Competition and Efficiency: Overseas Students and Technical Efficiency in Australian and New Zealand Universities

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Abstract

In this paper the impact of productivity and efficiency of Australian and New Zealand universities of exposure to international markets is examined using Stochastic Frontier Analysis (SFA). The analysis finds that there is an important link between competition in the market for overseas students that a university in Australia is exposed to and the level of technical efficiency at which they operate. What is true at the university level is also true at the level of business faculties. In the New Zealand case no definite conclusion on this issue can be made.

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Introduction

In recent years one of the fastest growing areas of international trade has been in the provision of education services across national borders. In the early 2000s around two million higher education students were studying outside of their country of origin and it has been estimated that this number could potentially rise to five million over the next twenty years (Organisation of Economic Cooperation and Development, 2002).

In the Australian case, the growth of higher education overseas student numbers was quite substantial during the late 1990s and early 2000s. From a figure of 40,494 students in 1994 (or 6.9 per cent of all students enrolled in Australian higher education) overseas student numbers (either onshore, distance or offshore) have risen to 210,397 by 2003 (or 22.6 percent of students: *Selected Higher Education Student Statistics*). The vast majority of these overseas students are enrolled in the government owned universities.[1] These universities as well as attracting students to home campuses in Australia have also promoted overseas enrolments through the use of offshore provision and distance education. Today through the development of twinning programmes and direct investment abroad Australian universities now have a presence in countries such as Malaysia, Hong Kong, China, Singapore, Fiji, South Africa, New Zealand and the Gulf States. Although New Zealand universities do not have as high a proportion of their students from overseas, nonetheless, universities in that country today enrol a far higher proportion of students from overseas than was the case in the early 1990s. In 1994 there were 5,567 overseas students enrolled in New Zealand tertiary institutions. By 2003 this figure had risen to 34,915 (10.4 percent in 2002 compared to only 2.8 percent in 1994; Table 1).[2]

In both cases expansion of overseas enrolments in Australian and New Zealand universities has tended to be driven by the growth in demand by students from the rapidly emerging economies in Northeast and Southeast Asia. In attempting to attract students from these locations Australian and New Zealand universities have had to compete strenuously with universities from countries such as the United States, Canada, Malaysia Japan, the United Kingdom and Ireland. These universities therefore are now the subject of greater levels of competition because of their attempts to venture into international markets.

The purpose of this paper is to examine if this exposure to international markets of the universities in Australia and New Zealand has impacted on the level of efficiency and productivity at which they operate. Stochastic Frontiers Analysis (SFA) is used to determine the levels of efficiency of the universities in both countries and to explore the links between efficiency and exposure of the universities to international competition as indicated by the proportion of students in universities from abroad is determined. In the first section of this paper a general background is given to the nature of the universities in Australia and New Zealand and the data used explained. In the following section the analytical framework is explained. This is then followed by presentation and examination of the results.

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[1] In 2003, Australian universities (including Bond and Notre Dame) enrolled 209,803 overseas students or 99.7 percent of overseas students studying in Australia (*Selected Higher Education Student Statistics*).

[2] The New Zealand tertiary education figures include those for the polytechnics. The bulk of overseas students however are enrolled in the eight universities (Auckland, Canterbury, Victoria, Otago, Massey, Waikato and AUT). In 2003 there were 25,090 overseas enrolments in New Zealand universities (15.6 percent of total enrolments: *Annual Reports*).

Background and Data Used

Over the past twenty years the Australian and New Zealand economies have been through a process of considerable micro-economic reform. One of the key elements of this process has been the opening up of markets to increasing levels of competition. The purpose of this reform has not been to promote competition for its own sake but instead for competition to be used as a means by which higher levels of efficiency might be achieved. Economists generally accept that market competition is an important driver of efficiency. Companies – and indeed organisations in general - that are strongly exposed to the pressures of competition are generally compelled to improve their methods of production and increase their levels of output compared to inputs (technical efficiency) and allocate resources to the production of goods and services that consumers desire (allocative efficiency). If they do not do so then they often lose market share to their more efficient rivals. If companies were forced to achieve higher levels of efficiency then it would be expected that the productive capacity of the economy would be raised and a higher standard of living for a country's inhabitants potentially realised.

Traditionally Australian and New Zealand universities have operated in markets that were imperfect in that the institutions did not have to fully compete with each other or with institutions abroad. During the 1970s and 1980s students in both countries had their fees paid entirely by government subsidy. In the 1990s domestic students paid a proportion of their fees in both countries although these did not cover the full cost of their tuition. This means that the demand by domestic students for higher education in both countries was greater than it would have been had students paid for the full cost of their education. Most universities in Australia and New Zealand, therefore, saw domestic enrolments grow at steady rates over the course of the 1970s, 80s and 90s without them having to compete too strenuously with each other. Competition between institutions certainly did occur in the sense that universities did try to attract the better students to them but few institutions in either country faced insufficient student demand for places as overall student demand in each country ran ahead of the supply of places.[3]

With a lack of competitive pressure in the higher education market evident in both countries it would be expected that a number of universities in both countries would operate at below best practice levels of efficiency and productivity. This would appear to have been borne out by the few studies that have been conducted on this issue (Coelli 1996; Abbott and Doucouliagos 2003)[4]. The situation in both countries has not been a static one; however, and in fact universities in both countries are now attracting an increasing proportion of their students from overseas, which do have to pay the full cost of their tuition. As this proportion rises it would be expected that there would be additional pressure put on the universities to improve their level of efficiency so that they could remain price competitive in international markets.

The raising of the efficiency at which universities operate is as important an issue as is efficiency levels in the economy more generally. The better resources are used to educate students and to conduct research in the universities, the more of both that can be produced

[3] Certainly there were a few institutions that did struggle to attract students but in most cases student places were filled simply by lowering entry standards rather than by competing in terms of fees charged.
[4] These studies do however find that overall Australian universities operate at relative high levels of technical efficiency.

with a given level of resources or alternatively the greater the resources that can be released for other purposes. If the growing level of competition that the universities face is not bringing about higher levels of efficiency then it is important to identify why this might not be occurring and rectify whatever impediments to efficiency enhancement there may be.

In conducting this study a variety of sources of data are used. In the Australia section we use two separate samples. The first involves using data from the 36 Australian government owned universities that operated over the years 1995 to 2002.[5] In the second sample, data for 34 business or commerce faculties associated with the Australian government universities, for the period 1997 to 2000 are used. Business faculty data is isolated from the rest of the universities purely because it is this discipline that attracts the largest proportion of overseas students to Australian universities. In 2003, 45 percent of all overseas enrolments at Australian higher education institutions were in business faculties (*Selected Higher Education Statistics*). The third sample used is for the seven government universities in New Zealand for the period 1997 to 2003.[6] The data for the Australian study has been taken from the statistical publications of the Higher Education Division of the Australian Government's Department of Education, Science and Technology. The New Zealand data has been taken from the Annual Reports of the seven universities. The time periods have been selected due to the availability of relevant information in all three cases.

Amongst the Australian universities it is possible to divide them into three groups based on their origins. The first group are the older universities that existed before the creation of the Unified National System in 1988. The rest of the universities were created substantially from converted colleges of advanced education after 1988 and are often referred to as "Dawkins universities" after John Dawkins, the government minister associated with their conversion. Finally of the older universities a sub-group of eight universities are often associated as being those with the greatest prestige in Australia and are often known as the "Group of Eight". The most substantial difference between these groups is that the Dawkins universities tend to have a very low research output compared to the older universities and in particular the Group of Eight. Another point of difference between the Dawkins universities and the other universities is the proportion of students that they have from overseas. Figure 1 compares the proportion of overseas students for the Dawkins universities, the non-Dawkins universities, and the Group of Eight. It is clear from Figure 1 that the Dawkins universities have the highest overseas students ratio and highest rate of growth in this ratio.[7] The most likely explanation for this is that the Dawkins universities are at a relative disadvantage in attracting income because of their low research output, and subsequent lower government funding and research contract income. Enrolling full fee paying overseas students has been one way for them to attract additional income. The issue then is what impact this has on their operational efficiency.

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[5] Private universities such as Bond University in Queensland and Notre Dame in Western Australia have been excluded from the analysis, as is the University of the Sunshine Coast, which did not operate throughout the whole of the period.

[6] Data for the Auckland University of Technology has not been included as it had polytechnic status before 2000.

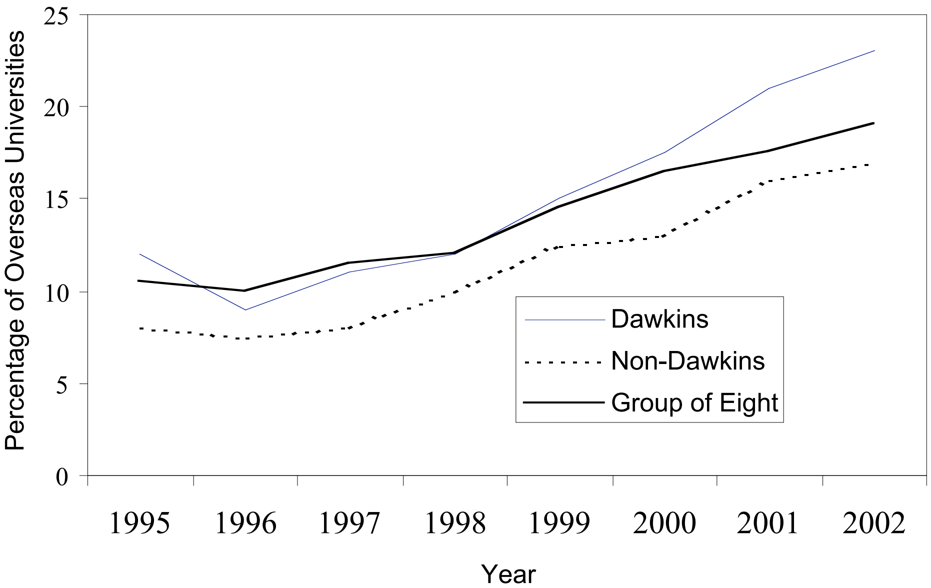
[7] The Dawkins universities are the Australian Catholic University, Central Queensland University, Charles Sturt University, Curtin University of Technology, Edith Cowan University, Queensland University of Technology, RMIT University, Southern Cross University, Swinburne University of Technology, University of Ballarat, University of Canberra, University of Southern Queensland, University of Technology, Sydney, University of Western Sydney and Victoria University of Technology. The Group of Eight universities are the Australian National University, Monash University, University of Adelaide, University of Melbourne, University of New South Wales, University of Queensland, University of Sydney, and University of Western Australia.

Table 1: Higher Education/Tertiary Education Student Numbers in Australia and New Zealand 1994 to 2003

	Australia			New Zealand		
year	Total student numbers	Overseas student numbers	Overseas percentage	Total student numbers	Overseas student numbers	Overseas percentage
1994	585,435	40,494	6.9	201,968	5,567	2.8
1995	604,176	46,187	7.6	212,068	6,742	3.2
1996	634,094	53,188	8.4	214,260	6,034	2.8
1997	658,849	62,996	9.6	242,826	7,587	3.1
1998	671,853	72,183	10.7	255,094	8,430	3.3
1999	686,267	83,111	12.1	253,773	9,034	3.6
2000	695,755	95,607	13.7	264,353	11,638	4.4
2001	726,418	112,342	15.5	282,808	17,659	6.2
2002	896,621	185,058	20.6	319,886	26,878	8.4
2003	929,951	210,397	22.6	337,004	34,915	10.4

Source: Australia, Department of Education, Science and Technology. New Zealand, Tertiary Education Commission.

Figure1: Proportion of Overseas students: Dawkins, Non Dawkins and Group of Eight Universities, 1995 to 2002



Econometric Analysis

Both Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) can be used to estimate the degree of technical efficiency in the Australian university system. In the past, both methods have been used to evaluate the efficiency of institutions in a range of industries including higher education (for summaries see Abbott and Doucouliagos 2003; and Worthington 2001). DEA and SFA are two means by which efficiency levels of like institutions can be ranked. They both effectively compare outputs to inputs and order the institutions in terms of their relationship to a best practice standard. In the case of the non-parametric technique DEA the best practice standard is the most efficient institution(s) in the group. In the case of the parametric estimation technique SFA, a best practice (maximum output attainable) frontier is estimated and the sample institutions compared to this level. That is, with DEA there will always be some institutions that are deemed to be on the frontier, while with SFA none of the institutions need be on the frontier. For a full explanation of these methodologies see Coelli, Prasada Rao and Battese (1998). In this paper we present the results of applying SFA to the three different samples in order to determine if any consistency in the results can be achieved. The DEA results are available from the authors and are broadly consistent with respect to the impact of competition for overseas students on technical efficiency.

1. Australian Universities

Our preferred estimation methodology is to estimate a stochastic output distance frontier. This parametric technique offers useful information on the underlying education production process, as well as information on the extent of inefficiency and the determinants of inefficiency. The translog version of the output distance function is given by:

$$\ln D_{Oi} = \square_0 + \sum_{m=1}^{M} \square_m \ln y_{mi} + \frac{1}{2}\sum_{m=1}^{M}\sum_{n=1}^{M} \square_{mn} \ln y_{mi} \ln y_{ni} + \sum_{k=1}^{K} \square_k \ln x_{ki} + \frac{1}{2}\sum_{k=1}^{K}\sum_{l=1}^{K} \square_{kl} \ln x_{ki} \ln x_{li} + \sum_{k=1}^{K}\sum_{m=1}^{M} \square_{km} \ln x_{ki} \ln y_{mi} \quad (1)$$

where ln denotes the natural logarithm, i denotes the ith university, D_0 is the output distance function, there are m outputs (y) and k inputs (x). Equation 1 enables interaction between the various inputs and outputs. The benefit of using a translog specification is that the inclusion of cross-terms offers valuable information on input and output substitution possibilities. Hence, this specification is preferable to more restrictive specifications, such as the Cobb-Douglas version. It is necessary to impose a number of constraints on the output distance function in order to ensure homogeneity of degree one in *outputs*, as well as symmetry. This can be achieved by choosing arbitrarily one of the outputs as the normalizing variable, and in this paper research performance is used to serve this role.

In equation 1, $\ln D_0$ is not observable. However, when normalised, the dependent variable in equation 1 becomes $\ln(D_0/y_m)$. This can be rewritten as $\ln(D_0)-\ln(y_m)$. Hence, we can make the dependent variable $-\ln(y_m)$, and transfer $\ln(D_0)$ to the residuals, as shown in equation 2.

$$\ln D_{Oi} = \square_0 + \sum_{m=1}^{M} \square_m \ln y_{mi} + \frac{1}{2}\sum_{m=1}^{M}\sum_{n=1}^{M} \square_{mn} \ln y_{mi} \ln y_{ni} + \sum_{k=1}^{K} \square_k \ln x_{ki} + \frac{1}{2}\sum_{k=1}^{K}\sum_{l=1}^{K} \square_{kl} \ln x_{ki} \ln x_{li} + \sum_{k=1}^{K}\sum_{m=1}^{M} \square_{km} \ln x_{ki} \ln y_{mi} \quad (2)$$

Coelli and Perelman (2000) use $-\ln(y_m)$, while we follow Paul *et. al.* (2000) and use $\ln(y_m)$ as the dependent variable. Using stochastic frontier estimation techniques applied to output distance function means that we allow both inefficiency as well as random errors to occur in the production process.[8] This is achieved by adding an error/residual term to equation (2) and then decomposing the error/residual term into a random component as well as a component attributable to technical inefficiency, where u is the random error term and v is a term for inefficiency. u is a two-sided symmetric random disturbance term (assumed to be iid $N(0,\square_u^2)$) while v is non-negative. For an excellent discussion on these issues, as well as the estimation of the output distance function by maximum likelihood techniques see Coelli *et al.* (1998).

For Australian universities, we use a three outputs and two inputs model, where the three outputs are research output, the number of post-graduate students and under-graduate students (the two teaching outputs), and the two inputs are academic and non-academic employees. Estimating the research output of a university is a contentious issue. In the Australian case a weighted index of various research outputs is calculated. The research types are: books, book chapters, journal articles and other. The weighting used was books (0.4), book chapters (0.2), journal articles (0.3) and other (0.1).[9] The Australian Government's, Department of Education, Science and Technology collect data on the different research categories. For details on the use of this series see Abbott and Doucouliagos (2004).

Equation 2 is used to identify the best practice frontier. We then use a separate equation to identify the determinants of technical inefficiency. This is given by:

$$DTE_{it} = \_{0} + \_{1}OS_{it} + \_{2}OS_{it}^2 + \_{3}RA_{it} + \_{4}D_{it} + \_{5}SA_{it} + \_{6}SC_{it} + \_{7}O_{it} + \_ \quad (3)$$

where DTE is the measure of technical inefficiency (not efficiency) of the ith university, OS denotes the proportion of overseas students, OS^2 is included to capture non-linearities in the association between overseas students and technical efficiency, RA is the ratio of general to academic staff, D is a dummy variable for the Dawkins universities, SA is the proportion of senior administrative staff, SC is the proportion of senior academic staff and O is the number of undergraduate program offerings.

The primary variables of interest in this study are the variables OS and OS^2, as these represent the degree to which the universities are exposed to overseas competition. The squared term is included to capture non-linearities in the association between overseas students and technical efficiency. At low levels of enrolments of overseas students there may actually be a reduction of technical efficiency if the university is not sufficiently prepared to service these students adequately. For example, overseas students have, on average, poorer

[8] The random error also captures the influence of any inputs other than labour and capital.

[9] Using different weights does not change the results reported in the paper to any significant extent.

English communication skills, and this can place a greater a workload on academics, diverting time and effort from other activities. Additional resources might also need to be devoted to overseas marketing and support services for overseas students. However, at higher levels of overseas student enrolments, universities can be expected to become more efficient as they should be significantly greater in size and therefore reap economies of scale, as well as be compelled to improve their level of technical efficiency in the face of competition from their many rivals in international markets.

Concerning the status of a university, it is unclear whether the Dawkins universities are less or more efficient than the older universities. On the one hand, they may tend to be less efficient as their output levels tend to be low because of their relative weak research output. On the other, it is possible that this lack of research output is more than counter balanced by a much greater level of teaching output per academic.[10] RA is the ratio of non-academic staff to academic staff and is a rough measure of administrative efficiency. The proportion of senior administrative staff is included to control for differences in administrative skills.[11] It is expected that higher levels of administrative staff would have a positive impact on technical efficiency.

The proportion of senior academic staff is included to control for differences in academic skills.[12] We are unclear about the impact of this variable. On the one hand, it would be expected that it would have a positive impact on efficiency if promotion to professorial level reflects higher levels of productivity and competency (particularly in creating research output); however, if promotion occurs for reasons not related to productivity, or if the research and teaching productivity of professors is tied down with committee and other administrative work, we would expect a negative impact on technical efficiency.

Another potential explanatory variable is the number of offerings that is the number of broad fields of study in which undergraduates are enrolled. As the number of offerings increases, administrative burdens rise and it is possible that this leads to inefficiency. On the other hand, if there are economies of scope, then we should find that the number of offerings should be associated with higher levels of technical efficiency.

The estimated parameters of the stochastic education output distance frontier applied to Australian universities are presented in Table 2a, for the period 1995-1999, and in Table 2b for the period 1995-2002. The two different periods are used to investigate the robustness of the results. Column 2 presents the results without the time trend (as a proxy for technological change) included in the university frontier, without non-linear overseas student effects and without the senior academic and non-academic inputs in the inefficiency effects equation. In Column 3, the senior academic and non-academic inputs are included as explanatory variables to the technical inefficiency effects. Column 4 includes non-linear overseas student effects. The figures reported in Column 5 allows for non-neutral technological change in the education production process. That is, allowing for technological change to result in factor using bias. The results of re-estimating equation 5 without the non-linear overseas students term are presented in Column 6.

[10] Note that we do not explore allocative efficiency (for which we lack adequate data) and hence are unable to test whether the higher teaching as a substitute for lower research is associated with allocative efficiency loses.

[11] Senior administrative staff are those with a classification of level six to nine.

[12] This variable is defined as academics with a classification above the senior lecturer level (including Associate Professors, Readers and Professors).

In Table 2a, Columns 2 and 3, overseas students has a negative coefficient, which is statistically significant in Column 3. The non-linear effects are statistically significant in Column 4, but they are not as significant when technological change is introduced (Column 5). Given the statistical insignificance of the overseas students interactive term, our preferred results are presented in Column 6, where the linear overseas students variable has a negative sign and is highly statistically significant, indicating that higher proportions of overseas students is associated with lower levels of technical inefficiency. Recall that the dependent variable is technical inefficiency; hence, a negative coefficient on overseas variable indicates that higher percentages of overseas students are associated with lower levels of technical inefficiency. When the longer time period is used (1995-2002), the results are weaker (Table 3b). The overseas students variable continues to have a negative coefficient, but this is in most cases not statistically significant at conventional levels. However, in the preferred specification (column 6), it has the expected negative sign and is statistically significant. The coefficient is -0.03 in Table 3b compared to -0.04 in Table 3a. We conclude that the effects of overseas students is to increase technical efficiency in Australian universities and that this effect is linear.

Turning to the other variables, the dummy for the Dawkins universities has a robust negative and statistically significant coefficient. This indicates that the newer universities have implemented measures that are reducing technical inefficiency. The coefficient on RA is variable, but it does have a negative coefficient and is statistically significant in the preferred specification. The number of offerings has a positive effect on efficiency (has a negative coefficient), suggesting that economies of scope arise from offering several fields of study.

As expected, the proportion of staff who are senior administrators (SA) is associated with higher levels of efficiency. However, the proportion of academics who are at the professorial level are associated with higher levels of inefficiency. This later result is somewhat unsettling, as it implies that Australian universities are not getting as much research and teaching output as they might be. This result is consistent with research conducted elsewhere. For example, in their review of Australian academic economists, Pomfret and Wang (2003) conclude that: "Despite concerns about deleterious consequences of a publish-or-perish ethos, the Australian norm is that most academic economists do neither". In their analysis of publication patterns of Australian economics professors, Bhattacharya and Smyth (2003) found that, as expected, time spent on teaching and administration had an adverse effect on research productivity.[13]

It is possible that the professorial effect reflects bad matching of jobs with academics. It can reflect also good staff stuck in professorial admin positions. It is consistent also with a self-sorting process, where poor staff seek promotion to escape academic work and then interfere with the work of others. That is, there are joint marginal products and these are reduced by committee, intrusive policies and tasks etc. Clearly more research is needed to identify whether this effect arises because of heavy administrative load (a substitution of effort effect) or because of low productivity (poor promotion effect). However, given the effect of SA, there is scope within universities to increase senior administrators and decreases the administration load of senior academics.

[13] They found also that there was no real difference in the performance of professors from the top five universities and those not in the top five.

Table 2a: Maximum-Likelihood Parameter Estimates of the Translog Stochastic Output Distance Function, Australian Universities, 1995-1999

	(2)	**(3)**	**(4)**	**(5)**	**(6)**
Variable	**Coefficient (t-statistic)**	**Coefficient (t-statistic)**	**Coefficient (t-statistic)**	**Coefficient (t-statistic)**	**Coefficient (t-statistic)**
Constant	7.64 (5.76)*	4.72 (3.53)*	3.76 (3.42)*	1.31 (1.20)*	1.90 (1.72)*
Post-Graduate	-0.22 (-0.50)	-0.46 (-0.90)	-0.19 (-0.28)	-1.41 (-2.82)*	-1.18 (-2.34)*
Under-Graduate	-0.12 (-2.70)*	-0.92 (-1.60)*	-1.17 (-1.57)*	0.07 (0.13)	-0.25 (-0.46)
Post-Graduate squared	-0.05 (-0.56)	-0.09 (-0.72)	-0.08 (-0.55)	-0.03 (-0.24)	-0.02 (-0.17)
Under-Graduate squared	-0.12 (-1.38)*	-0.11 (-0.98)	-0.10 (-0.77)	-0.06 (-0.61)	-0.03 (-0.24)
Post-Graduate · Under-Graduate	0.12 (0.72)	0.17 (0.72)	0.14 (0.56)	0.05 (0.24)	0.01 (0.03)
Academics	1.73 (2.28)*	1.78 (2.01)*	1.98 (2.50)*	1.79 (2.40)*	2.18 (2.75)*
Non-academics	-1.98 (-2.58)*	-1.10 (-1.34)*	-1.06 (-1.39)*	-0.64 (-0.86)	-1.06 (-1.43)*
Academics squared	0.29 (3.51)*	0.23 (2.65)*	0.25 (2.71)*	0.13 (1.73)*	0.12 (1.43)*
Non-academics squared	0.33 (4.68)*	0.26 (3.63)*	0.27 (3.85)*	0.17 (2.56)*	0.20 (2.82)*
Academics·Non-academics	-0.58 (-4.42)*	-0.52 (-3.83)*	-0.57 (-4.02)*	-0.34 (-2.88)*	-0.36 (-2.68)*
Post-Graduate· Academics	0.31 (1.67)*	0.50 (2.29)*	0.51 (2.20)*	0.40 (2.09)*	0.47 (2.39)*
Post-Graduate·Non-academics	-0.31 (-1.78)	-0.48 (-2.23)*	-0.52 (-2.45)*	-0.23 (-1.25)*	-0.32 (-1.71)*
Under-Graduate· Academics	-0.45 (-2.71)*	-0.52 (-2.60)*	-0.55 (-2.61)*	-0.38 (-2.33)*	-0.47 (-2.61)*
Under-Graduate·Non-Academics	0.61 (3.83)*	0.61 (3.23)*	0.67 (3.33)*	0.34 (2.02)*	0.44 (2.53)*
Time	-	-	-	0.17 (1.49)*	0.17 (1.43)*
Time squared	-	-	-	-0.01 (-1.28)*	-0.01 (-1.11)*
Academics·Time	-	-	-	-0.03 (-0.78)	-0.02 (-0.69)
Non-Academics·Time	-	-	-	0.03 (0.69)	0.02 (0.64)
Post-Graduate ·Time	-	-	-	0.04 (1.85)*	0.05 (1.83)*
Under-Graduate ·Time	-	-	-	-0.04 (-1.72)*	-0.04 (-1.70)*
Inefficiency Effects:					
□	0.25 (1.82)*	1.70 (3.42)*	0.98 (2.31)*	0.91 (2.33)*	1.17 (3.12)*
Overseas students (OS)	-0.02 (-1.56)	-0.04 (-2.26)*	0.05 (2.04)*	-0.01 (-0.02)	-0.04 (-3.45)*
Overseas students squared (OS^2)	-	-	-0.003 (-3.88)*	-0.01 (-1.54)*	-
Dawkins (D)	-1.58 (-2.42)*	-1.16 (-2.85)*	-0.57 (-3.53)*	-1.07 (-4.27)*	-1.07 (-4.06)*
Ratio (RA)	0.11 (1.53)*	-0.08 (-0.86)	-0.01 (-0.04)	-0.13 (-1.52)*	-0.12 (-1.59)*
Time	-0.20 (-2.91)*	-0.14 (-2.47)*	-0.08 (-2.31)*	0.08 (2.61)*	0.08 (2.35)*
% Senior Admin (SA)	-	-0.09 (-2.85)*	-0.06 (-2.94)*	-0.11 (-4.85)*	-0.10 (-3.96)*
% Senior Academics (SC)	-	0.10 (2.89)*	0.05 (3.90)*	0.11 (4.85)*	0.10 (4.85)*
Offerings (O)	-	-0.17 (-2.86)*	-0.10 (-2.93)*	-0.16 (-4.71)*	-0.16 (-4.31)*
□ 2	0.22 (2.68)	0.15 (2.73)	0.08 (4.48)	0.11 (4.40)	0.10 (4.69)
□	0.95 (47.48)	0.97 (65.30)	0.96 (51.32)	0.98 (94.24)	0.97 (4.69)
LR test one-sided	120.94	124.69	127.91	158.36	156.17
Sample size	180	180	180	180	180

* denotes a t-statistic greater than 1.

Table 2b: Maximum-Likelihood Parameter Estimates of the Translog Stochastic Output Distance Function, Australian Universities, 1995-2002

	(2)	(3)	(4)	(5)	(6)
Variable	**Coefficient (t-statistic)**	**Coefficient (t-statistic)**	**Coefficient (t-statistic)**	**Coefficient (t-statistic)**	**Coefficient (t-statistic)**
Constant	-9.58 (-5.98)*	-12.00 (-6.78)*	8.79 (7.03)*	2.69 (0.64)	1.69 (0.87)
Post-Graduate	0.26 (0.36)	0.20 (0.31)	-0.07 (-0.08)	-0.23 (-0.24)	-0.94 (-1.76)*
Under-Graduate	1.16 (1.72)*	1.29 (2.03)*	2.47 (3.25)	-1.20 (-1.09)*	-0.66 (-1.07)*
Post-Graduate squared	-0.003 (-3.72)*	0.02 (0.19)	0.81 (2.88)	-0.03 (-0.22)	-0.12 (-1.24)*
Under-Graduate squared	-0.16 (-1.74)*	-0.14 (-1.48)*	0.65 (3.14)	-0.02 (-0.11)	-0.08 (-0.86)
Post-Graduate · Under-Graduate	0.006 (0.03)	-0.04 (-0.24)	-1.78 (-3.95)	0.02 (0.07)	0.18 (0.97)
Academics	1.79 (2.47)*	1.89 (2.59)*	-11.90 (-10.25)*	1.62 (1.89)*	1.66 (2.28)*
Non-academics	1.06 (1.51)*	1.34 (1.94)*	8.38 (6.63)*	-0.43 (-0.54)	-0.27 (-0.36)
Academics squared	0.24 (3.39)*	0.25 (3.64)*	0.56 (2.73)*	0.35 (0.79)	0.17 (2.42)*
Non-academics squared	0.18 (3.24)*	0.17 (3.11)*	-0.47 (-2.90)*	0.28 (0.66)	0.15 (2.40)*
Academics·Non-academics	-0.53 (-5.09)*	-0.55 (-5.49)*	0.30 (0.90)	-0.68 (-0.85)	-0.39 (-3.52)*
Post-Graduate· Academics	0.13 (0.80)	0.21 (1.46)*	1.16 (2.06)*	0.40 (1.90)*	0.29 (1.78)*
Post-Graduate·Non-academics	-0.16 (-1.09)*	-0.22 (-1.54)*	-0.65 (-1.19)*	-0.38 (-1.59)*	-0.19 (-1.23)*
Under-Graduate· Academics	-0.28 (-1.94)*	-0.35 (-2.68)*	-0.24 (-0.51)	-0.48 (-2.54)*	-0.32 (-2.08)*
Under-Graduate·Non-Academics	0.22 (1.58)*	0.25 (1.99)*	-0.29 (-0.65)	0.54 (2.45)*	0.34 (2.24)*
Time	-	-	-	0.07 (0.75)	0.09 (1.22)*
Time squared	-	-	-	-0.003 (-1.07)*	-0.04 (-1.83)*
Academics·Time	-	-	-	-0.06 (-3.25)*	-0.05 (-2.71)*
Non-Academics·Time	-	-	-	0.07 (2.94)*	0.05 (2.80)*
Post-Graduate ·Time	-	-	-	0.005 (0.32)	0.03 (1.79)*
Under-Graduate ·Time	-	-	-	-0.003 (-0.20)	-0.02 (-1.52)*
Inefficiency Effects:					
□	0.19 (2.08)*	0.14 (0.56)	-0.24 (-0.61)	0.57 (1.10)*	0.83 (2.21)*
Overseas students (OS)	-0.001 (-0.03)	-0.01 (-1.24)	-0.006 (-0.36)	0.008 (0.21)	-0.03 (-5.80)*
Overseas students squared (OS^2)	-	-	0.003 (0.63)	-0.009 (-0.56)	-
Dawkins (D)	-0.44 (-4.30)*	-0.21 (-2.66)*	0.36 (2.91)*	-0.46 (-2.20)*	-1.05 (-5.32)*
Ratio (RA)	0.29 (5.32)*	0.04 (1.04)*	-0.02 (-0.17)	0.03 (0.70*)*	-0.26 (-3.68)*
Time	-0.38 (-6.31)*	-0.23 (-5.97)*	-0.08 (-3.43)*	0.06 (3.10)*	0.07 (3.39)*
% Senior Admin (SA)	-	0.003 (0.25)	0.03 (1.41)*	-0.05 (-2.35)*	-0.07 (-4.20)*
% Senior Academics (SC)	-	0.06 (6.68)*	0.01 (0.92)	0.04 (2.69)*	0.09 (4.88)*
Offerings (O)	-	-0.11 (-4.36)*	0.01 (0.03)	-0.08 (-2.89)*	-0.14 (-4.14)*

□ 2	0.15 (6.25)	0.08 (5.01)	0.22 (9.46)	0.06 (6.20)	0.11 (3.91)
□	0.95 (72.68)	0.90 (31.41)	0.01 (0.25)	0.90 (27.48)	0.94 (46.68)
LR test one-sided	143.95	183.56	22.70	173.35	182.52
Sample size	288	288	288	288	288

* denotes a t-statistic greater than 1.

2. Australian Business Faculties

As noted earlier, overseas students tend to be enrolled predominantly in business and commerce faculties. Hence, if competition does have an impact on efficiency, it should be revealed more solidly at the faculty level.[14] To explore this, we used data from Cecez-Kecmanovic *et al.* (2002). Unfortunately, the level of detail is not as good as at the university level. Data at the business faculty level is available for the total number of equivalent fulltime students, the fulltime equivalent academics employed and non-academic staff employed. We use this to estimate a single output translog production function of the following form:

$$lnY_{it} = b_0 + b_1 lnL_{it} + b_2 lnK_{it} + 0.5b_3 lnL^2_{it} + 0.5b_4 lnK^2_{it} + b_5 lnL_{it} lnK_{it} + b_6T + 0.5b_7T^2 + b_8 lnL_{it}T + b_9 lnK_{it}T + V_{it} - U_{it} \quad (5)$$

where Y denotes total student enrolments, L is academic labour, K is non-academic labour, and T is a linear time trend. The technical inefficiency effects are assumed to be defined by:

$$U_{it} = \_{0} + \_{1}OS_{it} + \_{2}OS^2_{it} + \_{3}T_{it} + \_{4}RA + \_{5}D_{it} + W_{it} \quad (6)$$

This is slightly different to equations 1 and 4 because of the lack of data at the business faculty level.

The parameter estimates that arise when equations 5 and 6 are estimated simultaneously are reported in Table 3. Column 2 presents the results for 1997 to 2000. Column 3 presents the cross-sectional results for 1999 for which research income data could be matched at the Faculty level. Note that in this case, the use of data for a single year rules out the use of the time and time interaction variables. In this case, a Stochastic output distance function frontier was estimated, similar to that for the university sector as a whole, with research income as the proxy for research output, and the number of students enrolled as the other variable, with research income as the normalising variable.[15] In both models, the coefficient on the overseas students variable is statistically significant and has the expected negative sign.

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[14] It is possible that competition for overseas students has an impact on the technical efficiency at the business faculty level, but not necessarily at the university level.

[15] The use of research income as a proxy of research output is standard in the education production process literature, see Abbott and Doucouliagos (2003).

Table 3: Maximum-Likelihood Parameter Estimates of the Translog Stochastic Production Frontier, Australian Business Faculties

	(2)	**(3)**
Variable	**Coefficient (t-statistic) 1997-2000**	**Coefficient (t-statistic) 1999**
Constant	8.75 (8.41)*	7.02 (8.68)*
Academics	-1.66 (-2.91)*	-0.19 (-0.48)
Non-academics	1.12 (3.95)*	-0.07 (-0.35)
Time	0.04 (0.21)	-
Academics squared	0.35 (4.43)*	0.11 (1.71)*
Non-academics squared	0.08 (2.11)*	0.04 (1.72)*
Academics·Non-academics	-0.32 (-3.82)*	0.01 (0.04)
Time squared	0.04 (1.83)*	-
Academics· time	-0.01 (-0.26)	-
Non-academics· time	-0.001 (-0.09)	-
Students	-	0.06 (0.29)
Students squared	-	-0.05 (-29.43)*
Students·academics	-	-0.08 (-1.67)
Students·non-academic	-	-0.12 (-2.91)*
Inefficiency Effects:		
□	0.93 (4.03)*	0.75 (0.43)
% Overseas Students (OS)	-0.04 (-5.35)*	-0.07 (-1.74)*
Time	0.19 (3.85)*	-
Ratio (RA)	0.16 (1.08)*	-0.14 (-0.86)
Dawkins (D)	-0.34 (-5.44)*	0.33 (0.59)
□ 2	0.06 (5.82)	0.09 (1.20)
□	0.88 (10.57)	0.99 (645.07)
LR test one-sided	103.42	312.25
Sample size	136	34

* denotes a t-statistic greater than 1.

The links between efficiency and overseas students enrolments are illustrated in Figure 2, which is a scatter diagram of the percentage of overseas students in each Australian business faculty on the vertical axis and the technical efficiency score on the horizontal axis. The positive association is more pronounced when data for a single year is used. For example, Figure 3 shows the technical efficiency scores in 2000 and the percentage of overseas students – faculties with higher percentage of overseas students also have higher levels of technical efficiency.

Figure 2: Scatter Diagram, Australian business faculties, technical efficiency and overseas student enrolments, 1997 to 2000

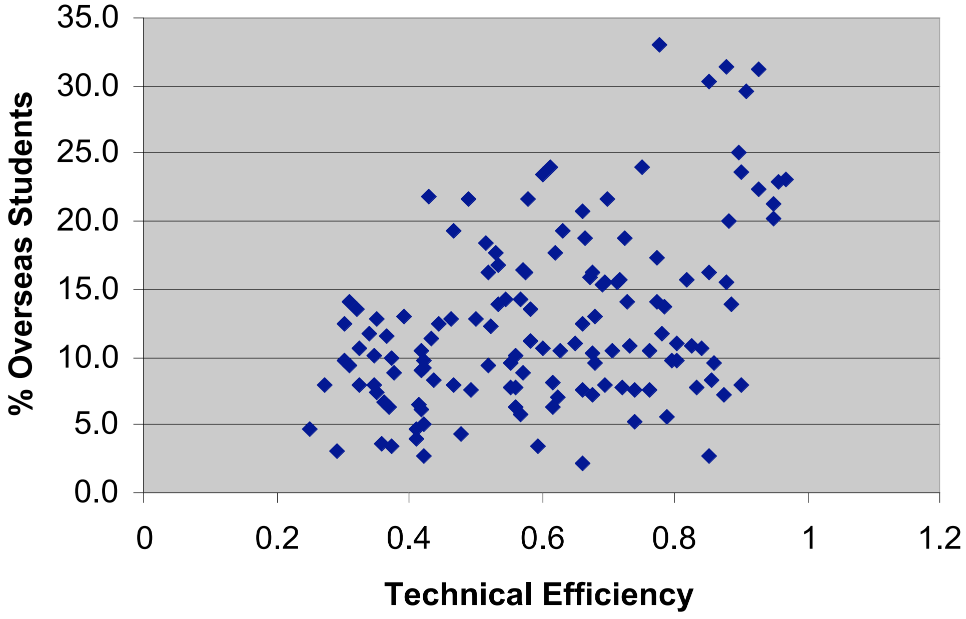
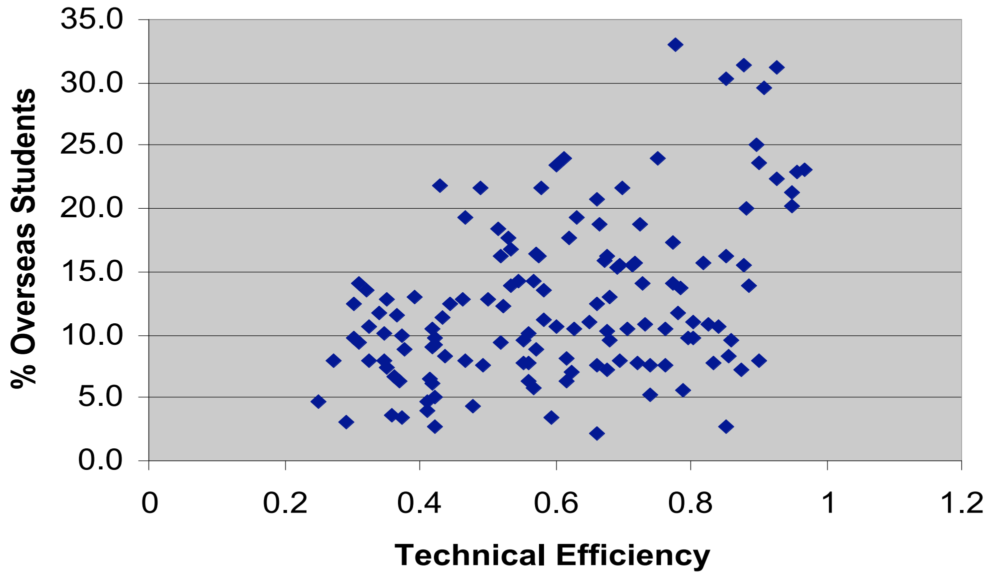


Figure 2: Scatter Diagram, Australian business faculties, technical efficiency and overseas student enrolments, 1997 to 2000



3. The New Zealand Experience

As mentioned earlier, the New Zealand universities are less exposed to overseas competition in the sense that they have a lower proportion of their students from overseas compared to the Australia ones. In 2003 for instance 15.6 percent of students enrolled in New Zealand universities were from overseas. This compares to 22.6 percent in the case of all Australian higher education institutions in 2003.

The dataset for New Zealand is limited to seven universities for the period 1995-2003. With only seven cross-sections, it becomes very difficult to use either DEA or SFA. Given the small cross-section, the SFA approach is preferred, however, the results should be interpreted with caution. For New Zealand we use a two output and two input model, with the number of equivalent fulltime students and Research Items as the two outputs and academic and non-academic labour as the two inputs.[16] The results are presented in Table 4a for the period 1997-2003 and in Table 4b for the full period 1995-2003.[17] Column 2 presents the results from the translog specification; Column 3 presents the results of eliminating the time interactive terms from the translog specification, while Column 4 presents the results associated with the Cobb-Douglas specification. For comparison purposes only, Column 5 in Table 4b presents the results when the inefficiency effects equation is not included in the estimation procedure; this is simply the education production function. The coefficient on the overseas variable is not robust, being negative and statistically insignificant in the case of the translog for the 1997-2003 period, and positive and statistically insignificant in the case of the translog for the 1995-2003 period. Interestingly, the coefficient is positive and statistically significant in the case of the Cobb-Douglas for the 1997-2003 period. In this later case, the results indicate that the New Zealand universities with higher levels of overseas students are *less* technically efficient. Given the statistically significant factor input and student variables, the Cobb-Douglas is *not* the preferred specification. Hence, our conclusion is that for the 1995-2003 period, competition for overseas students has not had any impact on technical efficiency in New Zealand. This is surprising, given the expectations of the effects of competition and the Australian results. The reasons for this difference between New Zealand and Australian universities warrant further investigation.

[16] In the New Zealand case research output is indicated by the number of research outputs as reported in the annual reports of the universities and by the *Tertiary Education Commission* (2002).

[17] As in the case of Australian universities, the different time periods are chosen to explore the sensitivity of the results. Other time periods were used as well. The full set of results are available from the authors.

Table 4a: Maximum-Likelihood Parameter Estimates of the Stochastic Output Distance Function, New Zealand Universities, 1997-2003

Variable	Translog Coefficient (t-statistic)	Restricted Translog Coefficient (t-statistic)	Cobb-Douglas Coefficient (t-statistic)
Constant	-1.16 (-1.19)*	1.16 (1.17)*	3.27 (14.02)*
Students	5.74 (5.83)*	4.90 (5.02)*	-0.72 (-34.32)*
Students squared	-0.10 (-2.99)*	-0.08 (-3.17)*	-
Academics	5.68 (7.34)*	5.71 (7.35)*	1.23 (12.17)*
Non-academics	-4.79 (-6.49)*	-5.43 (-7.44)*	-0.35 (-2.83)*
Academics squared	0.93 (2.14)*	0.65 (1.41)*	-
Non-academics squared	2.20 (5.11)*	1.90 (4.58)*	-
Academics·Non-academics	-3.06 (-3.75)*	-2.43 (-2.89)*	-
Students · Academics	1.95 (2.78)*	1.76 (2.55)*	-
Students · Non-academics	-2.80 (-4.06)*	-2.50 (-3.67)*	-
Time	-0.17 (-0.23)	0.02 (1.30)*	0.02 (7.96)*
Time squared	0.01 (0.54)	-	-
Students·Time	0.03 (0.09)	-	-
Academics·Time	0.08 (0.29)	-	-
Non-Academics·Time	-0.06 (-0.15)	-	-
Inefficiency Effects:			
□	0.34 (0.98)	0.58 (1.02)*	2.55 (4.90)*
Overseas students (OS)	-0.01 (-0.10)	0.60 (0.88)	3.67 (3.83)*
Overseas students squared (OS^2)	-0.02 (-0.02)	0.51 (0.56)	1.93 (1.94)*
Ratio (RA)	-0.33 (-1.28)*	-0.53 (-1.34)*	-2.72 (-5.56)*
Time	0.04 (1.30)*	0.03 (0.84)	0.03 (1.08)*
□ 2	0.01 (2.82)	0.02 (3.14)	0.07 (6.07)
□	0.94 (3.36)	0.99 (19.25)	0.99 (85.79)
LR test one-sided	6.57	14.24	46.48
Sample size	49	49	49

* denotes a t-statistic greater than 1.

Table 4b: Maximum-Likelihood Parameter Estimates of the Stochastic Output Distance Function, New Zealand Universities, 1995-2003

Variable	Translog Coefficient (t-statistic)	Restricted Translog Coefficient (t-statistic)	Cobb-Douglas Coefficient (t-statistic)	Translog Coefficient (t-statistic)
Constant	3.82 (5.01)*	7.26 (7.43)*	1.98 (1.65)*	1.13 (1.05)*
Students	6.92 (10.32)*	6.40 (6.50)*	-0.63 (-3.43)*	5.10 (5.75)*
Students squared	-0.12 (-5.44)*	-0.09 (-1.49)*	-	-0.18 (-6.41)*
Academics	8.67 (13.10)*	7.68 (10.19)*	0.64 (1.27)*	4.09 (0.91)
Non-academics	-9.67 (-16.94)*	-9.64 (-13.47)*	0.38 (0.62)	-7.16 (-1.17)
Academics squared	1.97 (5.62)*	1.62 (3.69)*	-	1.94 (1.89)*
Non-academics squared	3.95 (13.78)*	3.42 (8.06)*	-	3.09 (1.91)*
Academics·Non-academics	-5.69 (-8.76)*	-4.74 (-5.81)*	-	-4.66 (-1.84)*
Students · Academics	2.42 (8.24)*	2.13 (3.01)*	-	1.29 (3.14)*
Students · Non-academics	-3.41 (-21.36)*	-3.06 (-4.39)*	-	-1.98 (-4.19)*
Time	0.03 (1.97)	0.02 (0.33)	0.02 (1.47)*	0.03 (1.59)*
Time squared	0.003 (1.00)	-	-	0.006 (1.53)*
Students·Time	-0.02 (-1.22)	-	-	-0.06 (-3.22)*
Academics·Time	0.11 (21.40)	-	-	0.07 (0.95)
Non-Academics·Time	-0.11 (-7.56)	-	-	-0.06 (-0.81)
Inefficiency Effects:				
□	0.35 (1.29)	0.03 (0.03)	0.71 (0.35)	
Overseas students (OS)	0.12 (0.22)	0.01 (0.09)	1.98 (0.67)	-
Overseas students squared (OS^2)	0.09 (0.09)	0.006 (0.06)	-0.22 (-0.14)	-
Ratio (RA)	-0.27 (-3.19)*	-0.02 (-0.01)	-0.65 (-0.32)	-
Time	0.01 (0.26)	-0.01 (-0.01)	-0.005 (-0.12)	-
□ 2	0.03 (1.92)	0.04 (0.50)	0.05 (2.92)	0.21 (0.39)
□	0.99 (27.85)	0.97 (0.98)	0.99 (306.11)	0.97 (11.45)
LR test one-sided	14.84	10.00	48.29	19.51
Sample size	63	63	63	63

* denotes a t-statistic greater than 1.

Technical Efficiency Levels

The associated levels of technical inefficiency are presented in Table 5.[18] Note that the table reports efficiency levels relative to the individual sector and hence no information can be drawn across sectors. For the university sector as a whole, technical efficiency levels are relative high. Relative technical efficiency levels are highest among the Australian universities. Since the scores are relative scores, it is not possible to conclude, for example, that Australian universities are more efficient than New Zealand ones. For both Australian and New Zealand universities, technical efficiency levels were highest in the late 1990s, and have deteriorated somewhat since then. The reasons for this deterioration warrant further investigation. The average level of technical efficiency fell across Australian business

[18] For Australian universities, we use the results from column 6 Table 2b and for New Zealand, we use the results from column 2, Table 4b.

faculties, from 0.68 to 0.63, although the dataset for this group is too small to draw firm conclusions.

Table 5: Median Technical Efficiency Levels, Australian and New Zealand Universities

Year	Australian Universities	Australian Business Faculties	New Zealand Universities
1995	0.93	-	0.88
1996	0.93	-	0.87
1997	0.92	0.68	0.90
1998	0.93	0.68	0.92
1999	0.93	0.55	0.95
2000	0.91	0.63	0.88
2001	0.88	-	0.82
2002	0.91	-	0.84
2003	-	-	0.87

Summary

Universities worldwide are increasingly facing the pressure of competition. The effect of this competition on their operational performance is an important research question. Using three different datasets for Australia and New Zealand a number of important conclusions can be made from this study. First and most importantly of all it was found that there is an important link between competition in the market for overseas students that a university in Australia is exposed to and the level of technical efficiency at which they operate. What is true at the university level is also true at the level of business faculties. In the New Zealand case no definite conclusion on this issue can be made. A related issue is that the Dawkins universities tend to have a high level of technical efficiency as well as a relatively high level of overseas enrolments. Clearly these universities do have a tendency to seek higher overseas students in order to supplement their domestic income and this is helping to some degree to create pressure on them to improve their efficiency level. In the case of the older universities, perhaps with a smaller proportion of students from overseas and higher level of government grants in lieu of their research output[19] there is less competitive pressure on them to improve their levels of efficiency.

Finally a few results were derived in terms of the types of staff employed by the universities. The employment of additional senior administrators appears to have a positive impact on efficiency levels whist in the case of the employment of senior academics the reverse is true. The reasons for these links are not entirely clear and so therefore further research into these links should be undertaken.

[19] They enjoy also significant income from private sources, other than overseas income paying students.

References

Abbott, M. and C. Doucouliagos (2003). The efficiency of Australian universities: a data envelopment analysis. *Economics of Education Review*. 22, 89-97.

Abbott, M. and C. Doucouliagos (2004). The research output of Australian universities. *Education Economics*. December, forthcoming.

Cecez-Kecmanovic, D., M. Juchau, R. Kay and S. Wright (2002). *Australian business education study: enhancing the quality of Australian business education*. Canberra: Higher Education Group, Department of Education, Science and Training.

Australia, Department of Education, Science and Technology (Various Issues). *Selected higher education finance statistics*. Belconnen, ACT.

Australia, Department of Education, Science and Technology (Various Issues). *Selected higher education student statistics*. Belconnen, ACT.

Australia, Department of Education, Science and Technology (Various Issues). *Selected higher education staff statistics.* Belconnen, ACT.

Bhattacharya, M. and R. Smyth. (2003) The life cycle research output of professors in Australian economics departments: an empirical analysis based on survey questionnaires. *Economic Papers*. 22(2). 30-46.

Coelli, Tim (1996). Assessing the performance of Australian universities using data envelopment analysis. Centre for Efficiency and Productivity Analysis, University of New England.

Coelli, Tim, D.S. Prasada Rao and George E. Battese (1998). *An introduction to efficiency and productivity analysis*. Boston: Kluwer.

New Zealand, Tertiary Education Commission (2003). *Profile & trends: New Zealand's tertiary education sector 2002*. Wellington: TEC.

Organisation for Economic Cooperation and Development (2002). *Education at a glance; OECD indicators 2002*. Paris: OECD.

Pomfret, R. and L. C. Wang. (2003). Evaluating the research output of Australian universities' economics departments. Working Paper, Adelaide University.

Worthington, A. C. (2001). An empirical survey of frontier efficiency measurement techniques in education. *Education Economics*. 9(3), 245-265.