.32	0.80	2.48	40
Engineering	1.26	0.35	0.29	1.76	14
Group Average	1.74	0.67	0.86	4.13	
Masters to Lower Division					
	Mean	S.D.	Min	Max	N
Biology	4.63	2.52	1.27	16.33	42
Psychology	4.35	2.64	1.43	15.40	42
Social Science	4.22	2.03	1.57	12.18	49
Mathematics	4.21	2.37	0.74	11.38	48
Engineering	3.33	3.01	1.49	11.56	8
Computer Science	3.27	2.66	0.70	11.21	13
Letters	3.24	1.54	1.50	9.13	48
Business	3.15	2.08	0.93	14.14	37

TABLE 2 (Continued)
COST RATIOS BY SELECTED DISCIPLINES

Comprehensive Institutions					
Masters to Lower Division					
Art and Music	3.06	1.83	0.49	10.97	46
Education	1.87	1.35	1.00	10.44	43
Group Average	3.34	1.76	1.25	8.97	
Doctoral and Research Institutions					
Upper Division to Lower Division					
	Mean	S.D.	Min	Max	N
Biology	2.17	0.62	1.14	3.19	29
Computer Science	2.13	0.73	0.83	3.13	25
Mathematics	2.08	0.60	1.18	4.43	25
Letters	2.05	0.58	1.15	4.00	20
Social Science	2.02	0.48	1.13	3.37	28
Psychology	2.01	0.68	1.22	4.38	29
Physical Science	2.00	0.33	1.31	2.55	29
Art and Music	1.81	0.40	1.25	2.66	27
Business	1.65	0.32	1.17	2.09	31
Engineering	1.54	0.49	0.91	2.28	27
Education	1.19	0.30	0.63	2.20	29
Group Average	1.88	0.50	1.08	3.12	
Masters to Lower Division					
	Mean	S.D.	Min	Max	N
Psychology	6.72	2.67	4.17	15.30	23
Physical Science	5.53	1.82	2.80	10.34	30
Biology	5.42	1.48	2.88	11.00	29
Social Science	5.12	1.10	3.20	9.00	28
Mathematics	5.00	1.86	2.40	11.70	24
Letters	4.31	1.20	2.21	6.64	27
Business	4.13	1.35	1.92	8.48	31
Computer Science	3.97	2.06	1.38	7.73	25
Engineering	3.55	1.54	1.62	7.16	27
Art and Music	3.34	0.92	1.94	5.68	28
Education	1.70	0.62	1.02	3.84	29
Group Average	4.44	1.51	2.32	8.81	
Doctoral to Lower Division					
	Mean	S.D.	Min	Max	N
Computer Science	13.43	8.88	0.62	24.00	12
Mathematics	12.61	6.25	3.26	25.82	19
Social Science	12.16	3.20	5.23	19.00	22
Psychology	11.29	5.64	3.80	25.46	17
Physical Science	9.70	3.75	2.91	20.53	29
Biology	8.97	3.44	3.71	17.36	22
Letters	8.22	3.92	2.07	12.50	14
Business	7.81	6.10	1.92	22.70	18
Engineering	6.84	2.12	2.41	9.92	27
Education	4.72	1.50	1.94	7.10	22
Art and Music	4.23	1.48	2.00	8.33	15
Group Average	9.09	4.21	2.72	17.52	

Sources: See list in footnote 19.

19. Data sources used to create Tables 1 and 2: Waldo K. Anderson, "Factors Associated with Instructional Costs in Kansas Public Higher Education, 1958-59" (Ph.D. diss., University of Minnesota, 1963); Elwin F. Cammack, personal communication from University of Wisconsin System, Madison, Wis., August 14, 1985; Martha Casey, personal communication from University of Wisconsin System, Madison, Wis., June 26, 1985; Denis J. Curry and Norman M. Fischer, *Summary Report, 1974-75 Unit Expenditure Study* (Olympia, Wash.: Washington State Council for Postsecondary Education, 1977), from ERIC Document Reproduction Service, ED140879; Warren W. Gulko, *Unit Costs of Instruction. A Methodological Approach* (Boulder, Colo. Western Interstate Commission on Higher Education [WICHE], 1971); Stephen R. Hample, "A Cost Analysis of Instruction at Montana State University" (Ed.D. diss., Montana State University, 1975); Idaho Board of Education and Board of Regents of the University of Idaho, *Idaho College and Universities Statewide Cost Study, FY83-84 State Appropriated Funds* (Boise, Idaho: Idaho Board of Education and Board of Regents of the University of Idaho, 1985); Idaho State Board of Education, *Idaho College and Universities Statewide Cost Study, FY1979-80* (Idaho: Idaho State Board of Education, 1980); Illinois Board of Higher Education, *1983-84 Academic Discipline Unit Cost Study and 1983-84 Comparative Cost Study for Illinois Public Universities* (Springfield, Ill.: Board of Higher Education, 1984); Illinois Board of Higher Education, *Report of Continuing Studies of Costs in Illinois Public Senior Institutions* (Springfield, Ill.: Illinois Board of Higher Education, 1969); Frank Peter Johnson, "Differential Tuition Determined by Discipline Unit Cost for Higher Education" (Ph.D. diss., Colorado State University, 1975); Kansas Board of Regents, *Relative Funding of the Regents Universities Fiscal Year 1983* (Overland Park, Kans.: Kansas Board of Regents, 1984); Kentucky Council on Higher Education, *Statewide Cost Study of Kentucky's Public Higher Education Institutions Fiscal Year 1975-76* (Frankfort, Ky.: Council on Higher Education, 1978); Lucy L. Martin, personal communication from Board of Trustees of State Institutions of Higher Learning, Jackson, Miss., July 3, 1985; Michigan Council of State College Presidents, "Unit Cost Study: Instruction and Departmental Research 1970-71," A Study for the Public Colleges and Universities in Michigan (Lansing, Mich.: Michigan Council of State College Presidents, April 1972); William T. Middlebrook, *California and Western Conference Cost and Statistical Study for the Year 1954-55* (California University of California, 1955); Minnesota Higher Education Coordinating Board, "Report on Instructional Expenditure Patterns in Public Postsecondary Education in Fiscal Year 1981," Staff Technical Paper (St. Paul, Minn.: Minnesota Higher Education Coordinating Board, June 1982); National Center for Higher Education Management Systems, *Cost Data and Descriptive Information Developed Through Use of NCHEMS Analytical Tools and Preliminary Information Exchange Procedures* (Boulder, Colo.: NCHEMS, 1971-74). Separate studies were done on the following institutions Bluefield State College, California State University-Fullerton (2), Central State University (2), Central Washington State College, Clarkson College of Technology, Fisk University, Georgia Institute of Technology (2), Kearney State College, Mansfield State College, McPherson College, Northern Michigan University, Pomona College, Rhode Island College, Rider College (2), Shippensburg State College (2), State University of New York at Plattsburg, Williams College, University of Cincinnati, University of Maine, University of New Mexico, University of North Dakota, University of Northern Colorado (2), University of Scranton, University of Wisconsin-LaCrosse; J. Alan Owen, *Instructional Expenditure Comparison, Three General Campuses, Fiscal Years 1981-82, 1982-83, and 1983-84* (Boulder, Colo.: University of Colorado, April 1985); Don K. Richards, "An Analysis of Class Size, Teaching Level, and Instructional Salary Costs in Utah State-Supported Collegiate Institutions of Higher Education" (Ed.D. diss., Utah State University, 1963); John Ridenhour, Dick Tallman, and Jerry E. Jaqua, *Hours and Cost Matrices Load and Cost Study Credit Enrollment Report: Fall Term 1983-84* (Corvallis, Or.: Oregon State University, Division of Management and Planning Services, 1984); John D. Russell and James I. Doi, "Analysis of Institutional Expenditures," *College and University Business* 19 (1955): 19-21; Barry N. Siegal, "Costing Students in Higher Education—A Case Study," ERIC Document Reproduction Service ED 014143, August, 1967; State University System of Florida Board of Regents, *Expenditure Analysis 1983-84 Revised* (Tallahassee, Fla.: State University System of Florida

At comprehensive institutions, it is clear that relatively high cost ratios are common in the sciences, both natural and social, comparing upper to lower division as well as master's to lower division. It might be speculated, however, that the reasons for this pattern differ for the two types of science. For the natural sciences, it may well be laboratory courses and equipment requirements that drive up the ratios. For the social sciences, it is more likely that the effects result from lower-division costs being driven down by virtue of the disciplines having a service function in the overall curriculum. That is, many students take lower-division courses in the social sciences in support of their major, or simply as an elective. Enrollments in the lower division soar with large class sizes and low unit costs as a consequence. This phenomena is less likely to occur in the natural sciences.

Perhaps the most interesting result for the comprehensive institutions is that costs per credit hour in engineering differ relatively little within the undergraduate years, as measured by the mean or the difference between the minimum and maximum values. What is not indicated by the data in Table 2, but is generally true, is the relatively high cost of engineering programs. What the data here show is that these relatively high costs occur already at the lower-division level—they would have to in order to generate these low cost ratios.

In looking at the results for doctoral institutions, it is found that at the undergraduate level there is less volatility in the ranges than at the comprehensive institutions, even though the mean value is higher. This situation is probably due to the influence of the scale of operation. Doctoral institutions have sufficiently large enrollments to make severe diseconomies of scale at the upper-division level quite unlikely. This is less true for comprehensive institutions.

At doctoral institutions, there is very little difference from one set of cost ratios to another for the bottom ranked disciplines.

Board of Regents, 1985); Tennessee Higher Education Commission, *An Analysis of Instructional Costs Per Student Credit Hour, Fall Quarter 1983 for Public Higher Education Institutions in Tennessee* (Nashville, Tenn.: Tennessee Higher Education Commission, 1984); Jim Topping, *Evaluation of I.E.P. Costing Procedures: A Pilot Study by Six Major Research Universities* (Boulder, Colo. NCHEMS, 1979); Washington Council for Postsecondary Education, "1978-79 Unit Expenditures Study," Report No. 81-4 (Olympia, Wash. Washington Council for Postsecondary Education, June 1981); Washington State Council on Higher Education, *1972-73 Instructional Expenditure Study* (Olympia, Wash.: Council on Higher Education, 1975), ERIC Document Reproduction Service ED 109948; Robert L. Williams, "The Cost of Educating One College Student," *The Educational Record* 42 (October 1961): 322-329; David R. Witmer, "The Value of College Education: A Benefit-Cost Analysis of Major Programs of Study in the Wisconsin State Universities" (Ph.D. diss., University of Wisconsin, 1971).

Education, for instance, is ranked last or next to last in all three panels, and engineering, art and music, and business also are consistently near the bottom. There is consistency at the high end of the cost ratios as well. Although no discipline ranks in the top four in all three pairings, mathematics, biology, psychology, computer science, physical science, and social science do so in two out of three instances. These results are very similar to those recorded for comprehensive institutions, and they probably reflect similar phenomenon: very low costs at the lower-division level for mathematics and the social sciences, and relatively high costs at the upper-division level for the laboratory-oriented sciences.

As the standard deviations and ranges indicate, the cost ratios at the graduate level vary considerably among institutions. These differences represent variations in the way programs are configured at the respective institutions, and they should give pause to anyone who would use these figures for normative purposes. Ratios for doctoral-level instruction are especially volatile, no doubt reflecting differences in the kind of program offered (for example, psychology as a social science versus psychology as a laboratory science), differences in scale (which can be significant at the doctoral level even in very large institutions), and differences in the expectations that institutions and departments have for teaching loads, departmental research, and so on.

EFFECT ON COST—PER-STUDENT COMPARISONS

One of the important uses of cost-by-level ratios is to control for differences among institutions that might otherwise distort comparative financial data. A case in point are interinstitutional comparisons of costs per student. It should be intuitively obvious on the basis of the data in Tables 1 and 2 that failure to take into account, or control for, the extent of an institution's activity at the various levels of instruction could seriously prejudice any such comparison. In what follows, some actual expenditure and enrollment data are used in conjunction with the cost ratios to demonstrate the effects of failing to control for differences in cost by level of instruction.

Table 3 shows expenditures per student for eight institutions of the same type (fiscal 1980 HEGIS data). In the first column of expenditures in the upper panel, the figures are derived using unweighted student counts. The next column to the right shows index values based on these expenditures. An index value of 100 is average. In the next column of expenditures, the figures are based on the weights shown in Table 1 for doctoral and research universities combined, adjusted (as shown) for a per-student by

level-of-student analysis. (The cost-ratio for graduate students, 3.31, is derived by multiplying 4.78 by 0.77 by 0.9. The 4.78 comes from Table 1 for doctoral and research universities combined. The per-credit hour to per-student adjustment, 0.77, is based on the fact that for reporting purposes the average number of credits taken by an FTE graduate student is about 11.5, and 11.5 divided by 15, the average number of credits taken by lower-division students, is 0.77.) The next column to the right shows the index values for the weighted expenditures. As the data plainly show, the cost per-student indices are affected materially by the weights, even though the set of institutions are generally comparable: they are all large doctoral and research-oriented universities. The reason why is shown in the last two columns in the upper panel. Even though institutional mission and size may be similar, differences in enrollment by level in conjunction with

TABLE 3
THE EFFECT OF WEIGHTING ENROLLMENT BY ESTIMATED COST RATIOS
ON EXPENDITURE-PER-STUDENT RANKINGS

Inst'n	--- Unweighted ---		-- Study Weights* --		Enrollment Ratios	
	Exp's per Student	Index	Exp's per Student	Index	U:L	G:L
A	\$2,253	106.7	\$1,557	116.6	0.69	0.19
B	\$2,184	103.4	\$1,415	105.9	0.99	0.28
C	\$2,168	102.6	\$1,302	97.5	0.78	0.44
D	\$2,155	102.0	\$1,248	93.4	0.99	0.55
E	\$2,094	99.1	\$1,247	93.3	0.89	0.47
F	\$2,033	96.2	\$1,293	96.8	1.16	0.19
G	\$2,018	95.5	\$1,313	98.3	0.89	0.28
H	\$1,994	94.4	\$1,313	98.3	0.70	0.26
avg	\$2,112	100.0	\$1,336	100.0	0.89	0.33

*Lower division = 1, upper-division = 1.58, graduate = 3.31.

Inst'n	Alternate Weights*		Alternate Weights**	
	Exp's per Student	Index	Exp's per Student	Index
A	\$1,497	116.5	\$1,523	117.5
B	\$1,355	105.4	\$1,378	106.4
C	\$1,260	98.1	\$1,253	96.7
D	\$1,205	93.7	\$1,199	92.5
E	\$1,204	93.7	\$1,200	92.6
F	\$1,235	96.1	\$1,259	97.1
G	\$1,260	98.0	\$1,278	98.6
H	\$1,266	98.5	\$1,276	98.5
avg	\$1,285	100.0	\$1,296	100.0

*Lower division = 1, upper-division = 1.74, graduate = 3.31.

**Lower division = 1, upper-division = 1.58, graduate = 3.64.

differences in per-student costs by level lead to rather different conclusions about relative costs. Institution D, for instance, starts out with above average costs, and ends up, after the weighting, with costs that are well below average; in fact, they are second lowest in the group.

In the lower panel, the data show the results of increasing the cost ratios by 10 percent. The columns on the left show the results of changing the value for U:L; those on the right show the results for changing G:L. The effect on the indices is roughly 0.1 to 0.9 percentage points, depending on the institution, with the sensitivity being slightly greater for changes in G:L.

CONCLUSION

The data on cost by level of instruction suggest that considerable care needs to be exercised in developing and using cost ratios in funding or allocation formulas, in setting differential tuition rates, or in assessing equity in terms of resources allocated to the several levels of instruction. The data in Tables 1 and 2 show what the central tendencies are for these cost ratios at various types of institutions, but they also show how different the ratios can be among institutions of the same general type. These differences and the ratios themselves point to a fundamental aspect of most operating costs in higher education: they depend on what someone decides they will be, as well as being a function of technological imperatives. This fundamental fact does not gainsay, however, the value of knowing what the central tendencies are. The very flexibility of costs, i.e., of resource allocation and utilization, gives significance to data on what actually is done, on average, by various institutions across the nation. The average values are not so much norms as they are benchmarks, or signposts, that point the way to reasonable levels of resource requests, resource allocation, and pricing.