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Economics of Education. Part 9. Expenditure on Teaching and Research: Subject and Course Differentials

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For the first time in their history, financial management is about to become a key element in the Japanese national universities. Transformed by incorporation in 2004 into autonomous, "corporatized" institutions they acquired financial as well as academic responsibilities. Within institutions, the new status is welcomed, but only cautiously. Freedom - in principle - from civil service constraints is balanced against future uncertainties and new top-down managerial structures. Academic matters, long controlled by faculty, are to be exposed to presidential determination and external scrutiny. Ministerial policy is ambiguous, offering neither open market access nor explicit social priority. And while overall government funding for the national universities will decline over time, currently at a rate of 1% *per annum*, it will depend selectively on institutional plans, assessed against undisclosed criteria.

For universities, ability to sustain teaching and research constitutes their primary function. To do so they require resources: academic and non-academic staff, students, facilities and equipment. When the scale and scope of academic programmes, staffing and student numbers, and the level of funding are externally controlled, budgeting may require much detailed work but it is not a matter of institutional managerial complexity. When any of these factors is determined internally, complications arise. The responsibilities of autonomous institutions include an ability to assess the financial implications of such changes. In particular, the ability to implement change that enhances academic achievement and prestige is dependant on financial planning.

This presented universities with two problems. First was a lack of a sufficient number of administrators with financial management skills; second was the absence of basic planning data. Suitably experienced senior professional staff may be recruited externally. A rapid learning process on the importance of financial competence should ensure that academic vice-presidents and directors rapidly acquire necessary knowledge from their professional colleagues. The basic planning data notably include unit costs for teaching and research activities across the range of courses and subject areas in the university. Such data are also required centrally if the ministry is to estimate requirements for government support if it is expected that some linkage is to continue between policy and performance.

The necessary financial data are accessible by analysis of existing statistical sources. Values for the

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general categories of research and of undergraduate and graduate teaching have already been reported (Morgan, Nakajima, Torii and Ikeda, 2005). This paper extends the analysis to a wider spread of disciplinary costs for research and for the different levels of teaching. In the following section the statistical data and analytical procedures are described; the results are presented and discussed in the subsequent section and finally some conclusions are drawn.

Methods and Procedure

Estimates of unit costs are accessible in principle by multivariate analysis of total costs with respect to quantities of individual outputs. Appropriate outputs would be graduates, in various categories, and research. In practice, problems over the availability and validity of data lead to the use of proxies. Consequently the usual estimates are those showing the allocation of resources between the various provisions for teaching and research.

Sample. Data were obtained for the national universities in Japan for the year 2001. The sample employed consisted of 93 universities representing 98.6% of the national university sector. Excluded were 3 small specialist postgraduate institutions and 2 small single faculty universities for which only incomplete data were available.

Total Costs. Data for the total operating costs of national universities were not readily accessible. However, information on operating grants is available. Allocations to individual universities from the "Special Fund" of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) are listed by MEXT and published by each university. The allocations aggregate operating and capital funds for the universities and their associated hospitals and research institutes. By disaggregating and correcting for overlap between capital and recurrent elements, the amounts of operating funding can be obtained (Morgan *et al*., 2005). As there is no provision to retain unspent balances, the allocation provides an acceptable proxy for total operating cost.

Teaching. An identifiable output from teaching is graduates. While numbers of graduates in various categories are readily available, it is not clear over what period of time they have studied or how costs have varied over time. Consequently, current student load, expressed as full-time equivalent student numbers, provides a convenient proxy. Student numbers are conveniently accessible in the prospectuses, catalogues and yearbooks now published by each university. Data were collected for student numbers at 3 levels (undergraduates, masters, doctors); and for 4 subject areas categorized as "lower-cost" , education, "higher-cost" , and "medicine".[1)]

Research. Measures of research output are neither easily identified nor readily accessible. Publications are used as indicators but disciplinary cultures yield differing forms and varying lags in publication time cause problems in dating research output. In practice use of publications as a measure of research output in the national universities is precluded by a lack of data. Use of research activity as an alternative measure is accessible through information on research funding. A comprehensive list of external funding of research in the national universities is compiled by the Center for National University Finance and Management. The list categorises funding under 5 headings: grants-in-aid (constituting 51% of the total for 2001), donation and endowments (26%), contract (17%) and commissioned work (0.3%), and collaborative projects (5%). For purposes of the analysis, grants-in-aid for the COE scheme were excluded as this programme was only partly implemented in 2001. Non-research funding in all categories was also excluded: in total the exclusions amounted to about 10% of the total external funding.[2)] The totals and average size of project funding in each of these categories is shown in Table 1.

First-Order Calculations. The purpose of allocating income to the national universities is to fund their array of academic activities. With the assumptions that resources for administration and central service can be distributed among academic activities, and that distribution of resources is proportionate to levels of activity, a mathematical model can be written as:

$$(TA) = c + \sum a_{ij} S_{ij} + \sum b_i R_i + u \qquad (1)$$

where (TA) represents the total allocation, S and R are measures of student and research activity at level j and subject area i; a and b are coefficients and c is a constant. In the calculations up to 3 academic levels (corresponding to undergraduate, masters and doctors courses) and 4 subject areas (lower-cost, higher-cost,

TABLE 1 Aggregated Research Funding for National Universities, 2001

Total Research Funding ¥(000)	Lower-Cost Subjects	Education	Higher-Cost Subjects	Medicine
Grants-in Aid	6,989,705	2,394,622	58,576,832	28,618,056
Donations	1,433,114	1,326,905	21,341,012	23,983,573
Contracts	1,004,153	189,239	23,505,826	7,580,341
Commissions	27,367	27,988	352,832	287,393
Collaborations	118,895	93,532	8,301,633	1,623,488
Total	9,573,234	4,032,286	112,078,135	62,092,851
Funding *per* Project (av) ¥(000)				
Grants in Aid	2,269	1,744	3,785	3,768
Donations	1,458	1,410	1,205	705
Contracts	6,123	2,280	6,431	5,380
Commissions	219	243	458	18
Collaborations	1,723	1,231	2,179	2,899
All Sources (excluding Commissions)	2,215	1,619	2,753	1,417

education and medicine) are used. Additional terms may be added to the model in the form of “dummy variables” to examine the influence of the specific characteristics of some institutions. By using numbers of students and research income as measures of activity in each category, the model can be applied to each university in the sample. By regression of the resultant equations estimates of the coefficients a and b and the constant c are obtained.

Second-Order Calculations. To accommodate the effects of economies of size and of simultaneous production of multiple products it is necessary to expand the model to include second-order terms (Baumol, Panzar and Wittig, 1982). A model for such scale and scope analysis can be written as:

$$(TA) = c + \sum a_{ij}S_{ij} + \sum b_iR_i + \sum d_{ij}S_{ij}^2 + \sum e_iR_i^2 + \sum f_{ij}S_{ij}R_i + u \qquad (2)$$

where additional coefficients d, e, and f are derived from the second-order terms. The available data constrains the number of coefficients that can be estimated and limits the range of applicability of this model.

Results and Discussion

The most commonly encountered measure of university costs is obtained by dividing total expenditure by number of students. For the national universities in 2001, this “unit cost” was ¥1.85 million (RIHE, 2005). This measure conflates undergraduates and postgraduates, teaching and research, expensive and relatively inexpensive subjects; its sole virtues are ease of calculation and facilitation of international comparisons. For institutional and system-wide planning purposes, an ability to estimate the costs of each of the diverse individual components is desirable. This becomes essential when the balance between teaching and research, undergraduate and postgraduate courses, and subject areas is expected to change rapidly. Detailed costing of individual teaching and research activities across a university is a demanding undertaking. It requires information on actual operating and capital costs, uses of time, and levels of demand on facilities, overheads and consumables (Bowen, 1968; O’Neil, 1971; Verry and Layard, 1975; Verry and Davies, 1976). Statistical analysis of total costs in terms of proxies for outputs provides an attractive and accessible alternative. Methods developed for estimating costs in multiproduct industry (Baumol *et al.*, 1982) have been successfully applied to universities to yield average values for costs across homogeneous university systems (see *e.g.* Cohn, Rhine and Santos, 1989). These methods are constrained mainly by limitations in the available data.

Inadequacies in the data fall into two principal categories: inadequate quantity and deficient quality. The quantity of data limits the number of coefficients that can be estimated with statistical reliability: in practical terms, experience indicates that a sample size well in excess of 100 is desirable for evaluation of a dozen variables. The quality of data is affected by a number of factors, notably by its normality and homogeneity and by collinearity between variables. Data for the national universities might be expected to be homogeneous: supervision and funding of the system by MEXT ensures common criteria for academic programmes and standards, faculty and support personnel, and student enrolments. However, closer scrutiny reveals wide variations between the scale and scope of institutions. There are 7 large, post-imperial research universities and a similar number of other large universities; two-thirds of the universities offer doctorates in engineering, science and medicine; but only one-quarter in humanities and education. Almost half of the universities (44) are single faculty institutions: 13 are colleges of medicine, 11 of education and 13 of technology. Previous work had demonstrated that the distribution of student numbers is far from normal and that the data do suffer from extensive multicollinearity (Morgan *et al*., 2005). The consequent limitations on reliability restrict the extent of analyses, particularly for the second-order scale and scope procedures.

Separating data for academic activities according to costs ought to improve its quality. There is general recognition that costs of teaching and research in engineering and science are greater than in the humanities and social sciences. In England, HEFCE (2005) applies a multiplier of 1.7 to reflect these differences. The costs for medicine are even higher and attract a multiplier of 4. At the outset, four categories were selected: lower-cost (lc), education (ed), higher-cost (hc), and medicine (med); education was included in recognition of its more expensive structure as an academic subject in Japan, epitomised by its low student/staff ratio (8:1) in the national universities. Where it becomes desirable to reduce the number of variables for analysis, this was achieved by aggregating education with lower-cost areas, and medicine with higher-cost areas.

Similarly, separating the data for different academic activities should improve the quality of analysis. In addition to research (R), there are three identifiable academic levels: undergraduate (U), masters (M), and doctoral (D). Again, where it is desirable to reduce the number of variables, aggregating either masters and doctoral students as graduate students (G), or undergraduates and masters as taught students (T), or all of them as students (S) can achieve this. With these variables, first- and second-order analyses were performed.

First-Order Analyses. Initial results indicated that the model might be unable to accommodate the larger data sets. Accordingly it seemed desirable to establish a secure base for comparisons before proceeding to the more detailed and extended models. To this end, preliminary first order analyses of data undivided by subject area were obtained. Four sets of data were used: UMDR, UGR, TDR, and SR.

The results (Table 2) confirm the expected relativities: graduate students are more expensive than undergraduates; and doctoral students are the most expensive (*cf*. Bowen, 1968). The figures do not though give reliable estimates of the relative costs of masters and doctoral students and substantial differences occur in the estimates of expenditure on research. Moreover the results suggest that the various models are not congruent. If so this excludes the possibility of seeking additional information by combining the results algebraically (*e.g.* attempting to estimate the expenditures on masters students from the results for UGR and TDR).

The effects of including dummy variables in the models are shown in Table 3. Dummy variables for the former Imperial Universities (IMP), for institutions with Faculties of education (ED) and/or of medicine

TABLE 2 Coefficients for First Order Regression of Teaching and Research Activity on Total Funding. National Universities, Japan, 2001

	Mean Value	SR	TDR	UGR	UMDR
		Coefficient	Coefficient	Coefficient	Coefficient
U	4.971			**0.912**	**1.106**
M	0.898				(*0.761*)
T	5.869		**1.073**		
S	6.371	**1.687**			
G	1.400			**5.127**	
D	0.502		**11.861**		**12.091**
R	2.023	**2.326**	**0.948**	**1.411**	**0.954**
Constant		**0.610**	**1.727**	**1.332**	**1.719**
Adj Rsq		0.971	0.985	0.977	0.985

Notes Mean values of variables are expressed in thousands for numbers of students and in ¥ billions for research activity. The mean value of total funding is ¥15.895 billion. Coefficients shown in bold type are statistically significant at the 1% level or better; coefficients in plain type are significant at the 5% level. By using student numbers at all levels in thousands and total allocations (TA) and research activity in ¥ billion, values of the coefficients indicate average unit costs for students in ¥ million; and input of internal resources for each unit of external research funding.

TABLE 3 Effects of Dummy Variables on First Order Regressions of Teaching and Research Activity. National Universities, Japan, 2001

TDR	Regression Coefficients					
Dummies	none	IMP	ED	MED	IMP ED	IMP ED MED
T	**1.073**	**1.092**	**0.806**	**1.070**	**0.831**	**0.818**
D	**11.861**	**10.741**	**12.913**	**11.382**	**11.810**	**11.161**
R	**0.948**	**0.909**	**0.907**	**0.999**	**0.871**	**0.933**
IMP		**5.108**			**4.917**	**5.221**
ED			**2.403**		**2.340**	**2.424**
MED				0.964		**1.245**
Constant	**1.727**	**1.871**	**1.405**	**1.450**	**1.552**	**1.193**
Adj Rsq	0.985	0.986	0.987	0.985	0.988	0.989

Notes Mean values for dummy variables are IMP, 0.075; ED, 0.602; MED, 0.454 ¥ billion. Notes for Table 2 apply to Table 3 also.

(MED) were included for all the models: the results in Table 3 are typical. They confirm that in each case their inclusion is statistically significant and corresponds variously to provision of special funding for the former Imperial Universities (Arimoto, 2005), and of higher levels of resources for Faculties of education and medicine.[3] With each of the four models, the dummy variables demonstrate similar effects on the variable parameters: allowing for MED largely affects expenditure of doctoral courses; IMP and ED affect both undergraduate and graduate courses, though apparently in opposite directions.

Extension of the first-order models to accommodate differences in expenditure between subject areas involves multiplying the number of variables by the number of subject areas. Results from models incorporating subdivided lower- and higher-cost areas showed decreasing statistical reliability and increasingly irrational coefficients. Only a limited number of analyses of models with separate variables for education and medicine were made. Results for the models SR, UGR and TDR are shown in Table 4.[4] The

TABLE 4 Coefficients for First Order Regression of Teaching and Research Activity on Total Funding. Extended Data. National Universities, Japan, 2001

		Coefficients					
Dummy Model	MeanValues	None			IMP ED MED		
		SR	TDR	UGR	SR	TDR	UGR
U_{lc}	2.187			**0.456**			**0.586**
T_{lc}	2.442		**0.961**			**0.673**	
S_{lc}	2.545	**1.108**			**0.908**		
G_{lc}	0.358			**7.559**			**3.62**
D_{lc}	0.103		**8.49**			**5.947**	
R_{lc}	0.154	**8.635**	2.607	(*1.811*)	**12.394**	**6.209**	**7.135**
U_{hc}	2.784			**1.969**			**1.242**
T_{hc}	3.428		**1.098**			**1.029**	
S_{hc}	3.826	**2.038**			**1.714**		
G_{hc}	1.042			**1.535**			**3.058**
D_{hc}	0.398		**13.6**			**11.453**	
R_{hc}	1.869	**1.788**	**0.73**	**2.132**	**1.036**	**0.541**	**1.231**
Constant		0.610	1.725	0.891	0.670	1.313	0.442
Adj Rsq		0.971	0.985	0.977	0.984	0.990	0.986

Notes Designations lc and hc indicate respectively lower- and higher-cost subject areas. Coefficients for dummy variables are: SR, IMP, 7.817; ED, (*1.016*); MED, 2.37; TDR, IMP, 7.985; ED, 1.951; MED, 1.091; UGR, IMP, 9.755; ED, (*1.127*); MED, 3.333; except for those in plain type or italics all are statistically significant at the 1% level. Footnotes to Table 2 apply also to the results in Table 4.

results confirm the basic expectation that expenditures in lower-cost subject areas are lower than in higher-cost areas. The differentials between undergraduate and higher-level courses are also maintained within lower- and higher-cost areas - though this is only shown for the higher-cost areas when dummy variables are included (or a model is used that retains separate variables for medical courses). The ratios of expenditures between lower- (lc) and higher- (hc) cost areas are also in general accord with expectation (Bowen, 1968): for undergraduates a ratio of lc:hc of 1:3 (and for lc:med of 1:6 leaving other hc as 1:2); and for doctoral students a ratio of about 1:2 (though much smaller at 1:1.3 if medicine is excluded). An apparent anomaly is provided by graduate courses (G) where expenditure on higher cost subjects is shown as less than on lower cost subjects with the implication that masters courses in the sciences, engineering and medicine are not expensive activities.

The coefficients for research suggest an apparent anomaly in that they are greater for lower- than for higher- cost areas. In the models the research terms identify institutional expenditure incurred by externally funded research activity. The coefficient indicates the amount spent by the university for each unit of external funding. (In this it contrasts with students' courses where, because student numbers are the multipliers, the coefficients indicate expenditure incurred for each student.) Institutional expenditure on research is given by the product of the coefficient and the amount of external funding. For the "average" national university, the mean value of research funding in lower-cost areas (¥0.154 billion) is small in comparison with that in higher-cost areas (¥1.869 billion). Consequently even with a much larger coefficient, average institutional expenditure on research in lower-cost areas is in fact much smaller than in the higher-cost areas. In both areas much of this expenditure is attributable to the cost of supplying academic and support staff time.

Second-Order Analyses. Inclusion of second-order terms enables the effects of economies of scale and of co-production of multiple products to be estimated. Both the actual and relative costs of products can be expected to show changes. In principle the costs may be increased or decreased, but in general the changes, while significant are not expected to be substantial.

Performing a second-order analysis entails a large increase in the number of variables. For an output of 2 types (*e.g.* lower- and higher-costs) of 3 products (*e.g.* TDR) a full model would include 27 variables. This is clearly in large excess of the capacity of the data set from the national universities. It was though expected that many of the possible interactions (*e.g.* $U_{lc}G_{hc}$) could be assumed to be negligible and so allow analyses with restricted models. In the event this was largely pre-empted by extensive multi-collinearity in the data. Although the occurrence of collinearities will reduce precision, it will not prevent analyses unless its level is high. Tolerance of collinearities up to Pearson coefficients of about 0.92 is normal. Values considerably in excess of this (>0.97) are found here, particularly between second-order square and interaction terms involving doctoral programmes and research activities.

TABLE 5 Second-Order Regression of Teaching and Research Activity on Total Funding. National Universities, Japan, 2001

Models	Average Incremental Cost				Marginal Cost				Ray Econ. Scale	Global Econ. Scope
SR	S_{lc}	S_{hc}	R_{lc}	R_{hc}	S_{lc}	S_{hc}	R_{lc}	R_{hc}		
1. $(SR)_{lc}$, $(SR)_{hc}$	0.87	1.40	12.93	3.19	1.01	1.15	11.77	3.69	0.95	-0.04
2. $S_{lc}S_{hc}$, $R_{lc}R_{hc}$ omits R_{lc}^2, R_{hc}^2	1.08	1.29	11.47	2.67	0.90	1.23	17.87	3.20	0.95	0.03
3. model 1 + IEM	0.84	1.75	10.88	2.90	0.94	1.18	6.69	3.02	1.10	-0.19
4. model 2 + IEM	0.64	1.11	12.15	2.42	0.63	1.13	17.57	2.87	1.11	0.08
TDR	T_{lc}	T_{hc}	D_{tot}	R_{tot}	T_{lc}	T_{hc}	D_{tot}	R_{tot}		
5. $T_{lc}T_{hc}$, $D_{tot}R_{tot}$ omits D_{tot}^2, R_{tot}^2	1.37	0.78	9.21	1.96	1.20	0.77	10.55	2.28	1.0	0.06
6. $T_{lc}D_{tot}$, $T_{hc}D_{tot}$, $D_{tot}R_{tot}$ omits D_{tot}^2, R_{tot}^2	1.42	1.47	10.66	1.60	1.26	0.93	9.26	2.11	1.01	-0.12
7. model 5 + IEM	0.70	0.64	10.15	1.62	0.76	0.69	10.94	1.81	1.12	0.09
8. model 6 + IEM	0.91	1.14	10.64	1.49	0.89	0.80	10.05	1.81	1.14	-0.05
UGR	U_{lc}	U_{hc}	G_{tot}	R_{tot}	U_{lc}	U_{hc}	G_{tot}	R_{tot}		
9. $U_{lc}U_{hc}$, $G_{tot}R_{tot}$ omits G_{tot}^2, R_{tot}^2	1.53	0.81	1.71	3.18	1.26	0.65	2.82	3.93	0.94	0.07
10. $U_{lc}G_{tot}$, $U_{hc}G_{tot}$, $G_{tot}R_{tot}$ omits $G_{tot}^2R_{tot}^2$	2.14	0.58	1.92	3.57	1.36	0.57	2.68	4.10	0.93	0.01
11. model 7 + IEM	1.26	0.54	3.39	2.39	1.11	0.45	3.94	2.76	1.15	0.06
12. model 8 + IEM	1.75	0.46	3.10	2.50	1.24	0.42	3.61	3.12	1.08	0.02

Notes Models include all first-order terms and squared second-order terms unless otherwise noted; second-order interaction terms that are included are noted. Values for lower- and higher-cost areas are combined in G_{tot} and R_{tot}. IEM indicates that dummy variables, IMP, ED and MED, are included. Relevant notes to Table 2 also apply to Table 5. Full definitions of the terms AIC, MC, Ray economies of scale and Global economies of scope are given by Cohn *et al*. (1989).

Three models were identified as free from the problems of extreme multi-collinearities. In them the number of variables was limited to 8 - 10 either by conflating student courses (S) or higher- and lower-cost areas (G_{tot}, R_{tot}). The results (Table 5) are not directly comparable with the first-order coefficients. For students, average incremental cost (AIC) represents the average cost for an institution of average size allowing for the effect of scale and scope; marginal cost (MC) is, in effect, that of providing for one additional student. Economies of scale are indicated by a parameter greater than 1.0; and of scope by a value greater than zero.

Numerical values for AIC and MC derived from SR and TDR models conform quite closely to those from the first-order analyses; this is not so for the conventional UGR models. Economies of scale are indicated, especially when allowance is made for the areas of special funding though this effect does not extend to universities much larger than the comparatively small "average" institution (6,400 students). Overall economies of scope are not clearly indicated; individual interaction coefficients suggest that there are no economies to be found in teaching lower and higher cost undergraduates together but there are in combining facilities for undergraduate and graduate students in higher cost areas and in combining doctoral programmes with research activity.

Conclusions

The analyses clearly demonstrate the power and the limitations of the statistical procedures. It is unfortunate that the data are unable to support extensive second-order regressions and so fully resolve problems of economies of scale and scope. The limited evidence for small economies of scale and possible economies of scope is derived from restricted models only. At a time when amalgamations and selective funding are planned, it would be of interest to be able to demonstrate the effects that may occur within a system that has larger and more selective institutions. But the limiting high levels of collinearity may also reflect the inherent characteristics of a system where student quotas and single-source funding have been determined centrally. One statistical consequence of this may be the high precision of the regressions of data from the national universities (adj r^2, 0.98 - 0.99), higher than is reported from large studies of the more diverse U.S. system (0.88 - 0.98) (Cohn *et al*., 1989; Koshal and Koshal, 1999; Dundar and Lewis, 1995). As a further consequence, it is also likely that scale and scope effects will be small. Indeed, the few figures available (Table 5) are much smaller than those reported in the U.S. studies, where economies of scale lie in the range of 5% - 22%, and of scope of up to 50% for institutions of the average size.

A variety of models is available from the first-order analyses. Each provides a consistent description of expenditures, identifies relative expenditures for subject areas, and between undergraduate and graduate courses, and each provides precise regressions (adj r^2, 0.97 - 0.99). This allows any one of them to be used to identify total expenditures from elemental inputs, though the model combining student numbers for taught courses (T) and doctoral students (D) and research activity (R) appears to be more appropriate to the Japanese system than the conventional UGR model. Amongst other applications, the first-order models permit institutions to detect when their funding departs markedly from the norm. Yet none of them is fully comprehensive, nor are they mutually compatible. A major cause of these problems is likely to be the high level of collinearity that afflicts the data for higher cost doctoral and graduate students and research activity (r ~ 0.93 - 0.95). Consequently no single model can be used confidently as a reliable basis either for system-wide funding or for internal institutional allocation.

The statistical models all retain a number of fundamental flaws. One, of universal relevance, is their failure to identify factors or criteria reflecting educational and research quality, although much other evidence suggests that these are expensive. Of specific relevance to Japanese institutions is a problem due to the now conventional use of external research funding as a sole measure of research activity. This fails to identify the component of research activity funded internally by the institution. Internal funding for research, as distinct from institutional costs of research activity, may be substantial and may not be proportional to external funding. Indeed in Japan, from estimates of total university expenditure on research (Morgan, 2000), internal funding of research projects appears likely to be at least of similar size to that from external sources. In the absence of a comprehensive estimate of research output (*e.g.* publications) inclusion of a measure of internal funding for research may well be a necessary addition to the model for the national universities.

Despite their many limitations, the analyses indicate some other matters that merit further investigation. Failure to identify explicitly expenditures on master's programmes, especially in the higher-cost subject areas is a serious omission. This may well be resolved by current studies of expenditures in single subject areas. The origins of the relatively high expenditures on doctoral programmes also require further research: these may well be affected by collinearity and the incomplete data for research activity. In contrast, the relatively low expenditure on undergraduate programmes in lower-cost subject areas and which appears to be close to the level of tuition fees, is unlikely to be affected by collinearity; this may well be an issue that merits broader discussion. Further studies in a number of these and related areas are in progress and will be reported subsequently.[5)]

Notes

1) Lower-cost subject areas include humanities, social sciences and commerce; higher-cost subject areas include engineering, science, agriculture, and pharmacy.

2) Educational funds are provided for a wide range of activities. Those not categorized as contributions for research include: from grants-in-aid, in addition to COE funding, grants for health, media, physical training and international student centres, museums, libraries and lifelong learning; from donations, money for sponsored chairs, scholarships, affiliated schools and unspecified university activities; from contracts, fees for routine medical and pharmaceutical testing; and collaborations with media and administrative centres and for lifelong learning and international student activities. In total exclusions amounted to approx ¥21

billion (about 10% of total external funding).

3) Use of dummy variables for a range of other factors, *e.g.* single faculty institutions, doctoral awarding universities, universities with graduate schools in higher cost areas, showed only weak statistical significance.

4) Similar results were obtained for the model UMDR but they failed to provide statistically reliable results for masters courses. Results were obtained for SR, UGR and TDR models with expenditures in medical faculties separated from other higher-cost areas: where appropriate these results have been used in the discussion; similar results obtained by separating education from other lower-cost areas indicated no significant cost differences.

5) Compilation of the data for analysis was made possible only by the generous help provided by a number of people. The author wishes to acknowledge this generous help and to express his thanks in particular to: Miki Wakimoto and Naoko Sekiuchi, in the RIHE Library; to Satomi Ito, Megumi Tatsuda, Masayo Daikoku and Miharu Otono in the RIHE Office; and to Noriko Nakai.

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教育経済学（パート９）

—教育と研究の支出：学科・コース格差—

キース・J・モーガン*

この論文は，学生数と研究活動を多変量解析することにより，国立大学における平均的な教育研究コストを明らかにするものである。総支出は学士課程学生，大学院学生，研究活動の間でほぼ等分されており，また，低コスト分野に対しては全体の支出の３分の１が使われている。ユニットコストについては学士課程学生の場合，低コストの分野は高コスト分野の半分以下となっている。同様のことは，学士課程の学生と大学院の学生についてもいえ，分野に関係なく博士課程の学生に最も費用がかかっている。ここでの分析は，教育学部や医学部，そして旧帝国大学に対する特定財源も考慮に入れて行っている。データの精度上の限界のため，システム全体について信頼性のおけるファンディングモデルを構築することや，規模や範囲の経済を明らかにするためにモデルを拡大することはできないが，規模の経済が成り立つのは小規模な機関に限られると考えられる。

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