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A DISCIPLINARY ANALYSIS OF THE CONTRIBUTION OF ACADEMIC STAFF TO PHD COMPLETIONS IN AUSTRALIAN UNIVERSITIES*

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Abstract

This paper identifies the major areas of research strengths and concentration across all Australian universities, as demonstrated by the number of PhDs and academic staff members (S) in ten broad fields of education using the average audited data (2001-2003). The ratio of PhD completions to S is then presented to provide a tentative basis for benchmarking and productivity analysis. Inter alia, we found a very interesting relationship between the number of PhD graduates (as the dependent variable) and S using a fixed-effect model with both discipline-specific slope and intercept coefficients. The results provide policy implications for individual universities and government.

Key Words: Australian universities, ranking, PhD completions, cross-sectional model
JEL codes: A19; C23; I21; I28.

Introduction

It is well-recognised that doctoral students play a vital role in national research and the scholarship of research, partially justifying Commonwealth government funding. The environment for the doctorate has been shifting rapidly in recent years, a 'sea change' according to one author (Park, 2005, p. 192). PhD enrolments in Australia doubled to over 35,000 in the decade to 2003, the clientele has diversified to include more distance, mature age, and part time students, and the types of degree have expanded to encompass significant numbers of professional and practice-based doctorates, new route PhDs, and PhD by publication (Gatfield, 2005; Neumann, 2002; Park, 2005).

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Similarly, the policy field has been an active one. Governments have expressed concern at variations in completion times and rates, and have pushed for a shift to a generic skills-based approach to the PhD that emphasizes its role in providing competency training ahead of disciplinary content. This homogenizing process is consistent with a broad autonomous trend known as the commodification of knowledge wherein discipline specific knowledge and methodology is increasingly replaced by problem solving and knowledge management approaches (Park, 2005; Neumann, 2002).

Guides and handbooks on doctoral research tend to bear out this generic approach by providing advice to supervisors, students, and universities on general best practice (Park, 2005). Disciplinary differences are rarely considered in detail in the scholarly literature, with the focus either being on individual disciplines, mostly the medical sciences, or comparisons of functional matters such as different supervisory styles (Gatfield, 2005; Neumann, 2001). Such a muting of discipline-specific aspects of doctoral studies is somewhat surprising. Academics associate very closely with their particular discipline and it is clear in the literature on undergraduate teaching that philosophies and practices vary considerably between disciplines.

Becher's (1989) classic study of academic tribes and territories, for example, examined some of these disciplinary variations, while Biglam (1973a; 1973b) helped to provide a typology to distinguish between practices in the hard pure fields (sciences); hard applied (technologies); soft pure (humanities and social sciences); and soft applied (social science based professions). Neumann (2001) used these categories to suggest disciplinary differences influence the degree of difficulty of supervision and therefore the staff intensity required. In particular, she emphasized the nexus between research and supervision, the extent of group-based collaborative work ('social-connectedness'), the balance between undergraduate and graduate teaching, and the emphasis upon paradigmatic versus idiosyncratic methodologies and knowledge In the hard pure and applied fields there is a closer nexus between academic research and student supervision, relatively more time is spent on graduate versus undergraduate teaching, and paradigms are more clear cut making research less open-ended and speculative. In the hard pure and soft applied disciplines greater social connectedness among academics facilitates more graduate supervision. Each of these elements suggests that graduate supervision is less onerous in these fields enabling supervisors to take on more students and see them through to a rapid and successful completion. In a similar vein, a UK study on PhD degrees in the 1980s found that completion times were shortest and completion rates highest in the sciences, followed by engineering, social sciences, and arts/languages (Booth and Satchell, 1995). Likewise, an ARC study concluded that supervision was most onerous in the humanities since it was less 'dovetailed with the academic's own research than is the case in most other disciplines' (ARC, 1998, p. xix).

There is an ever-increasing focus in the Australian university system on quantitative measures of research performance including postgraduate research. However, to date this has mainly concerned assessment at an aggregate university-wide level or within a single discipline, which is inconsistent with the most recent policy emphasis on a holistic approach in identifying different research strengths. Put bluntly, focusing on research performance at the institutional level ignores the varied performance that occurs at the disciplinary level and the application of funding on this basis serves to stifle innovation in key research areas and maintain underperforming and outdated research areas. This provides a disincentive to focused, responsive, innovative and diverse research in Australian universities.

The purpose of the present paper is to complement this nascent body of work with an analysis of the recent distribution of PhD graduates among 40 Australian universities and across 10 broad fields of education using the audited numbers of PhD completions (in accordance with rules established by the Department of Education, Science and Training) and analysed in both total and per academic staff terms. The study is constructed so as to take advantage of the audited quantitative information on research performance periodically gathered by governmental authorities. To the best of our knowledge, the present study is the only independent (that is, non-government) one that quantifies the relationship between the number of PhD completions and the number of academic staff members for all Australian universities and disciplines using consistent and audited data.

The rest of the paper is organised as follows. In the next section we explain the methodology that we have used to formulate the relationship between PhDs and the number of staff members active in research using a fixed-effect model. After that, we describe the source of the data employed followed by the presentation of our empirical results. The penultimate section of the paper analyses the policy implications of the study, and the last section offers some concluding remarks.

Methodological Framework

Against the background of the preceding discussion, the present paper postulates the number of PhD completions across various disciplines and universities as a function of the corresponding number of academic staff members (S). That is:

$$PhD_{ij} = \alpha + \beta S_{ij} + \varepsilon_{ij} \quad (1)$$

where j (1,2,…d=10) and i (1,2,…, n=40) denote the j^{th} discipline and the i^{th} university, respectively. However, equation (1) which is described as Model (1) hereafter, does not differentiate among various disciplines and it assumes that each extra staff member will increase the number of PhD completions by a constant coefficient β. In order to capture inter-disciplinary heterogeneities one can use the fixed effects model, which allows α to vary across disciplines by estimating different intercept terms (*i.e.* α_1, α_2,… α_{10}). This method is also referred to as the "least squares with dummy variables" or LSDV. In this method we subtract the within mean from each variable and then estimate OLS using the transformed data. The following specification is thus referred to as Model (2) in this paper:

$$PhD_{ij} = \alpha_j + \beta S_{ij} + \varepsilon_{ij} \quad (2)$$

One can argue that the considerable heterogeneities among these disciplines may not be adequately captured by a simple "intercept varying model". Given the importance of the slope coefficient in this relation, Model (3) allows it to change across 10 disciplines:

$$PhD_{ij} = \alpha + \beta_j S_{ij} + \varepsilon_{ij} \quad (3)$$

It is also possible to specify the least restrictive model (Model 4) in which both the intercept and the slope coefficients can differ in the estimation process for each discipline:

$$PhD_{ij} = \alpha_j + \beta_j S_{ij} + \varepsilon_{ij} \quad (4)$$

However, allowing α_j and β_j to take specific values for each broad field of education entails a loss of the degree of freedom. In fact, estimating discipline-specific coefficients involves a trade-off between the degrees of freedom lost and the resulting gain obtained in terms of discipline specificity and the enhanced goodness-of fit statistics. However, it is necessary to formally test each of the first three models (referred to as the restricted models) against Model (4) or the unrestricted model using a Wald type test. One can also use an information criterion such as the AIC (Akaike Information Criterion) to choose among the rival models outlined above. As discussed later in this paper, both approaches point to Model (3) as a more statistically accepted model.

Data and Descriptive Analysis

Forty Australian universities have been included in the analysis, all of which are publicly funded and members of the Australian Vice-Chancellor's Committee (AVCC). The unpublished database used in this study was purchased from the DEST in December 2005 as specifically detailed at the bottom of Tables 1 and 2. The data include the number of PhD completions as well as the number of academic staff members by institutions and across 10 consistently defined broad fields of education, all of which we have averaged using annual observations for the period 2001-2003. In order to minimise bias in our results, we consider only those academic staff members who are classified as undertaking 'research-only' and 'teaching-and-research' activities. In other words, the variable that is referred to as academic staff (S) does not include 'teaching only' staff.

[Tables 1 and 2 about here]

We also construct Table 3, which is a way to juxtapose Table 1 with Table 2. Together, the three measures that we have used in this paper are: (i) the average annual number of PhD completions (Table 1); (ii) the average annual number of academic staff members (Table 2); and (iii) the average annual ratio of PhD completions to the average annual number of academic staff members (Table 3). It would be jejune to describe various individual cells in these tables without looking at any emerging overall patterns. Table 4, therefore, presents a summary of descriptive statistics of the annual averages for the forty universities across the 10 broad fields of education. Sample means, maxima, minima, standard deviations, coefficient of variation (CV) and the Gini coefficients are reported.

[Tables 3 and 4 about here]

Between 2001-2003 an average of 5998 PhDs were completed per annum. Table 1 confirms what we would intuitively expect in terms of the distribution: the Group of 8

(Go8) universities are the leading generators of PhD scholars in Australia. Between them they accounted for 3255 or 54 per cent of average annual PhD completions. Whether they constitute a distinctive cluster, though, is more questionable: the leading university, Melbourne (678), generated nearly three times as many PhDs as eighth-placed Adelaide (234), the latter being only 17 completions above the subsequent university. These universities provide PhD programs across the breadth of major discipline areas, the only exceptions were the absence of PhD completions in education and architecture/building at ANU.

At the other end of the scale, the bottom eight institutions, mostly self-grouped as New Generation Universities, each produced less than 30 PhDs per annum, or 2 per cent between them in total. These small aggregate numbers also reflected the limited spread of their programs, most of these universities yielding PhDs in less than half of the major disciplinary categories. The contrasting experiences of different universities is confirmed by a relatively high Gini coefficient for the 40 universities as a whole of 0.504. Ranking Australian universities by these aggregate PhD statistics correlates closely with alternative rankings of research performance based on other forms of gross output (Ville *et al.* 2006: Table 5).

Table 2 provides evidence of the academic staff available to supervise these PhDs. In a very similar fashion, we find the Go8 universities clustered at the very top and with an almost identical share of supervising staff of 53 per cent, while the bottom eight accounted for just 3 per cent and the Gini coefficient was 0.47. However, this time the largest employer in the Go8, Queensland, is only twice that of the smallest, Adelaide and then a significant break occurs before the 9th largest university, La Trobe.

Table 3 brings together the PhD data from Table 1 with the staffing data from Table 2 to generate PhD output per staff member. Throughout Australian universities 0.127 PhDs were completed per staff member per annum. In other words, it takes on average eight academic staff to generate one PhD per annum. Since most PhDs take 3-4 years to complete and require a supervisory panel of at least two academic staff, this suggests, on average, that each academic staff member is supervising one doctoral student at any particular time. In a very similar fashion, the estimated common slope coefficient in Table 5 shows that, averaged across all universities and disciplines, an additional 10 staff will generate 1.3 extra PhD completions per annum in a consistent manner.

[Table 5 about here]

Not surprisingly, the mean varies among universities (0-0.264) and between disciplines (0.042-0.229). Go8 dominance in terms of size does not translate into per capita PhD output - only Melbourne and Sydney are in the top 8, with the remaining Go8 members scattered through from 16th to 32nd place in the rankings. The university mean rankings in Table 3 progress in a fairly even and continuous fashion except for the rapid fall off of the bottom 5 universities. In addition, the highest mean was achieved by Southern Cross well ahead of second-placed New England. This university was lowly ranked in Tables 1 and 2 but achieved a well above average performance in Management & Commerce, which was also responsible for 57 per cent of its PhD completions, thereby pushing it into first place on a per capita measure of performance. One explanation for the high number of completions at Southern Cross, Charles Darwin, South Australia, Murdoch etc (See Tables1 and 3) in Management and Commerce could be due to the fact that they offer the DBA (Doctorate of Business Administration), which is different from a conventional Ph.D degree. At these universities that offer the DBA program, credit is given for courses completed in an MBA program while at other universities an MBA by itself does not even serve as an entry qualification to the Ph.D programme.

Similarly, New England achieved second place largely on the basis of being productive in its three largest PhD areas – agriculture/environment, education, and society & culture. Third placed Melbourne, however, looks quite different: it achieved its high ranking while operating substantial PhD programs across all major disciplinary areas.

We are also interested in the volatility of performance within individual disciplines. Calculating the coefficient of variation on the results in Table 3 indicates that the greatest intra-disciplinary volatility occurs in Agriculture & Environment; Architecture & Building; and Information Technology. These are also the fields generating the least PhD completions and with the most limited institutional coverage across the university system. Those with the lowest variation were also the generators of the largest numbers of PhD completions, notably the Sciences and Society & Culture.

Table 3 can help us identify unusual or extreme cases that bear out this picture. For example, in the field of Agriculture, Environmental and Related Studies, one prodigious academic staff member at Monash secured 2.3 PhD completions. One way to interpret this abnormal observation is that at Monash the supervisors were located in related disciplines such as chemistry or agribusiness. Similar examples in engineering and related technologies at Charles Darwin and Agriculture and the Environment at Wollongong reflect very small staff numbers as the denominator in deriving the mean. The smallness of these examples minimizes their impact on the institution but will affect intra-disciplinary measures of centrality. However, some very good results from larger disciplines and individual academic units should be noted. These include Melbourne in the field of Creative Arts where 77.21 staff members successfully supervised 50.33 PhD graduates (PhD/S =0.65) and Southern Cross University in the field of Management and Commerce, mentioned above, where 57 full-time staff members produced a copious output of 35 PhD completions, suggesting again a very high PhD/S ratio (0.61).

There were also a number of cases in our database where there were no staff members in a particular discipline but the number of PhD students was non-zero! In order to avoid obtaining indeterminate values (*i.e.* a/0, where a is a positive number), we have assumed such rare and fortuitous cases in Table 3 to be equal to zero. While the "divide by zero" problem is definitely observed, there is also a "divide by a small number" problem. This again can be attributed to the fact that the supervisors involved had expertise in related disciplinary areas. These spikes or abnormal observations, when PhD/S is too high or zero or next to zero, are exceptions rather than the rule. In the overwhelming majority of cells reported in Table 3, the number revolves around 0.13 ranging between 0.07 to 0.23 depending on discipline and/or university. This average range is not very large considering the multifarious disciplines and universities.

Empirical Results

Table 5 presents the estimation results of Model (1) to Model (4) using 400 observations (10 broad fields of educations times 40 universities). The figures for PhD and S are averaged to burnish out any particular rumbustious observation for a discipline and/or university. Model (1) imposes a common intercept (1.35) and a common slope coefficient (0.13). Despite varying intercept terms across ten disciplines, the slope coefficient remains robust at 0.13 in Model (2). We have also allowed the slope coefficients (in Model 3) and both the intercept and the slope coefficients (in Model 4) to be discipline specific. Now the question is which model is more statistically acceptable? Before we choose the best model, one should note that the estimated slope coefficients in Models (3) and (4) are very similar. Thus the results are quite robust and the choice between these two models are inconsequential. However, based on the AIC or the adjusted R^2, Model (3) is preferred to the other three models reported in Table 5.

We have also used the Wald test as to which model performs better even if the enhancement is quite ethereal. Using equation (4) as an unrestricted model, both Models (1) and (2) are rejected. In the case of comparing Model (1) with Model (4), the null hypothesis ($\alpha_j = \alpha = 1.35$ and $\beta_j = \beta = 0.13$) is rejected as F(20,380)=5.75 [P-value=0.000]. Comparing Model (2) and Model (4), the null hypothesis ($\beta_j = \beta = 0.13$) is also rejected as F(10,380)=7.37 [P-value=0.000]. So far both Models (1) and (2) are rejected when compared with Model (4). However when Model (3) is tested against Model (4) the results would be slightly different as the null hypothesis ($\alpha_j = \alpha = 1.35$) is marginally not rejected at 5 per cent level as F(10,380)=1.81 [P-value=0.06]. If we rigidly stick to 1 or 5 per cent levels of significance, the null is not rejected but at the 10 per cent we definitely reject the null.

As can be seen from Table 5, the adjusted R^2 and the AIC of both Models (3) and (4) are very comparable. However, only in Model (3) are all estimated slope coefficients statistically significant at 10 per cent or better. Given that the size (staff or students), overseas orientation, expert diversity, financial research orientation and staff research orientation vary from a discipline in a particular institution to another comparable discipline elsewhere, the adjusted R^2 of 0.81 is highly encouraging. In addition to the standard *t* ratios (obtained from the pooled ordinary least square standard errors), we have used the White cross-section standard errors and covariance matrix to correct an unknown form of heteroscedasticity in the residuals for each of the four models. Even the computation of the corrected *t*-statistics (referred to as *t*-ratio 2 in Table 5) did not reverse our conclusion in relation to the statistical significance of the all slope coefficients. That is to say, only in Model (3) are all the discipline-specific slope coefficients statistically significant at the 10 percent level or better. The use of the White standard errors in computation of the *t*-ratio 2 made the coefficients in Model (3) even more significant.

Therefore, we choose to continue the interpretation of our results using Model (3) but as mentioned earlier switching to Model (4) from Model (3) does not change the magnitudes of the estimated slope coefficients tangibly. Staff requirements for a PhD completion vary from discipline to discipline as well as university to university. As a rule of thumb, according to the results of the discipline-specific slope coefficients reported in Model 3 (or 4) in Table 5, one can argue that “Agriculture, Environmental and Related Studies”; “Engineering and Related Technologies”; “Education”; and “Creative Arts” are the four least staff-intensive disciplines as 10 extra full-time staff members in these four areas will lead to 2.3, 2.0, 1.8 and 1.8 PhD graduates, respectively. On the other hand, “Information Technology”; “Architecture and Building”; “Management and Commerce”; and “Health” are the four most staff-intensive disciplines as 10 extra staff members will yield only 0.7; 0.8; 1.0; and 1.1 PhD completions, respectively. These results are broadly consistent with the mean values PhD/S across various disciplines in Tables 3 and 4.

These findings provide some support for the qualitative evidence in the literature on disciplinary differences. Hard applied fields such as engineering and agriculture are amongst the least staff intensive, which is consistent with the benefits of working with clear paradigms and a close academic research-supervision nexus. Education’s low staff intensity may be related to the high degree of social connectedness among its researchers. Among the most staff intensive disciplines are applied social sciences and professions such as management/commerce and architecture as might be expected. Information technology does not fall into this field but perhaps may be explained by the comparatively small number of PhDs being supervised, which may reflect limited demand in this field more than intensity of supervision. More difficult to explain is the fact that sciences and society & culture (humanities) both fall in the middle of the results when the conceptual literature and qualitative observations suggest that sciences should be among the least staff intensive and humanities among the most intensive.

The slope coefficients reported in Table 5 can be used for benchmarking activities by a particular discipline and/or university. For example, according to Table 3 the performance of Management & Commerce in Western Australia in terms of the ratio of PhD/S is roughly 0.09, and for the whole university this ratio is 0.138. These ratios are very close to (a) the corresponding slope coefficients reported in Table 5 [0.10 (discipline-specific coefficient for Commerce and Management) and 0.13 (the common slope coefficient), respectively] and (b) the mean values of PhD/S for all Commerce and Management disciplines (0.102) in Australian universities and the entire disciplines in all universities (0.127). In this case, the aggregate performance of Western Australia or the performance of its Management and Commerce discipline is within an acceptable range. Although comparing figures in Table 3 to the estimated slope coefficients in Table 5 is similar to comparing the average propensity to consume (APS) with the marginal propensity to consume (MPC), one can tentatively make this comparison to check reliability of the estimated coefficients. In other words, $PhD/S \neq \Delta PhD/\Delta S$ but given three years averaged data, we expect these two figures to be close to each other as APC and MPC would be almost equal in the long-run.

Policy Implications of the Study

The present study has the great advantage of properly, in a statistical sense, allowing for any discernible systematic variation existing in the underlying relationship between the two variables, and distilling from that variation the marginal discipline-specific impact of an increase in staff numbers on PhD completions. Various discipline-specific coefficients are allowed to capture inter-disciplinary heterogeneities. Consistent with theoretical postulates, this paper finds that the number of PhD completions depends heavily on the number of available academic staff members. Although the labour intensity of supervising PhD students varies from one discipline (or university) to another, the marginal effect of an increase in the number of academic staff members (ΔS) on PhD completions (ΔPhD), in this paper is found to be in a narrow range between 0.07-0.23 with an average value mostly around 0.12-0.13, which appear to be verisimilitude.

A number of salient points are noted from the results of this study. Most universities in Australia provide postgraduate research training across the principal disciplinary areas. The scale of the Go8 universities places them in the highest (relative) grouping in terms of the size of their postgraduate training programs and numbers of staff. However, this does not translate into leadership in terms of PhD completions per staff member. Nor is there any consistency of pattern across universities for individual disciplines. Size, reputation and longevity are no guarantees of productive postgraduate training programs.

Ostensibly, these results may be interpreted as measures of performance or productivity. However, the heterogeneous nature of output in education makes it very difficult to draw clear conclusions about productivity even when dealing with the same category of qualification, notably the PhD. The lower average PhD output per academic staff member in some universities may reflect a higher quality program that provides more assistance and guidance to graduate students. Although national guidelines may exist for operating postgraduate training programs and universities have to respond to various forms of audit and benchmarking, the quality and approach of different PhD programs will in practice still vary. However, since no single university 'leads' in more than one disciplinary area in terms of either per capita output (high rank and mean) or staff input (low rank and mean), there are no obvious overall implications for the postgraduate performance of individual universities.

Different disciplines require varying levels of supervisor input and we need also to take account of other factors such as the provision of supporting infrastructure. Thus, the overall cost of a PhD in science or engineering would be higher than education or arts because of the cost of equipment. Intuitively, therefore, we might expect discipline specific influences on average PhD output to be greater than institutional influences and therefore a smaller variance in our results for a particular discipline compared across universities. Surprisingly, the intra-disciplinary variance was similar to the inter-institutional variance. It may be difficult, therefore, to appreciate why it takes, on average, nearly twice as many academic staff to generate a PhD scholar in the sciences at New South Wales compared with Sydney, two neighbouring Go8 universities, with similar sized faculties. While 'natural and physical sciences' covers a range of different disciplines, the more homogeneous sector of education manifests a greater diversity of results. Here it takes more than double the number of staff, on average, to generate a PhD at Sydney compared with Melbourne, again despite similar institutional characteristics. One possible explanation for this relates to the extent to which staff members in such disciplines are involved in research activities other than PhD supervision such as writing refereed articles or grant applications.

Our results, therefore, provide some important benchmarking and diagnostic opportunities for universities. If the PhD/S ratio for a particular university or discipline is consistently and substantially lower (or higher) than (a) the corresponding mean value reported in Tables 3 and 4; and/or (b) the corresponding common slope coefficient (0.13) or the reported discipline-specific slope coefficients in Table 5, then this may be a cause for concern. If the difference between a cell in Table 3 and its corresponding discipline (column) mean was more than twice the standard deviation of that discipline, the figure is shown in boldface. If the difference between a cell and its corresponding university (row) mean was more than twice the standard deviation of that row, the figure is underlined. Our results provide the opportunity for individual universities to diagnose and address reasons for this high level of variance.

These results additionally provide planning guidance for universities and governments by calculating the marginal cost of expanding (or contracting) particular PhD programs in terms of staffing. Thus, for example, at Tasmania, 10 new staff are predicted to generate 2.8 new PhD completions over three years in the sciences but only one in Management & Commerce. On a comparative intra-disciplinary level, 10 new staff will generate, on average, 5.6 additional PhD students in Creative Arts at Southern Cross but only 1.4 at Monash. Finally, in the light of current debate about the future of the unified national system, our results present a picture of PhD training institutions bifurcated between those providing a full line of services across all areas and those more akin to niche providers.

Concluding Remarks

This paper has analysed the extent and nature of PhD programs offered in Australian universities, combining a disciplinary with an institutional focus. Using triennial averages for 2001-3, obtained from audited DEST data, it finds that more than half of PhD completions and supervising staff are to be found at the Group of 8 universities. It then focused upon PhD completions per academic staff as a possible measure of performance, calculating the mean by discipline and institution and the marginal change through a fixed-effect model. It was found that each 10 extra staff members can boost the number of PhD completions by approximately 1-2 (more precisely 0.7-2.3 with a mean of 1.3) depending on which field of study is being examined. Given the size (staff or students), overseas orientation, expert diversity, financial research orientation and staff research orientation vary from a discipline in a particular institution to another comparable discipline elsewhere, this surprisingly narrow and immutable range can be described as a useful tool in research planning and benchmarking activities across both disciplines and universities. Cross-institutional comparisons between universities resulted in a very similar level of variance.

Some policy implications of this finding were noted. No individual university or group of universities stands out in terms of per capita output of PhD completions as a whole. It is possible to distinguish between some universities that provide a full line of PhD services and others that are niche providers. There are some notable variations in intra-disciplinary performance across universities, several examples of which have been noted, which may justify closer examination by individual universities. Finally, it should be noted that our results provide no evidence of the quality of specific PhD programs offered by individual universities and disciplinary units. Low output per capita may be indicative of purposefully enhancing the inputs and, by implication, the quality of the program.

References

Australian Research Council (ARC) (1998), *Knowing Ourselves and Others. The Humanities in Australia into the 21st Century*, Vol. 1, National Board of Employment, Education and Training, Canberra.

Becher, T. (1989), *Academic Tribes and Territories*, SRHE and Open University Press, Buckingham.

Biglan, A. (1973a), The Characteristics of Subject Matter in Different Scientific Areas, *Journal of Applied Psychology,* 57, 195-203

Biglan, A. (1973b), Relationships Between Subject Matter Characteristics and the Structure and Output of University Departments, *Journal of Applied Psychology,* 57, 204-213.

Booth, A. L. and Satchell, S. E. (1995), The Hazards of Doing a PhD: An Analysis of Completion and Withdrawal Rates of British PhD Students in the 1980s, *Journal of the Royal Statistical Society, Series A (Statistics in Society),* 58, 297-318.

Gatfield, T. (2005), An Investigation into PhD Supervisory Management Styles: Development of a Dynamic Conceptual Model and its Managerial Implications, *Journal of Higher Education Policy and Management,* 27, 311-25.

Neumann, R. (2001), Disciplinary Differences and University Teaching, *Studies in Higher Education,* 26, 135-146.

Neumann, R. (2002), Diversity, Doctoral Education and Policy, *Higher Education Research and Development,* 21, 67-78

Neumann, R. (2005), Doctoral Differences: Professional Doctorates and PhDs Compared, *Journal of Higher Education Policy and Management,* 27, 173-188.

Park, C. (2005), New Variant PhD: the Changing Structure of the Doctorate in the UK, *Journal of Higher Education Policy and Management,* 27, 189-207.

Ville, S., Valadkhani, A. and O'Brien, M. (2006), The Distribution of Research Performance Across Australian Universities, 1992-2003, and Its Implications for Building Diversity, *Australian Economic Papers*, 45(4), 343–361.

Table 1- The Average Number of PhD Course Completions By Institution and Broad Field of Education (2001-2003)

University	Natural and Phy. Sciences	R	IT	R	Eng & Related Tech.	R	Arc. & Buil.	R	Agr. & Env.	R	Health	R	Edu.	R	Manag. & Com.	R	Society & Culture	R	Creative Arts	R	All	R
Melbourne	130.3	1	2.7	11	65.3	2	9.7	3	38.7	3	106.7	2	70.3	1	14.7	8	189.3	1	50.3	1	678	1
Sydney	120.3	3	5.7	7	44.7	6	12	2	15	8	159	1	21.3	6	10.3	16	115	3	37.7	3	541	2
Queensland	129	2	14	2	60.7	3	3.3	9	42.7	1	82.3	4	18	9	15	7	115.7	2	11.3	12	492	3
Monash	59	8	32.7	1	51	5	0	21	2.3	20	102.7	3	24	4	32	3	107.3	5	19.7	6	431	4
UNSW	73.7	6	1.7	21	97	1	8	4	0.7	23	69	5	11.3	16	24.3	4	45.3	10	28.7	4	360	5
ANU	107.3	4	2	19	15	14	0	23	13	10	5.7	20	0	35	2.7	29	108	4	6	18	260	6
Western Australia	66.7	7	2.7	12	22	13	1	15	22.7	5	46.7	7	28.3	3	13.7	10	51.3	7	3.7	24	259	7
Adelaide	76.3	5	0	34	22.7	11	2.7	10	42	2	52	6	2	33	2.7	28	31.3	17	2.7	25	234	8
RMIT	42.7	11	9.7	4	53.3	4	14	1	0	27	3.7	26	21.3	7	13.7	11	16	22	44.7	2	219	9
La Trobe	42	12	2.3	18	3.3	25	0	28	6.7	14	24.7	9	22.3	5	4	25	71.3	6	8.3	14	185	10
Curtin	22	19	2.7	15	11.7	17	2.3	14	3.3	17	24.3	10	31.7	2	12.7	13	35.3	14	8.3	15	154	11
QUT	31	15	4	10	32	7	4.7	5	0	28	17	11	18	10	13.3	12	15.7	23	17.7	7	153	12
Griffith	12	27	7	5	13	16	0	24	18.3	7	11	15	13.3	13	16.3	6	32.3	16	24.3	5	148	13
Tasmania	48	9	1.3	25	9.7	19	1	16	27.3	4	8.7	18	7.3	22	4	26	18.3	21	12.3	11	138	14
Wollongong	27.7	16	10.7	3	28	9	0	22	2.7	18	11	16	12	15	8.7	19	20	20	10.7	13	131	15
South Australia	8.3	29	1.7	24	29.7	8	3.7	6	1	22	14	12	11.3	17	45.3	1	9.3	28	7	17	131	16
Newcastle	25	18	2.7	14	24	10	2.3	13	0.3	24	13	13	6	23	2	31	38.3	12	16.3	8	130	17
Macquarie	35.7	14	4	9	1.3	30	0.3	19	4.7	15	0.3	35	8.3	20	9.7	18	50	8	5.7	21	120	18
UTS	39	13	2.7	13	14.3	15	2.7	11	0	31	4.7	23	12.7	14	14	9	12.3	26	15.3	10	118	19
Deakin	18.7	21	4.3	8	11.3	18	3.7	7	0	29	11.3	14	13.7	12	7.3	22	45.3	11	0	34	116	20
Western Sydney	25.7	17	1.7	22	7.3	21	0.7	18	8	13	5.3	21	7.7	21	10.3	17	28	18	15.7	9	110	21
New England	16	23	0.7	30	1	31	0.3	20	20.7	6	4.3	24	19.3	8	5	23	36	13	2.3	26	106	22
Flinders	21.7	20	0.7	29	1.7	29	0	32	0	36	26.3	8	4.7	26	0.3	36	48.3	9	0	33	104	23
Murdoch	18.7	22	1	27	2.7	27	0	30	8.3	12	7.7	19	9.3	18	11	15	33	15	5.7	22	97.3	24
James Cook	45	10	1.3	26	4	24	2.7	12	8.3	11	4.3	25	8.7	19	1.7	32	13.7	24	4.3	23	94	25
Edith Cowan	3.3	34	7	6	2.7	26	0	29	2.7	19	9.7	17	14.3	11	12.3	14	12	27	8	16	72	26
Swinburne	13.7	26	0	35	22.3	12	0.7	17	0	32	0.3	37	0	37	20.7	5	12.3	25	0	35	70	27
Victoria	15	24	0.3	32	9.7	20	0	25	0	33	3.7	27	3.7	30	8.7	20	23.7	19	2	28	66.7	28
Southern Cross	7.7	30	1	28	0	36	0	36	4	16	5	22	2.3	32	35	2	3.7	36	6	20	64.7	29
Canberra	11	28	1.7	23	0.3	33	3.7	8	0	30	1.7	33	5	25	5	24	5.3	34	6	19	39.7	30
Charles Sturt	0	36	0	37	0	38	0	38	14.7	9	3	28	4.3	27	3.7	27	8.7	29	0	36	34.3	31
Southern Qld	4	33	0.7	31	5.3	22	0	26	0	34	1.3	34	4.3	29	8	21	7	31	0.3	31	31	32
Central Qld	14	25	2.7	16	2	28	0	31	0.3	25	2.3	29	3.7	31	0.7	35	2	37	0.3	32	28	33
Charles Darwin	7	31	0	36	0.7	32	0	33	2.3	21	2	31	4.3	28	2.3	30	7	32	1	30	26.7	34
Ballarat	2.7	35	2.7	17	0	35	0	35	0	38	2	32	1.7	34	1	34	7	33	2.3	27	19.3	35
ADFA	5.3	32	2	20	4	23	0	27	0	35	0	38	0	38	0	38	5	35	0	37	16.3	36
Australian	0	37	0	38	0	39	0	39	0	39	2.3	30	5	24	0	37	7.3	30	1.3	29	16	37
Sunshine Coast	0	38	0.3	33	0	37	0	37	0.3	26	0.3	36	0	36	1.7	33	1	38	0	38	3.7	38
Maritime College	0	39	0	39	0.3	34	0	34	0	37	0	39	0	39	0	39	0	39	0	39	0.3	39
Avondale	0	40	0	40	0	40	0	40	0	40	0	40	0	40	0	40	0	40	0	40	0	40
Discipline mean	33		3		17		2		8		21		11		10		35		10		150	

Source: The authors' calculation using a database purchased from DEST in December 2005 (the DEST source reference number OZUP-2002-2004). R=Rank.

Table 2- The Average Number of "Research" and "Teaching & Research" Staff (Full Time Equivalent) by Institution and Broad Field of Education (2001-2003)

University	Natural and Phy. Sciences	R	IT	R	Eng & Related Tech.	R	Arc.& Buil.	R	Agr. & Env.	R	Health	R	Edu.	R	Manag. & Com.	R	Society & Culture	R	Creative Arts	R	All	R
Queensland	969	2	207.8	2	291.6	3	76.8	3	221.3	1	855.1	4	53.7	21	207.8	4	707.1	2	45.7	16	3635.	1
Melbourne	809.1	4	82.4	6	237.7	4	70.2	5	158.6	2	991.6	1	179.2	1	127.3	11	617.7	6	77.2	12	3351	2
Monash	916.4	3	300.1	1	329.5	2	0	18	0.9	22	552.5	5	127.6	4	312.5	1	638.3	3	137.2	4	3315	3
UNSW	676.9	5	170	3	445.5	1	104.7	1	1.3	20	916.4	3	33.5	27	233.6	2	624	5	106.8	7	3312.	4
Sydney	591.4	6	44.7	19	162.5	9	43.4	8	67.6	7	942	2	116.6	5	211.9	3	633.1	4	123.8	5	2937	5
ANU	1261.6	1	47.3	18	124.3	12	0	20	92.6	4	181.3	12	0	35	97.1	17	904.1	1	161.3	2	2869.	6
Western Australia	528.5	8	30.1	27	164.7	7	31.5	10	74	5	513.3	6	30.6	28	150.9	7	335.7	9	19.1	31	1878.	7
Adelaide	554	7	31.9	26	94.2	14	19.3	14	134.3	3	443.9	7	9.2	34	76.8	23	302.8	11	45.4	17	1711.	8
La Trobe	224.8	11	20.6	31	54.2	20	0	24	28.1	13	300.7	9	59	17	109.6	15	383.4	7	40	22	1220.	9
Griffith	290.2	9	77.3	11	65	18	10.3	17	0	29	66.2	22	110.6	7	145.9	8	307.2	10	146.7	3	1219.	10
QUT	184.8	14	114	4	92	16	67.2	6	0	25	154.4	14	147.6	2	119.2	13	181.6	19	101.6	8	1162.	11
RMIT	224.1	12	112.6	5	179.6	6	71.7	4	0	24	65.1	23	44.8	23	145	9	142.2	25	171.9	1	1157	12
Newcastle	234.9	10	4.2	36	137.1	10	33	9	0	26	241.2	10	96.1	9	84.2	20	232.8	16	85.1	10	1148.	13
Curtin	171	17	35.7	25	127.8	11	29.8	11	29.4	12	199.6	11	29.4	29	102	16	295.2	12	44.8	18	1064.	14
South Australia	104.5	22	36.9	22	163.1	8	61.5	7	6.6	17	146.3	15	97.1	8	163.9	6	147.1	24	79.9	11	1007	15
Flinders	96.8	24	36.7	23	0	35	0	35	0	37	415.3	8	61	16	28.6	35	269	13	0	37	907.3	16
Western Sydney	109.7	21	52.1	16	39.1	22	25.9	12	12.6	14	131.7	17	87.4	12	112.2	14	247.7	14	87.7	9	906	17
Deakin	103.4	23	79	9	37.8	24	25.6	13	0	27	164.8	13	84.7	13	96.1	18	246.4	15	51.1	15	888.7	18
UTS	160.9	19	79.5	8	94.1	15	81	2	0	23	51.9	25	91.1	10	184.4	5	94.5	29	42.2	19	879.7	19
Macquarie	180.3	15	42.3	20	15	28	0	29	8.3	16	12.3	33	67.6	15	134	10	345.1	8	17.4	32	822.3	20
Tasmania	169.3	18	39.4	21	25.4	26	16.6	15	59.9	9	134.8	16	68.3	14	41.6	31	206.5	17	53.8	13	815.7	21
Edith Cowan	46.9	30	77.4	10	16.7	27	0	28	0	34	68.8	21	111.6	6	77.8	22	174.9	20	112.8	6	687	22
Wollongong	144	20	54.1	15	117.8	13	0	21	2.3	18	30.5	28	49.8	22	82.3	21	152.9	22	40.9	20	674.7	23
James Cook	176	16	18	33	36.9	25	0	27	51.1	10	117.7	18	54.1	20	43.2	30	111.5	27	40.2	21	648.7	24
Murdoch	207.7	13	36.5	24	11.2	29	0	30	68.2	6	28.3	31	34.3	26	54.5	28	147.2	23	36.5	24	624.3	25
Victoria	51.2	27	81.9	7	42.9	21	0	25	2.2	19	53.7	24	24.5	31	92.7	19	164.1	21	26.7	28	540	26
New England	62.2	26	23.3	29	0	36	0	36	60	8	33.1	27	90.5	11	39.6	32	200	18	4.7	35	513.3	27
Swinburne	28.8	34	56	14	194.1	5	0	19	0	30	3.2	36	0	36	126.3	12	55.2	35	38.2	23	502	28
Charles Sturt	49.8	28	60.5	13	0	34	0	34	39.1	11	72.3	20	55.3	18	65.7	24	104.1	28	29.1	27	476	29
Southern Qld	47.1	29	47.4	17	58.9	19	0	23	0	32	23.6	32	44.7	24	63.4	26	70.3	33	53	14	408.3	30
Central Qld	35.2	32	67.2	12	38.4	23	0	26	0	33	30	29	54.8	19	64.4	25	76.8	32	32.4	25	399.3	31
Australian Catholic	0	39	0	39	0	39	0	39	0	39	76.1	19	130.4	3	39.1	33	137	26	0	38	382.7	32
Canberra	33.2	33	22.8	30	6	31	14.8	16	0	28	7.7	35	25.9	30	48.7	29	88.7	30	22.8	29	270.7	33
ADFA	91.9	25	24.8	28	67.9	17	0	22	0	31	0	38	0	38	22.4	37	62.2	34	0	39	269.3	34
Southern Cross	24.1	36	13.3	34	0	37	0	37	10.8	15	28.4	30	20.9	32	56.8	27	79.9	31	10.8	33	245	35
Charles Darwin	36.2	31	8.9	35	0.8	33	0	33	0	36	8.1	34	35.7	25	6.1	38	45.9	36	19.9	30	161.7	36
Ballarat	17.8	37	20.6	32	5.9	32	0	32	0	35	35.3	26	18.5	33	26.5	36	20.2	37	10.8	34	155.7	37
Sunshine Coast	26.3	35	0	37	0	38	0	38	0	38	0	39	0	39	36.7	34	0	39	31.7	26	94.7	38
Maritime College	4.6	38	0	38	6.7	30	0	31	1.3	21	0	37	0	37	0.4	39	0	40	0	40	13	39
Avondale	0	40	0	40	0	40	0	40	0	40	0	40	0	40	0	40	0.7	38	1	36	1.7	40
Discipline mean	241		56		87		20		28		202		59		96		239		54		1082	

Source: The authors' calculation using a database purchased from DEST in December 2005 (the DEST source reference number: Staf2001.dat - Staf2004.dat). R=Rank.

Table 3-Average PhD Completions Per Academic Staff Member by Institution and Broad Field Of Education (2001-2003)

University	Natural and Phy. Sciences	R	IT	R	Eng & Related Tech.	R	Arc.& Buil.	R	Agr. & Env.	R	Health	R	Edu.	R	Manag. & Com.	R	Society & Culture	R	Creative Arts	R	All	R
Southern Cross	0.32	4	0.10	12	0.00	34	0.00	34	0.37	8	0.18	6	0.11	25	**0.62**	1	0.05	35	**0.56**	2	**0.264**	1
New England	0.26	7	0.00	24	0.00	35	0.00	35	0.34	9	0.13	10	0.21	11	0.13	7	0.18	6	**0.49**	3	0.206	2
Melbourne	0.16	20	0.00	27	0.27	7	0.14	5	0.24	12	0.11	13	0.39	4	0.12	10	**0.31**	2	**0.65**	1	0.202	3
Wollongong	0.19	14	0.20	2	0.24	8	0.00	18	**1.15**	2	**0.36**	1	0.24	9	0.11	11	0.13	17	0.26	8	0.195	4
RMIT	0.19	16	0.10	8	0.30	4	**0.20**	3	0.00	22	0.06	26	0.48	3	0.09	19	0.11	23	0.26	9	0.189	5
Sydney	0.20	12	0.10	3	0.27	6	**0.28**	1	0.22	14	0.17	7	0.18	14	0.05	27	0.18	8	0.30	6	0.184	6
Tasmania	0.28	6	0.00	23	0.38	2	0.06	11	0.46	6	0.06	25	0.11	26	0.10	17	0.09	28	0.23	12	0.169	7
Charles Darwin	0.19	15	0.00	34	**0.82**	1	0.00	17	0.00	27	0.25	3	0.12	20	**0.38**	2	0.15	13	0.05	28	0.165	8
Murdoch	0.09	28	0.00	28	0.24	9	0.00	19	0.12	19	**0.27**	2	0.27	8	0.20	4	0.22	3	0.16	21	0.156	9
La Trobe	0.19	17	0.10	5	0.06	28	0.00	29	0.24	13	0.08	21	0.38	5	0.04	29	0.19	5	0.21	14	0.152	10
Canberra	0.33	3	0.10	14	0.06	30	**0.25**	2	0.00	21	0.22	4	0.19	12	0.10	15	0.06	34	0.26	10	0.147	11
Macquarie	0.20	13	0.10	7	0.09	25	0.00	27	0.56	4	0.03	34	0.12	24	0.07	25	0.14	16	0.33	5	0.146	12
Curtin	0.13	24	0.10	16	0.09	26	0.08	8	0.11	20	0.12	12	**1.08**	1	0.12	9	0.12	19	0.19	17	0.145	13
James Cook	0.26	8	0.10	15	0.11	24	0.00	26	0.16	16	0.04	33	0.16	16	0.04	30	0.12	20	0.11	23	0.145	14
Swinburne	0.47	1	0.00	32	0.12	23	0.00	25	0.00	31	0.10	17	0.00	35	0.16	6	0.22	4	0.00	32	0.139	15
Western Australia	0.13	23	0.10	9	0.13	21	0.03	16	0.31	11	0.09	18	**0.93**	2	0.09	18	0.15	14	0.19	16	0.138	16
Adelaide	0.14	22	0.00	35	0.24	10	0.14	6	0.31	10	0.12	11	0.22	10	0.03	32	0.10	26	0.06	27	0.137	17
Queensland	0.13	25	0.10	17	0.21	13	0.04	13	0.19	15	0.10	15	0.34	6	0.07	24	0.16	11	0.25	11	0.135	18
UTS	0.24	9	0.00	25	0.15	20	0.03	15	0.00	26	0.09	19	0.14	18	0.08	23	0.13	18	0.36	4	0.134	19
QUT	0.17	19	0.00	21	0.35	3	0.07	9	0.00	24	0.11	14	0.12	22	0.11	13	0.09	27	0.17	20	0.132	20
South Australia	0.08	30	0.10	19	0.18	17	0.06	12	0.15	17	0.10	16	0.12	23	0.28	3	0.06	33	0.09	24	0.130	21
Deakin	0.18	18	0.10	18	0.30	5	0.14	4	0.00	23	0.07	23	0.16	15	0.08	22	0.18	7	0.00	33	0.130	22
Monash	0.06	33	0.10	6	0.15	19	0.00	23	**2.54**	1	0.19	5	0.19	13	0.10	16	0.17	10	0.14	22	0.130	23
Ballarat	0.15	21	0.10	4	0.00	33	0.00	33	0.00	36	0.06	28	0.09	28	0.04	31	**0.35**	1	0.22	13	0.124	24
Victoria	0.29	5	0.00	33	0.23	11	0.00	20	0.00	28	0.07	24	0.15	17	0.09	20	0.14	15	0.07	25	0.123	25
Western Sydney	0.23	10	0.00	26	0.19	15	0.03	14	0.64	3	0.04	31	0.09	29	0.09	21	0.11	24	0.18	18	0.122	26
Griffith	0.04	35	0.10	11	0.20	14	0.00	21	0.00	29	0.17	8	0.12	21	0.11	12	0.11	22	0.17	19	0.121	27
Flinders	0.22	11	0.00	29	0.00	36	0.00	36	0.00	37	0.06	29	0.08	30	0.01	35	0.18	9	0.00	34	0.114	28
Newcastle	0.11	27	0.60	1	0.18	16	0.07	10	0.00	25	0.05	30	0.06	33	0.02	34	0.16	12	0.19	15	0.113	29
UNSW	0.11	26	0.00	30	0.22	12	0.08	7	0.52	5	0.08	20	0.34	7	0.10	14	0.07	32	0.27	7	0.109	30
Edith Cowan	0.07	32	0.10	10	0.16	18	0.00	22	0.00	30	0.14	9	0.13	19	0.16	5	0.07	31	0.07	26	0.105	31
ANU	0.09	29	0.00	22	0.12	22	0.00	24	0.14	18	0.03	35	0.00	36	0.03	33	0.12	21	0.04	29	0.090	32
Southern Qld	0.08	31	0.00	31	0.09	27	0.00	28	0.00	32	0.06	27	0.10	27	0.13	8	0.10	25	0.01	30	0.076	33
Charles Sturt	0.00	36	0.00	36	0.00	37	0.00	37	0.38	7	0.04	32	0.08	31	0.06	26	0.08	29	0.00	35	0.072	34
Central Qld	**0.40**	2	0.00	20	0.05	31	0.00	31	0.00	34	0.08	22	0.07	32	0.01	36	0.03	37	0.01	31	0.070	35
ADFA	0.06	34	0.10	13	0.06	29	0.00	30	0.00	33	0.00	37	0.00	37	0.00	38	0.08	30	0.00	36	0.061	36
Australian Catholic	0.00	37	0.00	37	0.00	38	0.00	38	0.00	38	0.03	36	0.04	34	0.00	37	0.05	36	0.00	37	0.042	37
Sunshine Coast	0.00	39	0.00	39	0.00	39	0.00	39	0.00	39	0.00	39	0.00	39	0.05	28	0.00	38	0.00	38	0.039	38
Maritime College	0.00	38	0.00	38	0.05	32	0.00	32	0.00	35	0.00	38	0.00	38	0.00	39	0.00	39	0.00	39	0.026	39
Avondale	0.00	40	0.00	40	0.00	40	0.00	40	0.00	40	0.00	40	0.00	40	0.00	40	0.00	40	0.00	40	**0.000**	40
Discipline mean	0.161		0.063		0.158		0.043		0.229		0.099		0.19		0.102		0.124		0.164		0.127	

Source: The authors' calculation using Tables 1 and 2. R=Rank. Notes: (1) if the difference between a cell and its corresponding discipline (column) mean was more than twice the standard deviation of that discipline the figures are shown in boldface. If the difference between a cell and its corresponding university (row) mean was twice the standard deviation of that row, the figures are underlined.

Table 4- Summary Statistics of the Data Employed Averaged for the Period 2001-2003 by 10 Broad Fields of Education

University	Natural and Physical Sciences	Information Technology	Engineering and Related Technologies	Architecture and Building	Agriculture, Environmental and Related Studies	Health	Education	Management and Commerce	Society and Culture	Creative Arts	All Disciplines
The number of PhD completions											
Mean	33	3	17	2	8	21	11	10	35	10	150
SD	36	6	22	3	12	35	13	10	41	12	155
Minimum	0	0	0	0	0	0	0	0	0	0	0
Maximum	130	33	97	14	43	159	70	45	189	50	678
Gini	0.553	0.628	0.638	0.743	0.714	0.702	0.523	0.518	0.556	0.615	0.504
CV (%)	109	200	129	150	150	167	118	100	117	120	103
The number of research and "research & teaching" staff members (full-time equivalent)											
Mean	241	56	87	20	28	202	59	96	239	54	1082
SD	306	59	103	29	50	283	45	68	218	47	1014
Minimum	0	0	0	0	0	0	0	0	0	0	2
Maximum	1262	300	446	105	221	992	179	313	904	172	3636
Gini	0.596	0.484	0.589	0.717	0.761	0.65	0.428	0.384	0.468	0.469	0.47
CV (%)	127	105	118	145	179	140	76	71	91	87	94
Per academic staff PhD completions											
Mean	0.161	0.063	0.158	0.043	0.229	0.099	0.19	0.102	0.124	0.164	0.127
SD	0.112	0.102	0.152	0.071	0.447	0.078	0.222	0.112	0.074	0.16	0.052
Minimum	0	0	0	0	0	0	0	0	0	0	0
Maximum	0.474	0.63	0.821	0.277	2.542	0.361	1.078	0.616	0.346	0.652	0.264
Gini	0.381	0.572	0.473	0.752	0.731	0.414	0.514	0.48	0.321	0.516	0.221
CV (%)	70	155	96	169	195	80	117	110	59	98	41

Source: The authors' calculation using Tables 1 and 2.

Table 5 -Relationship Between the Number of PhD Completions and the Number of Academic Staff Members Using 400 Cross-Sectional Observations

Variable/statistics	Model 1			Model 2			Model 3			Model 4		
	Coefficient	*t*-ratio 1	*t*-ratio 2	Coefficient	*t*-ratio 1	*t*-ratio 2	Coefficient	*t*-ratio 1	*t*-ratio 2	Coefficient	*t*-ratio 1	*t*-ratio 2
Common intercept	1.35	1.9**	2.1				0.4	0.5	0.5			
Discipline specific intercept:												
Natural and Phy. Sciences				2.74	1.3	1.3				7.67	3.4*	3.0*
IT				-3.66	-1.9**	-4.3*				-0.98	-0.4	-1.1
Eng & Related Tech.				5.87	3.1*	3.2*				-0.96	-0.4	-1.0
Arc.& Buil.				-0.48	-0.3	-1.3				0.29	0.1	1.5
Agr. & Env.				4.21	2.2*	4.1*				1.58	0.8	2.1*
Health				-4.28	-2.1*	-1.7**				-2.17	-1.0	-1.3
Edu.				3.90	2.1*	2.5*				1.26	0.4	0.4
Manag. & Com.				-2.23	-1.2	-1.3				0.43	0.1	0.3
Society& Culture				4.61	2.2*	1.7**				-4.41	-1.7**	-1.2
Creative Arts				2.88	1.5	2.4*				-0.13	0.0	-0.1
Common slope coefficient	0.13	36.0*	11.7*	0.13	32.9*	10.4*						
Discipline specific slope coefficient:												
Natural and Phy. Sciences							0.12	24.9*	8.0	0.11	18.3*	6.7*
IT							0.07	2.9*	3.9	0.08	2.6*	3.7*
Eng & Related Tech.							0.20	14.4*	13.3	0.20	11.9*	13.7*
Arc.& Buil.							0.08	1.6**	3.6	0.09	1.4	4.7*
Agr. & Env.							0.23	7.2*	9.6	0.22	6.2*	9.8*
Health							0.11	21.1*	7.8	0.12	18.5*	7.1*
Edu.							0.18	7.1*	4.6	0.17	4.4*	2.7*
Manag. & Com.							0.10	6.2*	8.0	0.10	3.8*	6.3*
Society& Culture							0.15	26.6*	7.9	0.16	20.3*	6.2*
Creative Arts							0.18	6.8*	5.1	0.18	4.9*	4.5*
R-squared	0.77			0.78			0.81			0.82		
Adjusted R^2	0.76			0.78			**0.81**			0.81		
Akaike info criterion	7.859			7.818			**7.686**			7.689		
F-statistic	1299*			141.78*			167.2*			90.6*		
Prob(F-statistic)	000			000			000			000		

Notes: (1) * and ** indicate that the corresponding null hypothesis is rejected at the 5 and 10 per cent significance levels, respectively. (2) *t*-ratio 1 is obtained by using the pooled ordinary least square standard errors. (3) the White cross-section standard errors & covariance matrix has been used to compute the *t*-ration 2 to correct for an unknown form of heteroscedasticity.