Economics of Education. Part 8.
Analysis of the Costs of Teaching Undergraduate and Graduate Students and of Research in Japanese National Universities

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1. Introduction

Universities are complex organisations. They perform a diversity of functions. The two major functions, teaching and research are expensive and require different resources. But because they share facilities it is not easy to establish what are their respective costs; nor to establish what advantage might accrue from concurrent teaching and research or from changes to the scale and scope of their operations.

To the surprise of many in universities, such complexities and multifunctional activities are not unique. These characteristics are shared by a large number of public and commercial enterprises. They also share the problem of identifying the costs and synergies of their component activities. This problem was addressed by Baumol, Panzar and Wittig, (1982) who developed an elegant analytical procedure. The procedure uses multivariate analysis of total costs in terms of the measured quantities of products to yield average costs of forming each product. Then, by standard econometric procedures, the results can be used to identify economies arising from co-production and potential economic advantages from changes in the scale of production and the scope for varying the mix of products.

The method has been widely applied to a diversity of enterprises – telecommunications (Panzar and Wittig, 1979), finance (Baumol, *et al*., 1982), garbage collection (Mayo, 1984), transport (Wang and Friedlaender, 1985), petrochemicals (Shoesmith, 1988), hospitals (Fournier and Mitchell, 1992). It has also been applied to analysis of expenditure in universities (Cohn, Rhine and Santos, 1989). For universities, the products can be identified as graduating students – usually separated into first degree and advanced degree graduates – and research. The results identify the average expenditures on undergraduate teaching, postgraduate teaching, and research across a university system; and provide economic criteria to assess the advantages from combining teaching with research and from changes to the scale and scope of institutions within the system.

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The information on expenditures for undergraduate and for graduate students and for the institutional support of research constitutes key data both within universities and for system-wide planning decisions. Other sources of similar basic data require extensive and detailed study of institutional operations and substantial assumptions about relative costs. Consequently, scale and scope studies have been reported for university systems in many countries: US, UK, Australia, Turkey, China. The expenditures of private universities in Japan have been studied by Hasimoto and Cohn (1997); and a first study of the expenditures of the national universities has been reported by Nakajima, Morgan, Torii, Kominato and Ikeda (2004). It has now been possible to extend the study of the national universities by using a more comprehensive sample; the results of this more detailed analysis are reported here.

The paper is divided into 4 sections. In Section 2 the data are described, identifying the sources and the procedures necessary to formulate material for analysis. The methods of calculation are outlined in Section 3; and in Section 4 the results are presented in terms of unit costs and the statistical constraints on the analyses are examined. The discussion in Section 5 deals with the conclusions that can be drawn from the analyses and considers problems that arise from limitations in both the data and the conventional model.

2. Data

The required data for analysis are the total operating costs and measures of the quantities of the different outputs from each of the institutions in the sample. In Japan in 2001 there were 98 national universities. The sample employed excluded 3 small specialist postgraduate institutions and omitted 2 small single faculty universities for which data was incomplete. The resultant sample of 93 universities represents 98.6% of the total national university sector.

In multivariate analysis of universities' costs, it has become conventional to use proxies rather than direct measures of output. So in place of numbers of first and advanced degree graduates, numbers of undergraduate and graduate students are used. This removes complications and uncertainties arising from the lengthy period required to produce graduates; and given the ultimately high completion rates shown by students in the national universities this is unlikely to introduce substantial numerical errors. Data on student numbers are available from government statistics but these refer to approved student quotas; actual student numbers, provided by many of the universities in response to requests and published annually by all of them in their "prospectuses", "catalogues" or "year books", provide better data.

Similarly, a proxy is also used for research output. In principle, the number of research publications (in the widest sense) could provide a direct measure of research output. The time taken for research to be completed, the lag between completion and publication and the differing publication patterns all complicate the use of publications in this way. However, in practical terms their use is excluded as data are not uniformly available across all – or even a majority of the national universities. As an alternative measure of research activity, research funding is conventionally employed. Amounts of research funding are reported by many universities

in their prospectuses, and were supplied for this study in response to a request for the information. A comprehensive list is compiled by the Center for National University Finance and has the advantage of using a fixed time frame for recording the annual data: data from this source was used in this study.

Research funding is categorised under 4 headings. The major source is Grants-in-Aid obtained competitively: these constitute half of the total. The second largest component (23%) is provided by donations and endowments; contracts contribute 21% and collaborative research projects 5%.[1]

Data for total operating costs of the national universities are not readily accessible: no comprehensive collection of data from the national universities is publicly available. Information on allocations from the Special Fund is published by universities and is listed by the Ministry of Education, Culture, Sports, Science, and Technology (MEXT). As there is no provision for carrying balances forward, these allocations provide an appropriate proxy but require correction. Special fund allocations include both operating and capital funds for both universities and for the hospitals associated with medical schools. While it can be argued that hospitals offer an essential teaching resource for medical schools, clearly their costs differ from those associated with other teaching and research costs in universities. In fact, the revenues obtained from the hospitals, which are transmitted directly to central government, amount in each case almost exactly to the designated funding for the hospital. Subventions for hospitals are identified by individual universities in their publications. Capital funding, for buildings, equipment and libraries, is identified explicitly as an element of the Special Fund allocation. This does provide a significant contribution to operational resources but its benefit accrues over time, not in the year of allocation. Indeed substantial annual variations in capital funding occur, particularly for major capital works programmes involving building and purchases of land. For expenditure on books and equipment, averages across the whole national universities sector remain largely constant year-on-year, at about 8% of the total Special Fund allocation less the amounts identified for capital and hospital funding. Accordingly, for each university, total operating costs were identified with a proxy provided by 108% of (total Special Fund allocation less capital and hospital funding).[2]

3. Methods

Following Baumol *et al*. (1982) and Cohn *et al*. (1989), a linear second order equation is used to relate the proxy for total expenditure (*TC*) to the outputs in the form:

$$TC \ = c + \sum a_i F_i + \sum\sum b_{ij} F_i F_j \ + u$$

where *a* and *b* are coefficients, *c* is a constant, and F_i and F_j are functions of the output proxies undergraduate numbers (U), postgraduate numbers (G) and research (R). The second order terms are included to allow for the effects of size and of simultaneous production of multiple products. The form of the function, F_i, F_j, is not defined by any theoretical criteria. A logarithmic form has been employed (*e.g.* de Groot, McMahon and Volkwein, 1991), but, as preferred by Baumol *et al*., generally the simple numerical form is employed. A preliminary exploration of the use of translog values revealed no obvious benefit; accordingly, numerical

values of TC, U, G and R were employed, either directly or as "centred" values (*i.e.* converted to deviations from mean values). Additional components that may be associated with special institutional characteristics (*e.g.* student: staff ratios or universities with medical schools) can be added to the model as first order terms or controlled for by addition of dummy variables.

When expanded, the basic equation has nine coefficients: three first order (a_U, a_G, a_R), three second order square terms ($b_U{}^2$, $b_G{}^2$, $b_R{}^2$), and three second order interaction terms (b_{UG}, b_{UR}, b_{GR}). Values of the nine coefficients, the constant (c) and any additional first order terms and dummy variables were obtained by hierarchical multiple linear regression following a sequence of first order terms, second order square terms, second order interaction terms. This procedure also yields values of the three coefficients (a_U, a_G, a_R) for a limited regression for first order terms only; and for the six coefficients for first order and second order squared terms only.

The procedure used by Cohn *et al.* (1989) was used to generate a series of economic parameters from the coefficients and the mean values of the input data. The fundamental parameters are average incremental cost (AIC) and marginal cost (MC) and are given by expressions (1) and (2). The ratio (AIC)/(MC) indicates the existence of possible product-specific economies of scale (E) when the relative proportions of outputs remain constant. Overall economies of scale, from proportional increases in all products (ray economies) may arise if expression (3) has a value greater than unity. Potential for product specific economies of scope (PSE) arising from savings due to shared production is shown by a positive value of expression (4).

<table>
<tr><td style="text-align:center">Average Incremental Cost
$AIC_U = [(TC)_{UGR|} - (TC)_{GR}]/U$
(1)</td><td style="text-align:center">Marginal Cost
$MC_U = \partial(TC)/\partial U$
(2)</td></tr>
<tr><td style="text-align:center">Ray Economies of Scale
$(TC)_{UGR}/[\, U(MC)_U + G(MC)_G + R(MC)_R]$
(3)</td><td style="text-align:center">Product Specific Economies of Scope
$[(TC)_U - (TC)_{GR|} + (TC)_{UGR}]/\,(TC)_{UGR}$
(4)</td></tr>
</table>

4. Results

Multivariate analysis of the data for all 93 national universities gives the nine coefficients shown in Table 1. From these are obtained the derived values for average incremental costs, marginal costs and the related scale and scope parameters that are shown in Table 2. The results suggest that overall ray economies of scale exist allowing expansion of the mean size of universities to occur without imposing increased costs. These economies of scale are driven by the product-specific economies that are shown for undergraduate and graduate students. Through calculations using multiples of the mean values, these economies of scale are shown to persist over the range of at least 0.2 – 2.5 times the mean values for the total output, and also for undergraduate and graduate students separately. For research, the results indicate diseconomies of scale

both at the mean value and over the whole range examined. Similarly, for a smaller sub-set of 51 universities without medical schools, multivariate analysis yields coefficients (Table 1) that enable average incremental and marginal costs and the derived parameters to be estimated (Table 2). The mean values for this group of universities are substantially smaller than those for the whole sample but the results show a general similarity. However there are clear differences in the economy of scale shown for research as well as for undergraduate and graduate students (although the economies of scale for graduate students are restricted to mean values in the range $0.2 - 1.5$) and in economies of scope both globally and product specific graduates restricted to mean values in the range $0.2 - 1.0$.

TABLE 1 Regression Parameters for Multivariate Analysis of Expenditures for National Universities in Japan (2001)

National Universities	All Universities		Non-Medical Universities	
	Mean Value	Coefficient	Mean Value	Coefficient
Total Cost (¥ billion)	15.895		7.986	
Constant		1.212 (t 1.551)		1.634 (t 2.357)
Undergraduates (U) x 10³	4.922	1.665 (t 3.672)	3.565	1.142 (t 2.888)
Graduates (G) x 10³	1.402	0.015 (t 0.015)	0.705	4.277 (t 2.042)
Research (R) (¥ billion)	2.044	3.505 (t 3.876)	0.482	−0.246 (t −0.077)
(Undergraduates)² (U²)	37.689	−0.060 (t −0.896)	17.144	−0.026 (t −0.332)
(Graduates)² (G²)	5.768	0.425 (t 1.173)	1.002	−2.304 (t −1.115)
(Research)² (R²)	27.134	−0.021 (t −0.988)	1.164	−0.001 (t −0.001)
(Undergraduates)(Graduates) UG	12.582	0.234 (t 0.742)	3.226	0.016 (t 0.023)
(Undergraduates)(Research) UR	21.204	−0.154 (t −1.336)	2.319	0.344 (t 0.476)
(Graduates)(Research) GR	11.410	*excluded*	0.954	1.357 (t 0.340)
Number in sample	93		51	
Correlation (adj R²)	0.973		0.911	
Standard Error of Estimate	2.826		1.468	

TABLE 2 Scale and Scope Parameters for Expenditure of National Universities in Japan (2001)

	Average Incremental Cost[a]				Marginal Cost[a]			
	U[b]	G[b]	R[c]		U[b]	G[b]	R[c]	
All Universities	1.140	3.872	1.629		1.087	2.367	2.661	
Non-medical Universities	1.255	2.912	4.092		1.134	1.739	1.936	

	Economies of Scale				Economies of Scope			
	E_U	E_G	E_R	RE	PSE_U	PSE_G	PSE_R	GE
All Universities	1.048	1.036	0.612	1.127	0.098	-0.109	0.282	0.173
Non-medical Universities	1.107	1.873	2.114	1.288	0.098	0.036	-0.057	0.141

Notes　[a] ¥ million; [b] per student; [c] per ¥ 1 million research funding.
　　　　Economies of scale and scope are estimated for the mean values of the sample.
　　　　Economies of scale (E) and overall ray economies of scale (RE) arise for values greater than 1.
　　　　Overall, global economies of scope (GE) and product specific economies of scope (PSE) arise for
　　　　positive values. (see Baumol *et al*., 1982; Cohn *et al*., 1989)

Although the results appear numerically reasonable their derivation reveals major statistical defects. Few of the coefficients are statistically significant; neither the full data set nor the smaller sub-set is sufficiently large to yield reliable analyses for nine parameters; neither set shows statistically normal characteristics and both have a degree of skewness and Kurtosis. None of these defects invalidates the analyses but they weaken their reliability.   More fundamentally serious is the high level of multicollinearity shown by the input data: in particular the cross terms, UG, UR and GR show very high multicollinearity, as also do the basic components G and R and their squared terms. A standard technique for reducing multicolinearity when powers of variables are included in the analysis lies through transformation of the variables into deviation scores from their mean values: with these data this did not yield any significant statistical improvement.

To examine the significance of these factors, two alternative procedures were employed. A primary component of the multicollinearity could be removed by excluding terms in either G or R from the analysis. The effects of doing this were examined both by simple exclusion of terms in R; and by combining terms in U and G to give a total measure of students (S). The results appeared to give quite reasonable values for AIC and MC and show acceptable significance and precision but do not eliminate multicollinearity between the residual parameters. As these procedures necessarily preclude discrete results for all three basic elements, they were not explored further. Alternatively, a step-wise (statistical) regression procedure was employed. This indicated that close to optimal statistical results might be obtained by limiting the input data to the 3 first order variables, U, G. R, plus the 3 squared terms, U^2, G^2, R^2. The results from applying this constraint to the full data set are shown in Table 3.

While multicollinearity of the terms in G and R remains, exclusion of the interaction-terms yields results

TABLE 3 Restricted Multivariate Analysis of Expenditures of National Universities in Japan (2001)

(a) Regression Coefficients						
	No dummy	**Dummy Medicine**	**Dummy Med & SFMed**	**Dummy Large**	**Dummy Large & Med**	**3 Dummies**
Const.	1.277 (t 1.706)	0.041 (t 0.055)	1.070 (t 1.191)	1.721 (t 2.752)	0.723 (t 1.124)	1.473 (t 1.928)
U	1.525 (t 4.188)	1.968 (t 5.599)	1.678 (t 4.479)	1.007 (t 3.214)	1.401 (t 4.501)	1.200 (t 3.662)
G	1.639 (t 1.605)	1.530 (t 1.630)	1.222 (t 1.307)	3.083 (t 3.513)	2.852 (t 3.470)	2.582 (t 3.126)
R	2.487 (t 5.250)	1.577 (t 3.229)	1.556 (t 3.241)	2.318 (t 5.882)	1.635 (t 3.969)	1.617 (t 3.974)
U²	−0.042 (t 1.347)	−0.090 (t −2.925)	−0.079 (t −2.571)	0.013 (t 0.482)	−0.030 (t −1.069)	−0.023 (t −0.841)
G²	0.431 (t 2.276)	0.677 (t 3.678)	0.726 (t 3.978)	−0.284 (t −1.466)	−0.022 (t −0.112)	0.036 (t 0.184)
R²	−0.044 (t −4.484)	−0.039 (t −4.301)	−0.041 (t −4.566)	0.002 (t 0.153)	0.001 (t 0.075)	−0.002 (t −0.183)
Med		2.969 (t 4.105)	4.349 (t 4.401)		2.289 (t 3.689)	3.343 (t 3.909)
SFMed			−2.800 (t −2.009)			−2.097 (t −1.767)
Large				14.609 (t 6.307)	13.116 (t 5.964)	12.724 (t 5.828)
adj R^2	0.978	0.982	0.983	0.985	0.987	0.988
SE	2.823	2.594	2.549	2.343	2.187	2.160
(b) Derived Parameters						
Average Incremental Cost[a]	**No Dummy**	**Dummy Medicine**	**Dummy Medicine & SNF[d]**	**Dummy Large**	**Dummy Large & Medicine**	**3 Dummies L,M & SNF**
U[b]	1.203	1.279	1.073	1.106	1.171	1.024
G[b]	3.412	4.315	4.207	1.915	2.761	2.730
R[c]	1.903	1.059	1.012	2.349	1.648	1.590
Marginal Cost[a]						
U[b]	1.112	1.082	0.900	1.135	1.106	0.974
G[b]	2.848	3.428	3.258	2.287	2.790	2.683
R[c]	2.307	1.418	1.388	2.326	1.639	1.609
Ray Economies of Scale (Global)						
Mean Values	1.120	1.220	1.376	1.081	1.162	1.275
0.2 mean values	1.439	1.126	1.590	1.609	1.338	1.707
2.0 mean values	1.109	1.393	1.507	0.970	1.179	1.258

Notes　　[a] ¥ million;　[b] per student;　[c] per ¥ million of research funding;　[d] single faculty medicine

that appear to be both more significant (as t-values) and more robust with no loss of precision. Values for the regression coefficient, R^2_{adj}, remain high and are little changed from those given by the use of 9 variables; F-values are significantly increased. The coefficients for the first-order terms show high significance and conform to the expectation that they will provide the larger components of cost; the lower significance of the second-order terms is, at least in part, attributable to their smaller magnitude and wider variability amongst diverse universities. Necessarily, restriction of the model to six variables precludes evaluation of economic effects of changes in scope (*i.e.* changes derived from combining provision for teaching undergraduate and graduate students with research in the same institution). However, the uncertainty derived from the multicollinearity shown by the interaction terms and their negligible statistical validity renders the results obtained with their inclusion of doubtful validity.

By using the reduced sets of input variables it is possible to allow for the effects of specific cost centres with dummy variables. Three dummy variables were found to have statistical significance: these were with separate dummies for a small group of 8 of the most expensive universities (Large); for all universities with medical schools (Med); and for single faculty medical universities and colleges (SFM). The results of applying these dummy variables are shown in Table 3.

5. Discussion

Since its introduction, multivariate scale and scope analysis has found wide application across a diversity of multiproduct operations. Given the widespread economic interest in education it is not surprising that extensive studies of higher education systems have also been made. These include the initial key studies of universities in the USA by Cohn *et al.* (1989) and their subsequent extension through other studies of US institutions (de Groot, *et al.*, 1991; Nelson and Hevert, 1992; Dundar and Lewis, 1995; Koshal and Koshal, 1999) and to studies of systems in Australia (Lloyd, Morgan, and Williams, 1993), UK (Glass, McKillop, and Hyndman, 1995; Johnes, 1996, 1997, 1998), Turkey (Lewis and Dundar, 1995), Japan (Hadhimoto and Cohn, 1997; Nakajima, *et al.*, 2004) and PR China (Hou and Weifang, 2004).

A primary emphasis in all these studies has been placed on the indicators for economies of scale and scope accompanying growth or contraction of the institutions. The results for the national university system in Japan given in Section 4 provide comparable indicators. Both for the full set of all 93 National universities and the smaller set of 51 non-medical universities there are ray economies of scale over a range of sizes from 0.2 – 2.5 of the mean values. This is perhaps not surprising given that the mean sizes for institutions are small in both cases (4,922 and 3,565 undergraduates respectively). In both cases economies of scale are indicated for undergraduate and graduate students; but for research only in the non-medical universities. The indicators for economies of scope also point to global economies for both sets of data, though while these apply across the full range of sizes (0.2 – 2.5) for all the national universities, they apply only to a narrower range of 0.2 – 1.2 of mean values for the non-medical universities. Individually the analyses indicate opportunity for

economies in the full national university system from increasing the proportion of undergraduates and of research provision across the whole range $0.2 - 2.5$, though for graduate students, part of this is dependent on economies derived from undergraduate students and research. Conversely, for the set of non-medical universities, global economies of scope and for all three components individually are restricted to an average size of institution smaller than the current mean value.

It is though necessary to regard such conclusions with considerable caution. The statistics indicate that the limitations of the available data impose severe constraints on the reliability of the results. Use of a restricted range of variables removes a large part of the statistical limitations but it also constricts the accessible parameters. So, while the use of 6-variables supports the existence of ray economies of scale over the range of $0.2 - 2.5$ of mean values, it can offer no evidence for economies of scope as the interaction terms are excluded. This restriction is perhaps of greater academic than pragmatic concern by the failure to contribute to discussions of teaching undergraduate and graduate students together or of combining teaching and research. The greater statistical significance of the results from use of 6-variables is though important in providing access to more reliable and robust data of immediate relevance to financial allocation and planning.

Currently, a basic planning tool, unit cost of students, is familiarly obtained by dividing total expenditure by total number of students. In practice this procedure is refined in order to accommodate special circumstances, notably by inclusion of factors for expensive courses and graduate students, but it cannot generate any rational estimate of concurrent research costs. In effect, the process represents research either as a free good, or as an activity implicit in the process of teaching, or as one financed fully from designated research funding. None of these assumptions is credible as a basis for funding or planning. Multivariate analysis provides discrete values for the costs of all three products. The results (6-variables) for undergraduate, ¥1.203 m, and graduate students, ¥3.412 m (per student), can be compared with the usual "unit cost" for 2001 of ¥ 2.09 m (including the costs of research institutes, academic equipment and books).[3)] The ratio of expenditure on undergraduate and graduate students, approximately 3.0, falls within a range found in elsewhere (see *e.g.* Verry and Layard, 1975; Bowen, 1980; Nelson and Heveth, 1992) and is substantially smaller than the ratio of greater than 50 reported for private universities in Japan by Hasimoto and Cohn (1997). For research expenditure, the results indicate that for each ¥ 1 million of designated research funding, close to ¥ 2 million is required from university expenditure: most of this is likely to be in the form of academic salary costs.

Within and among institutions, expenditures vary. One factor arises from differences in the proportions of expensive subjects, such as medicine; another from differences in the proportions of work at differing levels. Indications of such factors are provided by inclusion of dummy variables in the multivariate analysis of expenditures. As indicated in Table 3, inclusion of 3 dummy variables – one for the 8 largest universities, one for the 42 universities with medical schools, and one for the 13 single faculty medical universities – marginally improves the correlations and reduces the standard errors of estimate.   Each of the dummy variables is statistically significant.

Numerically largest and most significant is that for the large universities. In effect it indicates that they

are able to undertake additional expenditures of about ¥13 billion, approximately 20% of their average annual allocations. This money is necessarily spent on one or more of the 3 principal products.   When these additional expenditures are held within the dummy variable, significant changes are shown in average costs (Table 3). The largest change is a reduction in costs for graduate students of 44%. This may well reflect the higher proportion of more expensive doctoral students located in the largest universities. But a much larger effect on total expenditure is likely to lie in their ability to support proportionately higher levels of research activity than other universities.[4]

Also important are the dummies for medical universities, which indicate special funding to the extent of about 10% of average university costs. It is universally acknowledged that the costs of medical education and research are high. This appears to be reflected in the values for AIC/MC for undergraduates and for research when costs are controlled for special funding for medicine (Table 3). In contrast are the apparent higher costs for graduate students after controlling for medicine. This could indicate that costs of clinical work for postgraduate medical students are cross-subsidized from hospital revenue. Alternatively it is possible that the dummy variable also serves in part as a proxy for other high cost courses and research. This could be indicated by the coexistence of all these courses in the multifaculty universities as opposed to the single faculty medical universities for which the dummy variable has a negative value.

Further examination of these issues requires additional and more detailed data. Such data is also required to analyse generally the effects expenditures on teaching and research that differ between subject areas and levels of courses. Its availability would also permit separate analysis of individual academic segments, allowing the model better to represent the operational structure of universities. Only to a limited extent are the effects of scale in a university determined by its overall size. For most activities it is the size of the effective academic unit - variously a School, a Faculty or a Department that is important. Consequently, to use total institutional student numbers or research activity as criteria of the production processes constitutes a considerable distortion. This applies both to the existence of economies of scale and to the interactions between undergraduate and graduate students and research activities that determine economies of scope. Fortunately, more detailed data for the national universities that will permit this extension are now becoming available. The results of analyses of these data will be reported in future articles.

Acknowledgements

Notes

1) Overall, national agencies and government contribute two-thirds of designated research income; private donors and companies, one-third; local government contributes less than 1%. Excluded from grants in aid are the initial payments under the Center of Excellence scheme, which was partially introduced in 2001: these payments amounted to about 4% of total research funding. Excluded from contract income are payments received for routine medical and product testing (about 4% of total research funding).

2) In a very small number of cases, the total allocation for capital expenditure was less than 8%; in these cases the actual allocation for capital was used in the operating cost proxy.   It is possible, by considering the accumulated capital provided for land, buildings and equipment and its depreciation over time, to identify its current value and to estimate the return it offers to operation of the national university sector. This could be expressed either as a return *per* student (Morgan, 1997); or alternatively could be expressed as proportionate additions to the average incremental costs identified in section 4.

3) By weighting the figures from the analysis for expenditures on undergraduate and graduate students by their proportions in the system, a calculated "true" student unit cost of ￥ 1.56 m is obtained; by subtraction, this gives a notional "research unit cost" of ￥ 0.53 m, per student, or 25% of the apparent usual student unit cost.

4) Research funding in the large universities (￥ 110 billion) is equivalent to 20% of their total allocations; across all other universities the comparable figure is 8.5%. By using the indicated factor of 2 for research expenditure from allocations, the average difference in expenditure that this would generate for each of the larger universities amounts to ￥ 15 billion.

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教育経済学（パート８）

—日本の国立大学における学部・大学院教育と研究に関するコスト分析—

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　大学の職務を構成する三つの要素（大学教育，大学院教育，研究活動）に要するコストの把握は，国家レベルにおいても組織レベルにおいても，計画策定における基本的要件である。教育活動と研究活動は財源を共有しているため，正確なコストの算出は困難である。しかし，各国立大学の総支出に関する多変量解析を利用することによってこれらのコストを導き出すことは可能である。教育活動に要する平均支出は，学部教育で学生１人あたり120万３千円，大学院教育では341万２千円となっている。研究活動には，研究費100万円あたり190万３千円かかっている。こうした分析は，「規模の経済（economies of scale）」の存在を示すとともに，「範囲の経済（economies of scope）」の可能性も示唆している。データに統計上の限界があるゆえに，教育活動と研究活動とから生じる経済的便益について信頼性の高い算出を行うことは不可能である。

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