A Cost Function for Higher Education in Australia *

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Abstract

This study estimates a cost function for higher education in Australian universities using pooled series of cross-sectional data. The study enabled the quantification of the cost differences between levels of studies and subject areas. The cost function is useful in an number of ways. It can be used by universities to evaluate the effect of changes in course structure and size on university budgets. It may also be used by universities to help develop pricing policy for courses for fee paying courses. In this paper it was used to derive estimates of the overall cost of providing higher education to overseas students.

1. Introduction

This study estimates a cost function for higher education in Australian universities. The estimated function is used to examine the cost of providing higher education to overseas students. In the higher education sector, production functions are useful for evaluating the structure of the industry and can serve as guides for individual institutions on policies affecting their size and scope. Moreover, in view of the relaxation of provisions under which universities can provide higher education to full-fee paying domestic students, information from cost functions can assist institutions to develop appropriate pricing strategies.

Cost functions also provide an opportunity to evaluate the cost of providing higher education to overseas students. Higher education costs for an individual university can be established from a detailed accounting exercise in which the explicit and implicit costs allocated to courses and levels are collected. However, in obtaining the costs of overseas students, there is still be a need for a cost function because it is necessary to examine what the costs would be under alternative student numbers, that is, with and without overseas students. Some idea of the variation in costs with different numbers can be obtained by comparing universities at the same date but with different student profiles. Hence the use of cost functions provides a method for measuring the net benefits (or costs) of the providing education to overseas students.

The paper is organised as follows. Section 2 reviews some of the previous work done on the Australian higher education sector and discusses some relevant issues. Section 3 presents the basic cost function model, describes the data and presents empirical results. Section 4 presents results from the application of the cost function, including the costs predictions for the provision of higher education for overseas students. Section 5 draws policy implications and conclusions.

2. Previous Work and Some Issues

Throsby (1986) estimated the cost of providing higher education using data from 18 Australian universities for the period 1978 to 1982. This was followed by Lloyd et al. (1993) and Lloyd (1994), which defined the conditions under which the functional form of the cost function allows economies of scale and scope in the production of multiple outputs, that is research and teaching in various disciplines and at different levels. Estimates from these studies were used to analyse the impact of the amalgamations that followed the 1987 reforms.

In particular, the estimated equation was used to evaluate the likely cost savings arising from the amalgamation of two or more institutions. The most recent cost function estimate for Australia is reported in Throsby and Heaton (1995). Using 1991 cross-sectional data on 42 institutions, Throsby and Heaton analysed the relationship between the operating costs of institutions and the number of students in 10 broad subject areas and three levels of studies, using a quadratic function of the student numbers (implying constant marginal costs). Their cost function was used by Baker, Creedy and Johnson (1996) to evaluate the cost of overseas students.

A number of issues arise in deriving and using such a model. First, previous studies failed to account for unobserved differences between universities. Each institution has a particular structure that may make the provision of particular courses more cost efficient in one university than in others. In addition, the explanatory variables chosen may not adequately represent the characteristics of particular institutions; for example, there may be variation of quality and the proportion of resources devoted to research. The implicit assumption that quality of teaching is independent of variations in student numbers is also made.

Second, there are aggregation problems associated with the accurate specification of the variables. These occur because the choice of discipline or course level categories masks large differences between components of the aggregated discipline. For example, health includes the training of both high-cost doctors and relatively low-cost nurses. At the aggregate level they may be combined into a single composite group, but individual universities may specialise in either the high-cost or the low-cost product. Accordingly, their total costs will be under- or over-estimated by the use of an averaged set of parameters defined over the universities as a whole.

Third, the conventional cost minimisation assumption does not apply naturally to the higher education sector when government (to a large extent) determines both the funding and the output. In fact, many universities may use the same model as used by the government to determine the funding of domestic students (the Relative Funding Model) for setting fees for overseas students.

In general, the first and second problems are features of the availability of appropriately disaggregated data and model specification. Preliminary investigation has revealed that while

finding an answer to the second problem is difficult, a more rigorous study can tackle the first. This third problem is intrinsic to the cost function methodology.

The cost function approach is nonetheless a useful tool for higher education policy development. Universities can compare their own performance with the average performance estimated by the cost function. Universities can vary size and structure of the student body and consider the likely effect on their budget. The cost function may also be fed into the mechanism for providing funding for domestic students through the Relative Funding Model.[1] The cost function may also be used to evaluate new ways of reimbursing institutions and can be useful in evaluating pricing policy for domestic full-fee students. It may be used to estimate the costs and benefits of provision of higher education for overseas students, and thereby guide pricing policy with respect to them.

3. The Cost Function

3.1. The Basic Model

The cost function is defined as:

$$C = f\left(L, D, X\right) \tag{1}$$

where C is the cost of course provision, L is the vector of the student numbers enrolled in the different levels of university studies D is the vector representing enrolments levels of various disciplines in the institution's portfolio and X represents all other factors.[2] A number of specifications for f are possible, although expressions involving third degree polynomials are preferred because they are capable of capturing total cost movements along production stages of increasing and declining average costs, unlike the quadratic case used by Throsby and Heaton (1995).

More specifically, let C_k denote total teaching costs at university k, L_{ik} denote the i^{th} level of study (i = 1,…,I), and D_{jk} denote the student share of the j^{th} discipline group (j =1,…,J). The form of the cost function explored in this study is:

$$C_k = \alpha + \sum_i^I \beta_{1i} L_{ik} + \sum_i^I \beta_{2i} L_{ik}^{\ 2} + \sum_i^I \beta_{3i} L_{ik}^{\ 3} + \sum_j^J \delta_j D_{jk} + \varepsilon_k, \tag{2}$$

and ε_k is the random error. The associated marginal and average cost functions are:

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[1] Direct evaluation of the Relative Funding Model using the cost function may be prejudiced to the extent that the former is endogenous to the cost function estimation.

[2] In the absence of additional information attention is restricted to L and D and the vector X is subsumed in the error term.

$$MC_{L_i k} = \frac{\partial C_k}{\partial L_{ik}} = \beta_{1i} + 2\beta_{2i} L_{ik} + 3\beta_{3i} L_{ik}^{\ 2} \tag{3}$$

holding $\partial D_{jk} / \partial L_{ik}$ fixed for each $i = 1,\ldots,I$;

$$MC_{D_i k} = \delta_{jk} \tag{4}$$

for all $j = 1,\ldots,J$; and,

$$AC_k = \frac{C_k}{\sum_{i=1}^{I} L_{ik}} \tag{5}$$

where $\sum_{i=1}^{I} L_{ik}$ is total student load.

3.2. The Australian Data

Annual data on costs and student loads were collected for 32 higher education institutions for the years 1993 to 1997[3]. Of the 36 universities in the Unified National System (UNS), six were excluded for reasons of data continuity or for having very small student numbers. [4] As in previous studies, the Australian National University was also excluded because of its special funding arrangements. The 5-year panel dataset is the most comprehensive set of statistics assembled for a cost function study on the higher education sector in Australia. Table 1 present some summary statistics.

The size of universities as measured by total student load (in equivalent full-time student numbers or EFTSUs) continue to vary widely post reform, with the largest university having EFTSU numbers that are at least 14 times the size of the smallest university. During the years 1993 to 1997, mean student load across the 32 universities rose steadily at a rate of 2 per cent per annum. A significant proportion of this is due to a steady increase in the mean

[3] Data for 1998, 1999 and 2000 were available but were excluded due to data inconsistency problems. For example, from 1999, student load numbers were markedly increased from previous years because of a change in the reporting procedure of the federal government department responsible for higher education. While the name of this department has undergone a number of changes over recent years here we will refer to it as the Department of Education, Training and Youth Affairs or DETYA. Also, the period from 1998 onwards marked the proliferation of double degree courses that made it difficult for DETYA to categorize students in one discipline only. The DETYA publications in 1998, 1999 and 2000 report double degree students in both disciplines causing a sudden jump in student load numbers for these years.

[4] Stability in the UNS was not achieved until at least 1996. Institution mergers occurred between 1990 and 1992, but subsequent dissolutions (of unsuccessful mergers) also occurred during 1994-1995 period.

participation rates of domestic students. There was also a substantial and steady increase in the average numbers of overseas students during those years. In column (5), it is seen that the composition of students in the Australian higher education sector is gradually changing. In 1993, overseas students accounted for less than 8 per cent of EFTSUs, and this has steadily risen to over 10 per cent in 1997. Published statistics from 1998 onwards show that this trend has continued and is likely to continue in the foreseeable future.

Table 1. Summary Statistics, Student Loads and Teaching Costs, 1993-1997.

	Total Student Load (EFTSU)				EFTSU share by Level of Study			
Year	Mean	Min	Max	EFTSU share by Student Type	Postgraduate Studies by Research	Postgraduate Studies by Coursework	Under-Graduate Studies	Total Teaching Cost ($000s)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
All Students								
1993	12963	2624	28191	100.00	4.89	10.25	84.85	110900
1994	13095	2653	28520	100.00	5.24	10.13	84.64	121130
1995	13499	2865	29744	100.00	5.41	10.46	84.13	139810
1996	14207	2858	30502	100.00	5.24	10.69	84.07	155250
1997	14861	2748	30885	100.00	5.24	10.60	84.17	156600
Domestic Students								
1993	12027	2496	25659	92.78	4.40	10.17	85.43	na
1994	12076	2553	24851	92.22	4.80	9.85	85.35	na
1995	12333	2750	25844	91.36	5.04	10.02	84.94	na
1996	12833	2735	26178	90.33	4.98	10.11	84.90	na
1997	13274	2608	26087	89.32	5.07	9.76	85.17	na
Overseas Students								
1993	936	128	2532	7.22	11.22	11.32	77.35	na
1994	1019	100	3669	7.78	10.40	13.44	76.15	na
1995	1166	115	3900	8.64	9.26	15.09	75.56	na
1996	1374	123	4324	9.67	7.71	16.08	76.35	na
1997	1587	140	4798	10.68	6.62	17.64	75.74	na

In columns (6) to (8), the distribution of students by level of study is shown. About 85 percent of all students pursue undergraduate studies, about 10 percent pursue postgraduate studies by coursework, and around 5 per cent pursue postgraduate studies by research. This distribution holds also for the case of domestic students only. For foreign students, there is a greater proportion of students pursuing postgraduate studies. Further, there is an apparent shift in the mode of postgraduate studies pursued by overseas students over the study period.

In 1993, an equal proportion of students pursued postgraduate studies by research and by coursework. This has gradually changed in favour of the latter.

Column (9) shows the average total cost attributed to teaching only. This variable is not directly available from any higher education publication but was derived in the following way from data provided by DETYA. For each university, DETYA provides data on the total operating cost before abnormal items in the relevant year and excluding an implicit rental for capital stock. DETYA, through the ABS, also provides data on the total annual expenditure on research and experimental development activities for each institution. To obtain the cost of teaching, the ratio of this research expenditure item to total expenditure was calculated per year, then averaged across the years to obtain a robust estimate of the budget share of research for each university; see Appendix Table A1. The resulting proportion, which varies across university but is fixed over time for each university (within the five year period), is subtracted from the annual total operating cost to obtain the total cost for the teaching function only. All costs are real costs with a base of 1997. Student load data are disaggregated by domestic and overseas students, but the total operating cost and research cost data are aggregate.

3.3. Estimates

The cost function's dependent variable is total teaching cost. The independent variables used are the total student loads disaggregated by levels of study, L_i, and subject area or discipline, D_j. For the level of study, the student loads are grouped into Postgraduate Studies by Research (Pr) , Postgraduate Studies by Coursework (Pc) and Undergraduate Studies (U). In addition, there are ten broad fields of study or discipline areas to which students may belong: Agriculture and Animal Husbandry, Architecture and Building, Arts/Humanities/Social Science, Business Administration and Economics, Education, Engineering and Surveying, Health, Law and Legal Studies, Science, Veterinary Science, plus a residual category known as Non-Award.

A number of alternative specifications for equation (1) were estimated, including all possible interaction terms and their polynomial equivalents (up to 3rd degree), including the form in equation (2) above. Experimentation showed that the magnitudes and signs of the coefficients are highly sensitive to the functional form used. The significance of the estimates is also affected. Predicted values of the costs (total, average and marginal costs) derived from each

alternative specification were also used to assess the comparative performance of the models. The cost function models were estimated using pooled ordinary least squares estimation with standard errors that are adjusted for cross-section heteroskedasticity and cross-section correlation; see Greene (1993).

The question of whether the classification of universities into groups makes a difference to the results was investigated. Universities were divided into 'sandstone' universities and all others. Sandstone universities is a term used to refer to those higher education institutions which are usually older, more traditional, and are more academically orientated as opposed to being more technical-skill orientated. On the other hand, the non-sandstone universities are relatively new, usually have developed from colleges of advanced education (CAEs) and are perceived to be more focused on offering technical courses. The hypothesis that teaching costs vary between these two broad university types was tested, based on two definitions of sandstone university. In the first definition, the term sandstone university included University of New South Wales (UNSW), University of Sydney, University of Queensland, University of Adelaide, Monash University, University of Melbourne, and University of Western Australia. In a second classification, the number of sandstone institutions was expanded to include University of Tasmania, Flinders University of South Australia, Macquarie University, University of Newcastle, and Murdoch University. It was found that the second larger grouping of universities made more impact on the estimation results compared with the first grouping. However, the dummy variables for sandstone universities yielded insignificant coefficients for both cases.

The chosen model specified in Equation (2) is thus reported using data for all the 32 universities included in the study. The choice of which discipline to omit from the regressions is arbitrary and the resulting parameter estimates are interpreted relative to the omitted category. For prediction purposes, models with alternative omitted categories yield identical results.

Table 2 presents the estimated model where Education was the omitted category.[5] The negative sign on the constant term implies large overhead costs. Across the three levels of study, only the coefficient for the Postgraduate by Research was significant. The L_1^3 was also

[5] Note that since our focus is not on the importance of particular variables but rather on constructing the best model for forecasting we retain insignificant variables.

significant at the 10 per cent level. The positive signs of these coefficients show that an increase in the student load at each level of study increases the total cost for teaching assuming all the other variables remain the same. The coefficients on the disciplines variable, D_j, are interpreted relative to the omitted discipline. Hence, the significant positive sign for Agriculture means that the cost of running Agriculture courses are significantly greater than those for Education, all other things being equal. Similarly, the results show Architecture, Arts, Business and Health are likely to be significantly more expensive than Education. The coefficients for other disciplines were not significant.

Table 2. Cost function estimates

Variable	Coefficient Estimates	t-ratio
(1)	(2)	(3)
Constant	-90344	-2.300
L_1 (Postgrad by Research)	82.994	2.367
L_2 (Postgrad by Coursework)	20.518	0.429
L_3 (Undergraduate Studies)	1.27	0.196
L_1^2	-5.68E-02	-1.787
L_2^2	-5.08E-03	-0.172
L_3^2	8.89E-05	0.205
L_1^3	1.58E-05	1.891
L_2^3	2.27E-06	0.412
L_3^3	5.13E-09	0.527
Agriculture	121650	2.757
Architecture	346990	4.514
Arts	158650	2.832
Business	211730	3.367
Education	omitted discipline	
Engineering	23383	1.370
Health	211670	9.120
Legal Studies	62618	0.890
Science	14738	0.238
Veterinary Science	-228170	-1.346
Non-Award	36206	0.260
No of Observations	160	
Adjusted R-squared	0.9466	

4. Application of the Cost Function

4.1. Total Costs

In this subsection, the estimated coefficients of the chosen cost function above are used to derive estimates of total cost as defined in equations (2). The predicted values for 1997, using data for all students, are presented in Tables 3 and 4 below.[6] In Table 3, the universities are arranged from smallest to largest (by EFTSU load), and are presented with information on student load. Total cost figures – both actual and predicted – are also shown. The model yields predicted values of total costs that are reasonable approximates of the actual costs, with over 70 per cent of predicted values within a 10 per cent margin of error. There appears to be a relatively constant relationship between the student load and the total cost of teaching implying that average costs are in a tight band. This issue is explored further below.

The cubic form of the cost function indicates rising costs of teaching at low student load levels, while the rate of growth gradually diminishes as student numbers rise because of gains from economies of scale. At very high student numbers, the cost function implies a renewed rapid rise in the costs incurred by Australian universities. A typical cubic cost function is presented in Figure 1, which represents the cost of providing higher education to a Postgraduate by Research student, using UNSW fixed values for discipline shares and other levels of study. The curve is typical of universities in Australia with large postgraduate enrolments. For smaller universities such as the University of Canberra or the Northern Territory University, the total cost curve is similarly shaped but with relatively lower levels of costs. The renewed rapid rise at high postgraduate student load may be a consequence of the universities having a more expensive staff profile with higher proportions of professors as their postgraduate student load increases. As universities increase the size of their PhD programs they are able to mount more ambitious and more costly research programs that also attract the more able and higher paid academic staff.

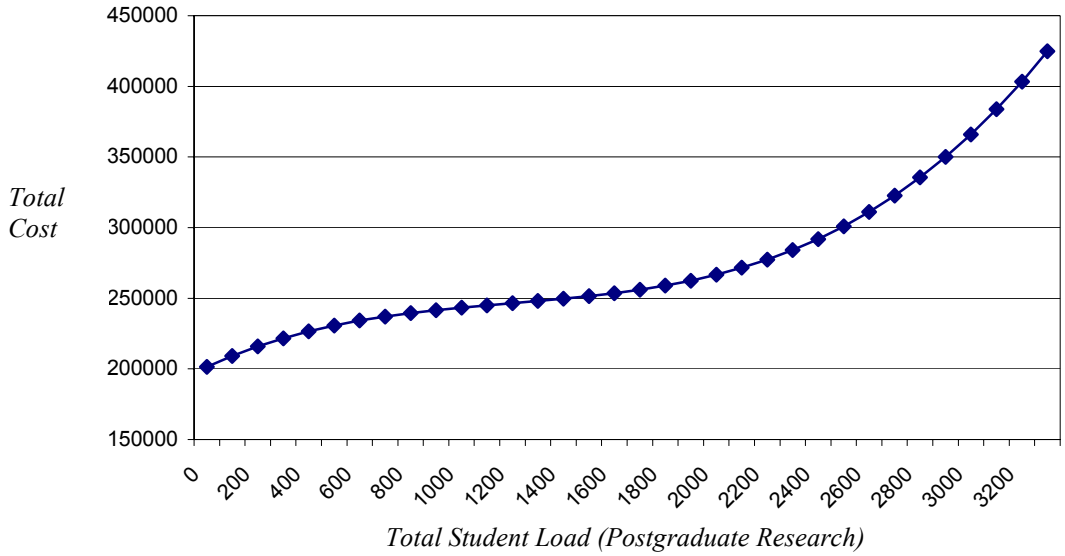
[6]For space reasons, only 1997 results are presented here. The complete set of predicted values can be obtained from the authors by request.

Table 3. Cost Estimates, All Students, 1997

Institution	Student Load (EFTSUs)	Cost of Teaching (000s)		$\frac{predicted\ cost}{actual\ cost}$
		Actual	Predicted	
(1)	(2)	(3)	(4)	(5)
1 Northern Territory University	2748	35654	38408	1.0772
2 University of Ballarat	3835	41897	37967	0.9062
3 University of Canberra	6768	74765	75121	1.0048
4 James Cook University	6899	82546	64558	0.7821
5 Central Queensland University	7546	84711	64812	0.7651
6 Murdoch University	7558	70966	68841	0.9701
7 Swinburne University	8454	76356	80547	1.0549
8 Flinders University of South Australia	8989	82115	89955	1.0955
9 University of Southern Queensland	9286	80797	87724	1.0857
10 University of Wollongong	9837	116769	89645	0.7677
11 University of Tasmania	10145	92085	95106	1.0328
12 University of Western Australia	12034	117972	113045	0.9582
13 University of Adelaide	12194	154857	122652	0.7920
14 Victoria University of Technology	12362	122560	123390	1.0068
15 Charles Sturt University	12511	122598	114180	0.9313
16 Macquarie University	13102	105049	133545	1.2713
17 Edith Cowan University	13437	137012	105836	0.7725
18 University of Newcastle	13759	134780	122008	0.9052
19 Griffith University	17187	147739	149737	1.0135
20 Sydney University of Technology	17215	148293	175143	1.1811
21 Curtin University of Technology	17390	201974	190105	0.9412
22 University of South Australia	17462	182603	179014	0.9803
23 La Trobe University	17765	173444	178620	1.0298
24 Deakin University	18704	192204	174888	0.9099
25 University of Western Sydney	20697	210485	204618	0.9721
26 Royal Melbourne Institute of Technology	21377	239816	228979	0.9548
27 University of New South Wales	22930	310844	278209	0.8950
28 University of Queensland	23551	240730	242767	1.0085
29 Queensland University of Technology	23746	212251	230303	1.0851
30 The University of Melbourne	27287	282583	311326	1.1017
31 University of Sydney	27888	356177	337657	0.9480
32 Monash University	30885	378537	354378	0.9362

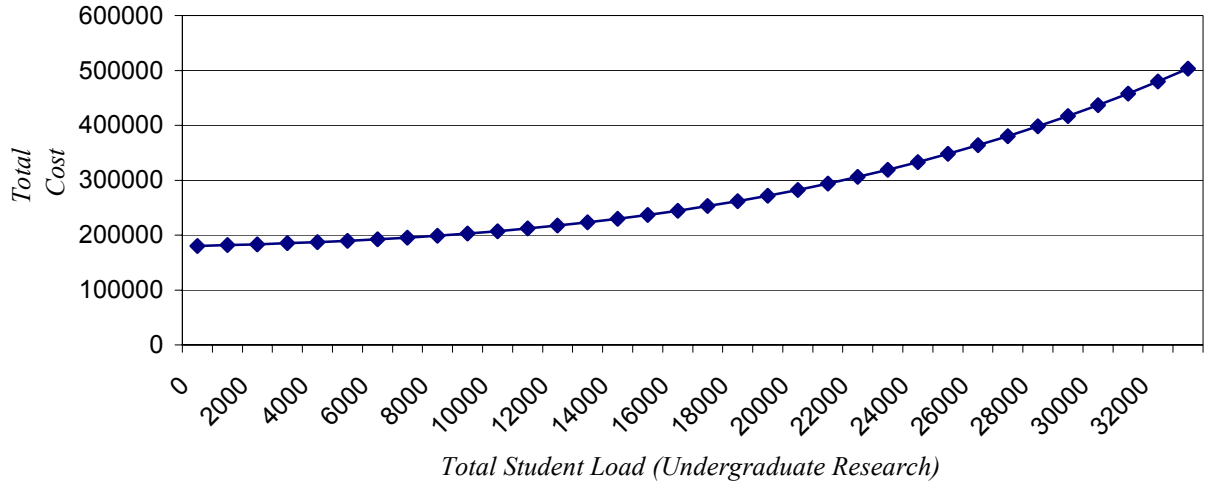
The total cost curves for Postgraduate by Coursework Students, using fixed values for all the other variables, yield a flatter cubic curve than for postgraduate by research work. Whereas most students undertaking postgraduate by research degrees are PhD students, the coursework postgraduate courses are predominantly at the Masters level. Masters level courses would not require as expensive a staff profile as PhD students.

Figure 1. Total Cost Curve for Postgraduate by Research Students, using UNSW fixed values



A contrast is shown by the corresponding curve for Undergraduate students, shown in Figure 2, where costs monotonically increase by virtue of the positive coefficients obtained for all three undergraduate student load regressors, L_3, L_3^2 and L_3^3 and over the range shown the cubic term appears to have little effect. In this case, economies of scale gained from increasing postgraduate students numbers are not realised in the same way with the increase in undergraduate student numbers. It is also possible that within universities, cross-subsidisation of teaching costs occurs between levels of studies, where it becomes cheaper to mount particular types of postgraduate courses when there are large numbers of undergraduate students.

Figure 2. Total Cost Curve for Undergraduate Students, UNSW fixed values



4.2. Average and Marginal Costs

The average and marginal cost estimates for 1997 are presented in Table 4. The average cost of higher education across the universities ranged between between $7900 to just under $14000 in 1997. Columns (3) to (5) present the marginal costs by level of study. The marginal costs for undergraduate students are around $2000 for smaller universities and these costs tend to increase with the EFTSU load of the universities. Monash University, the largest university with 15 times the student load of the NTU (the smallest university), has a marginal cost for undergraduate students of $16300. In general, the marginal cost for undergraduate students is small compared with that of graduate students.

Marginal costs of coursework graduate students lie in between those of the undergraduate and research postgraduate students, but are also positively correlated with the size of the university. In contrast, the marginal costs for Research Postgraduate students are substantially higher than both Coursework Graduate and Undergraduate students, and university size does not explain the observed variations. Of the ten largest universities on the list, three have marginal costs over $75,000 for their Research Postgraduate students, but at the same time, the remaining large universities have corresponding marginal costs of under $35,000. At the other end of the scale, some smaller universities have marginal costs for research postgraduate students that are over $60,000. A selection of universities have marginal costs for coursework postgraduate students that are significantly higher than research postgraduate

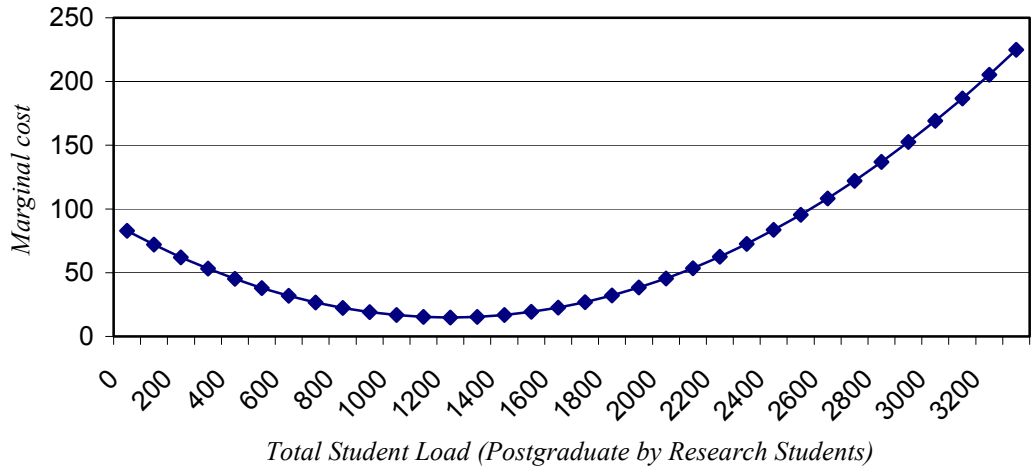
students: these include Macquarie University, La Trobe University, RMIT, QUT and Monash University. This variation is likely to arise for a combination of reasons. First, large universities are not necessarily those with large proportions of postgraduate students. Second, there may be large differences in composition by discipline with some universities specialising in high cost courses. Third, small sample sizes in some (smaller) universities may lead to misleading results.

Table 4. Average and Marginal Cost Estimates, All Students, 1997

	Institution	Average Cost (000s)	Marginal Costs (000s)		
			Postgraduate Studies by Research	Postgraduate Studies by Coursework	Undergraduate Studies
	(1)	(2)	(3)	(4)	(5)
1	Northern Territory University	13.98	68.51	17.99	1.76
2	University of Ballarat	9.90	75.48	17.96	2.07
3	University of Canberra	11.10	60.74	16.74	2.80
4	James Cook University	9.36	36.90	17.49	2.88
5	Central Queensland University	8.59	67.81	17.14	3.04
6	Murdoch University	9.11	41.30	16.77	2.99
7	Swinburne University	9.53	53.58	18.03	3.26
8	Flinders University of South Australia	10.01	39.49	16.98	3.66
9	University of Southern Queensland	9.45	70.03	17.17	3.74
10	University of Wollongong	9.11	31.58	18.78	3.65
11	University of Tasmania	9.37	30.53	17.46	4.16
12	University of Western Australia	9.39	14.92	16.72	4.62
13	University of Adelaide	10.06	15.18	16.93	4.66
14	Victoria University of Technology	9.98	49.34	20.44	4.85
15	Charles Sturt University	9.13	68.31	25.64	4.82
16	Macquarie University	10.19	23.84	30.88	4.66
17	Edith Cowan University	7.88	49.91	19.12	5.49
18	University of Newcastle	8.87	34.52	16.80	5.81
19	Griffith University	8.71	32.32	18.95	7.58
20	Sydney University of Technology	10.17	40.67	42.57	6.81
21	Curtin University of Technology	10.93	27.10	24.65	7.32
22	University of South Australia	10.25	41.94	30.32	7.31
23	La Trobe University	10.05	19.26	23.25	7.49
24	Deakin University	9.35	36.77	29.93	8.08
25	University of Western Sydney	9.89	31.19	28.44	9.47
26	Royal Melbourne Institute of Technology	10.71	17.29	40.60	9.30
27	University of New South Wales	12.13	31.47	68.66	9.19
28	University of Queensland	10.31	77.00	23.77	10.54
29	Queensland University of Technology	9.70	32.09	42.23	11.35
30	The University of Melbourne	11.41	93.61	46.08	12.61
31	University of Sydney	12.11	100.86	36.37	13.41
32	Monash University	11.47	35.32	51.51	16.31

In general, the marginal cost of higher education is U-shaped, as in Figure 3 below, reflecting increasing returns with economies of scale, then diminishing returns derived from fixed inputs to teaching. At low student numbers, marginal costs are relatively high but this gradually declines as student numbers rise to about 1200 EFTSUs. Thereafter, the marginal costs increase. A typical marginal cost curve for Postgraduate Research students is shown in Figure 3, derived using fixed values for postgraduate coursework and undergraduate student loads for UNSW.

Figure 3. Marginal Cost Curve for Postgraduate by Research Students, UNSW



The cost of providing postgraduate courses is higher than undergraduate courses because of the high level of specialised resources required. The distribution of students across the various disciplines is also important in explaining differences between Universities, with many universities specialising in the provision of certain courses.

4.3. The Cost of Overseas Students

The cost function can be used to estimate the cost of providing higher education to overseas students. However, information on the costs of higher education in Australia is available only for the total number of students, that is, overseas plus domestic students, at a particular date. No data are available relating to the cost that would be incurred if only domestic students were being educated. This means that estimates of the extra cost involved in educating overseas students can only be obtained by using university cost functions and evaluating the

costs under alternative assumptions about the number of students. The quality of such estimates is therefore necessarily constrained by the properties of empirical cost functions.

The cost function is applied to domestic student data to predict the average and marginal costs for domestic students. Corresponding values for overseas students are obtained as the residual values of the cost estimates for all students and for domestic students only. The results of this exercise for 1997 are shown in Table 5.

Universities across Australia vary widely in the distribution of student load between domestic and fee-paying overseas students. In general, the overseas student population comprise less than five per cent of the student population in most regional universities, but are much more important in universities located major city centres. In 1997, the top five universities, in terms of numbers of full-fee paying foreign student loads are Monash University, RMIT, the University of Melbourne, UNSW and Curtin University of Technology. However, in relative student shares, RMIT is highest with 29 per cent of its student load from overseas, followed closely by Curtin University with foreign students comprising 27 per cent of its total student load.

There is a compositional issue in generating costs for overseas students. If the cost structure of overseas students is projected from information about all students and domestic students, the implicit assumption is made that the discipline composition of overseas students is the same as that of domestic students. However, this is not the case. Data from DETYA, 1998 show the discipline composition of overseas students. In 1997 about half of all overseas students were undertaking courses in the Business, administration and economics field of study whereas among domestic students the proportion undertaking courses in this discipline was about 20 percent.[7] Since business, administration and economics is a fairly low-cost course the effect of the assumption is likely to inflate the calculated average cost of overseas students.

With this caveat in mind, the average costs are shown in the final column of the table. In general, the apparent average cost of higher education provision for overseas students is greater than for domestic students. In many institutions, these apparent cost differences are greater by a factor of two or three. The table also shows that while the estimated costs of

[7] Among undergraduate overseas sourced students the proportion was 54 per cent, among postgraduates by coursework it was 57 per cent and among those undertaking postgraduate study by research it was 13 per cent.

higher education for domestic students are comparable across the universities nationwide, the corresponding costs for overseas student vary widely.

Table 5. Cost Estimates, Domestic and Overseas Students, 1997

	Domestic Students			Overseas Students			
		Predicted Values		Student Load (EFTSUs)		Predicted Values	
Institution	Student Load (EFTSUs)	Total Costs (000s)	Average Cost (000s)	no.	%	Total Costs (000s)	Average Cost (000s)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1 Northern Territory University	2608	31626	12.13	140	5.37	6782	48.45
2 University of Ballarat	3623	29429	8.12	212	5.85	8538	40.27
3 University of Canberra	6232	66289	10.64	536	8.60	8832	16.48
4 James Cook University	6567	58454	8.90	332	5.06	6104	18.38
5 Central Queensland University	6462	47003	7.27	1084	16.77	17809	16.43
6 Murdoch University	6366	45946	7.22	1192	18.72	22895	19.21
7 Swinburne University	7282	66882	9.18	1172	16.09	13664	11.66
8 Flinders University of South Australia	8304	82383	9.92	685	8.25	7572	11.05
9 University of Southern Queensland	7451	65906	8.85	1835	24.63	21818	11.89
10 University of Wollongong	8051	63726	7.92	1786	22.18	25919	14.51
11 University of Tasmania	9247	84423	9.13	898	9.71	10682	11.90
12 University of Western Australia	10467	93101	8.89	1567	14.97	19943	12.73
13 University of Adelaide	10947	110963	10.14	1247	11.39	11689	9.37
14 Victoria University of Technology	11005	110728	10.06	1357	12.33	12662	9.33
15 Charles Sturt University	12108	107256	8.86	403	3.33	6924	17.18
16 Macquarie University	12279	110763	9.02	823	6.70	22782	27.68
17 Edith Cowan University	12068	87417	7.24	1369	11.34	18419	13.45
18 University of Newcastle	12966	107983	8.33	793	6.12	14025	17.69
19 Griffith University	15648	128070	8.18	1539	9.84	21667	14.08
20 Sydney University of Technology	15869	147531	9.30	1346	8.48	27612	20.51
21 Curtin University of Technology	13663	146951	10.76	3727	27.28	43154	11.58
22 University of South Australia	16087	153206	9.52	1375	8.55	25809	18.77
23 La Trobe University	16585	163652	9.87	1180	7.11	14968	12.68
24 Deakin University	17249	148946	8.64	1455	8.44	25941	17.83
25 University of Western Sydney	19249	179940	9.35	1448	7.52	24679	17.04
26 Royal Melbourne Institute of Technology	16586	163946	9.88	4791	28.89	65033	13.57
27 University of New South Wales	19031	192114	10.09	3899	20.49	86095	22.08
28 University of Queensland	21842	199063	9.11	1709	7.82	43704	25.57
29 Queensland University of Technology	21955	198204	9.03	1791	8.16	32098	17.92
30 The University of Melbourne	25022	252549	10.09	2265	9.05	58777	25.95
31 University of Sydney	25868	279131	10.79	2020	7.81	58526	28.97
32 Monash University	26087	263649	10.11	4798	18.39	90729	18.91

Across universities, the per capita cost of teaching for a domestic students range only between $7000 and $12000, reflecting the discipline and level of course structure of the university. In contrast, the apparent per capita cost of teaching overseas students varies

widely, from $9300 to as much as $48,500. The two smallest universities, the Northern Territory University and the University of Ballarat, incur the highest apparent per capita cost in mounting courses for overseas students of at least $40,000 per student.

A number of universities incur apparent per capita cost for overseas students between $20,000 and $29,000. These include Macquarie University, Sydney University of Technology, UNSW, University of Queensland and the University of Sydney. The relatively low per capita costs incurred by RMIT and Curtin for its overseas students (with large foreign student shares in their total student population) may be a result of two effects. First, economies of scales are achieved with relatively high student numbers. Second, with a high proportion of overseas students in the total student load, the compositional problem mentioned above is less important since the overseas student discipline structure is closer to that of the total student discipline structure.

5. Conclusion

Information derived from the estimation of a simple cost function can assist planners and university managers in addressing problems of resource allocation and pricing. Although methodological difficulties exist, the estimation of a cost function can nevertheless help to view university production and cost relationships in a systematic and theoretically plausible way.

In this study, new cost functions were estimated for the Australian university sector using pooled series of cross-sectional data. The study enabled the quantification of the cost differences between levels of studies and subject areas. It was hypothesised that university total costs would exhibit varying cost movements along production stages suggesting a higher order functional form. Accordingly a cubic functional form was used to estimate model. It was found that the cubic and quadratic terms were useful in expaining total costs though not in all instances.

The new cost function will be a useful tool for university managers in exploring the effect of varying size and structure of courses on university budgets. To illustrate the use of the tool the model was used to derive estimates of the overall cost of providing higher education to overseas students. Application of the model suggested a large variation in average costs per overseas student between universities reflecting student load and course composition.

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Appendix

5.1.1.1 Table A1. Selected Higher Education Statistics

University	EFTSUs share (across all unis) Year: 2000	share of total teaching cost (across all unis) Year: 2000	% of budget devoted to research (6- year average)[8]
University of Canberra	0.01	0.13	0.11
Avondale College	0.00	0.02	0.00
Charles Sturt University	0.04	0.24	0.07
Macquarie University	0.03	0.31	0.30
The University of New South Wales	0.05	0.56	0.38
The University of Newcastle	0.03	0.25	0.29
The University of Sydney	0.05	0.63	0.34
University of Technology, Sydney	0.05	0.41	0.21
University of Western Sydney	0.04	0.41	0.06
University of Wollongong	0.02	0.21	0.27
Northern Territory University	0.01	0.06	0.28
Central Queensland University	0.02	0.17	0.11
Griffith University	0.04	0.31	0.30
James Cook University	0.02	0.15	0.30
Queensland University of Technology	0.05	0.43	0.19
The University of Queensland	0.05	0.47	0.47
University of Southern Queensland	0.02	0.15	0.14
The Flinders University of South Australia	0.02	0.14	0.42
The University of Adelaide	0.02	0.28	0.39
University of South Australia	0.04	0.36	0.16
Australian Maritime College	0.00	0.03	0.00
University of Tasmania	0.02	0.17	0.38
Deakin University	0.04	0.38	0.10
La Trobe University	0.03	0.32	0.25
Monash University	0.06	0.71	0.23
Royal Melbourne Inst, of Tech. University	0.05	0.44	0.11
Swinburne University of Technology	0.02	0.16	0.15
The University of Melbourne	0.05	0.53	0.46
University of Ballarat	0.01	0.08	0.07
Victoria University of Technology	0.03	0.23	0.14
Curtin University of Technology	0.03	0.39	0.14
Edith Cowan University	0.03	0.25	0.08
Murdoch University	0.02	0.14	0.32
The University of Western Australia	0.02	0.22	0.56

[8] This information is obtained by the Australian Bureau of Statistics. Until 1997, yearly data were collected and made publicly available. Subsequently, this information was gathered every second year.