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# Research productivity of Australian academic economists: human-capital and fixed effects

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## Abstract

This study investigates why some economics departments in Australian universities are more research productive than others. The hypothesis is simple: research productivity depends upon the human capital of department members and the department-specific conditions under which they work. A Tobit model is used to estimate the magnitude of the two effects. Both are found to be important. Our results help explain why a small number of departments consistently outperform the others in studies that rank Australian economics departments according to research output.



## Keywords

research productivity, human capital, economics departments

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**Research Productivity of Australian Academic Economists:**

**Human-Capital and Fixed Effects***

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JEL codes: A11; C24; J24

## *I Introduction*

There is an extensive literature dating back four decades that examines the research output of academic economists in the United States, and there is a growing literature elsewhere. From the several studies that have employed Australian data, most of which rank economics departments according to their research output during particular time periods, the major findings to emerge are as follows. First, a small number of Australian economics departments consistently outperform the others regardless of the measure of research output used and the time period employed in constructing the ranking. Second, in almost all Australian economics departments a small proportion of academic staff account for most of the research output. Although there are several prolific researchers, most Australian academic economists do not publish regularly in prestigious, refereed journals. Third, the presence of just one or two highly productive researchers can have a substantial impact on a department's ranking. Recruiting a 'superstar' can catapult an otherwise mediocre department towards the top of the rankings table; the departure of a 'superstar' can have the opposite effect. Finally, international studies have shown that academic economists in Australian universities have low research output by international standards. Only five or six Australian universities are in the top 200 universities world-wide according to rankings based on economics research (Kalaitzidakis, *et al.*, 2003; Coupe, 2003).

The question that remains is: 'Why?'. Are Australian academic economists less well trained than their colleagues elsewhere? Are teaching and administrative loads higher in Australian universities than in universities in other countries? Are teaching and administration favoured over research in promotion decisions? Is tenure granted too easily or for the wrong reasons? The current study is motivated by these issues and a desire to learn more about what makes some Australian economics departments more research productive than others. An understanding of these issues is necessary if Australian economics departments are to improve their research performance, and in the current tertiary-education environment, there is increasing pressure to do so.

The objective of this study is to examine the effect of two factors on a department's research productivity. The first is the human capital embodied in the department's members and the second is the department-specific environment. We have constructed a large set of panel data on more than 800 academic economists in teaching departments of 29 Australian universities that, for several years, have offered a doctoral degree in economics. This is almost a complete enumeration of Australian academic economists who were employed at the level of lecturer or above during at least one year from 1996 through 2000. Few previous studies have attempted to analyse the factors that affect research productivity of Australian academic economists. All were based on small samples of cross-section data obtained from surveys that achieved low response rates. None has attempted to quantify department-specific effects on research productivity.

The remainder of this paper is organized as follows. Section II reviews current knowledge of the factors that influence research output of academic economists, particularly those in Australian universities. In Section III we describe the conventions used to measure research productivity, document our data sources and summarize the data used in our analysis. We do the same for human capital in Section IV. The econometric model used to analyse research productivity is discussed and estimates of its coefficients are presented in Section V. The results of our analysis are discussed in Section VI. Section VII offers some concluding remarks.

## *II Previous Research Findings*

A recent ranking study[1] of Australian economics departments by Pomfret and Wang (2003) noted that high-quality research output by Australian academic economists is low on average by international standards, and highly skewed, both at the national level and within departments. Several explanations are conjectured by the authors. First, Australian academics who establish good publication records emigrate and Australians who complete their PhD studies overseas fail to return home. Second, research output is neither valued nor supported as much in Australian universities as it is elsewhere. Third, Australian academics face different incentives with respect to producing published research than do their colleagues in other countries. There is little doubt that salary differentials between Australian and North American universities make it difficult to recruit and retain productive researchers; all Australian universities face this problem. Other conditions, however, such as requirements for tenure and promotion, are under the control of individual universities. The extent to which such institutional conditions impact upon research productivity is a question that has motivated the research reported in this paper.

Three earlier studies sought to identify the variables that influence research productivity in Australia. Fox and Milbourne (1999) identified several factors that affect research productivity of individual economists: teaching loads, access to research grants, and human capital − in particular, the grade of honours received in the first degree, the possession of a PhD and whether the PhD involved coursework as well as a thesis. There was no attempt to take account of the quality of the institution from which the PhD was obtained or how long ago the degree was conferred – factors that we investigate later in this paper. Neither did Fox and Milbourne attempt to

[1] Other studies that have ranked Australian economics departments include Harris (1988, 1990a and 1990b), Anderson and Blandy (1992), Towe and Wright (1995) and Sinha and Macri (2002 and 2004). An extensive survey of the rankings literature can be found in Macri and Sinha (2006).

explain the differences between departments in research productivity – that was not their objective. However, a department's productivity is obviously related to that of its individual members so the inferences are clear. One would expect departments that consistently rank well to employ staff with high levels of human capital, to have lower-than-average teaching loads and higher-than-average success rates in obtaining outside grants.

A decade earlier, Harris (1990a) investigated the factors that affect research productivity of economics departments rather than of individual economists. Harris identified four important explanatory variables: the department's size, the number of hours of face-to-face teaching per academic per week, the department's student-to-staff ratio and the number of secretarial staff per academic. Department size was observed to have a nonlinear effect, the optimum size being approximately seventeen academic staff. Harris noted that the variation in research productivity was much greater within departments than between departments, suggesting either that some important environmental factors vary within departments or that individual attributes are important in explaining research output.

Subsequently, Harris and Kaine (1994) used multivariate methods to explore whether individuals' preferences and perceptions about various research-related issues were correlated with research performance. The authors concluded that research performance is more a function of individual motivation than of resource support. They found that highly active researchers not only worked longer hours (65 hours per week on average) than those in the other two groups (53 and 55 hours per week) but they also devoted a larger proportion of their time to research (65 percent versus 53 and 52 percent). Highly productive researchers undertook research projects that would further their careers. They interacted with academics outside their own departments and were active in several research-related areas. They also felt motivated, found it easy to find research topics, had little difficulty getting their work published and they enjoyed the freedom and challenge of their positions.

Today, the extent to which individual motivation can compensate for a lack of resources is open to speculation. Resource constraints have become more binding on Australian academics in the last decade as universities have been forced to seek funding from the private sector, student-to-staff ratios have increased, the nature of the student body has changed, and subject delivery is expected on-line, at-a-distance and off-shore, as well as on-campus in the traditional lecture format.

The above three studies all produced their results using cross-section data obtained from surveys that achieved typical, but low, response rates. Slightly less than one third of the individuals surveyed by Fox and Milbourne (1999) responded. Harris (1990a) surveyed 18 departments but responses from only 12 departments were usable. The data used by Harris and Kaine (1994) were obtained from a survey of 330 individuals, 134 of whom responded. Non-response bias is a possible weakness of all three studies suggesting the need for a broader-based investigation.

Several studies have investigated the factors that influence research productivity of academic economists in other countries, particularly the United States. Research productivity has been found to be related to the quality of the academic's PhD degree (Davis and Patterson, 2001; Broder, 1993; Laband, 1986), whether the academic is employed in a department that offers a PhD program and, if so, the quality of that program (Davis and Patterson, 2001; Conroy, *et al.*, 1995; Broder, 1993; Baumann, *et al.*, 1987), and the academic's field of specialization (Davis and Patterson, 2001; Fish and Gibbons, 1989; Baumann, *et al.*, 1987). The student-to-staff ratio and the number of research assistants per academic are also important (Thursby, 2000). Research productivity generally declines after tenure (Davis and Patterson, 2001) and with age (Oster and Hamermesh, 1998), although the reasons for the latter are unclear. There is some evidence that males publish more than females (Fish and Gibbons, 1989; Barbezat, 1992) or at least in more highly rated journals (Broder, 1993). However, Davis and Patterson (2001) found no evidence of gender differences when human capital, type of employer and field of specialization were held constant.

## *III Measuring Productivity: Conventions and Data Sources*

This study examines research productivity of academic economists employed in teaching departments in Australian universities that, for several years, have offered a doctoral degree specialising in economics. Members of research institutes are not included because they face quite different working conditions than do academics who are required to teach as well as conduct research. We focus on doctoral-granting universities because it seems reasonable to assume that academics in departments offering PhD supervision are expected to undertake research.[2]

Table 1 lists the academic units whose members were included in our study. To allow valid comparisons across universities, we included academics from the disciplines of economics, econometrics and economic history, whether or not they were located within the same academic unit. In those universities where the finance discipline was a separate academic unit we excluded their staff from our study on the assumption that their members had more in common with accountants than with economists. At universities where academics from other disciplines such as marketing

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[2] Departments offering a PhD in economics were identified using the Commonwealth Universities Yearbook. Charles Sturt University, Charles Darwin University, Swinburne University of Technology and Southern Cross University were excluded from the analysis because we were unable to distinguish the economists from academic staff in other disciplines during the time period of the study, namely 1996-2000. Recent web sites of these universities indicate that currently they each employ fewer than five economists, who are located in schools or faculties containing academics from other disciplines.

or management were located in the same academic unit as economists we included only those from the discipline of economics.

The 'economists' in our study were lecturers, senior lecturers, associate professors, readers and professors (only) during at least one year from 1996 through 2000. Those on leave were included. All others, such as associate lecturers, visiting fellows, emeritus and adjunct academics, were excluded. We grouped 'economists' into a single entity for each university, referred to hereafter as a 'department'.

To measure the research productivity of a department it is necessary to know its membership during the time period of the study. We used the universities' annual reports, handbooks, calendars *etc.* to construct lists of academic economists, year-by-year from 1996 onwards. In a few cases where such documents were not available we used alternative sources, including the Commonwealth Universities Yearbook, staff lists provided to us by department members, and individuals' vitae posted on various Web sites.[3] Table 1 reports the number of 'economists' in each 'department' annually from 1996 through 2000, and the number of 'economists' employed during at least one year from 1996 through 2000. Depending upon the number of hires and quits, the number of 'economists' present sometime during 1996-2000 can be considerably larger than the number present in any one year.

Since the objective of this study is to understand why some economics departments are more research productive than others it is appropriate to measure the flow of research originating in a department over a given time period rather than the stock of research attributable to academics who are members of a department at a given point in time. Our hypothesis is that the flow of research will be influenced by

[3] Affiliations on published papers can be used to identify total research output of a university but not a department's productivity. The affiliations on published papers tell us nothing about who did not publish. Nor do they distinguish members of teaching departments from members of research institutes or from graduate students in the same university.

department-specific conditions at the time the individual was employed. Research conducted prior to joining a department is unaffected by that department's conditions. Even research that was done in a particular department, but a long time ago, says little about that department's later research environment. We concentrate on research published from 1998 through 2002. Like others (Harris, 1988 and 1990a; Fox and Milbourne, 1999) we assume a publication lag of two years: publications are attributed to a given department if and only if the author was a member of that department two years prior to the publication date, that is, sometime between 1996 and 2000. This period is recent enough for rankings to be of interest; it is also convenient because after 2000 restructuring of academic units containing economists took place in several universities, making it difficult to track some economists.

We define a department's research productivity from 1996 to 2000 as the (weighted) average productivity of its individual members. Productivity is measured in publications rather than citations because we are interested in recent research, which necessarily is little cited.[4] Like almost all other studies of academic research output, we use only refereed journal articles because we agree with Neary, Mirrlees and Tirole (2003, p.1241) that "only published journal articles undergo a widely-accepted process of peer review which is the essence of quality control in any scientific discipline". We measure an individual's research productivity by the number of publications per year resulting from work undertaken during that portion of the period 1996 through 2000 when the individual was employed in the department. Averaging output over a number of years takes away some of the "lumpiness" that

[4] The two approaches to measuring an individual academic's research productivity (based either on the individual's publications or on citations of the individual's work) both have practical and conceptual difficulties, which are discussed by Pomfret and Wang (2003, pp.420-423).

appears in annual data. For an article with n authors, each author was given credit for an equal proportion (1/n) of the article.

There is no consensus as to whether research should be measured in articles or pages. Pomfret and Wang (2003, p.421 and p. 430) count articles, arguing that important contributions have been ‘brief and succinct’. We prefer page counts because we agree that ‘length is correlated with importance, at least as perceived ex ante by editors and referees’ (Neary, Mirrlees and Tirole, 2003, p.1241). In computing page counts we adopt the common procedure of adjusting for the different page sizes of journals relative to that of a benchmark journal, namely the *American Economic Review*. Adjustments for page size of 468 journals were made using the conversion factors used, and generously provided to us, by Sinha and Macri (2002). The page counts of articles from other journals were adjusted using a conversion factor of 0.68, which is the average page-size conversion factor of all but the 71 journals that were identified by Towe and Wright (1995) as the most prestigious.

Although most academics would agree that article quality is closely related to the quality of the journal in which it is published, how to take account of the latter is a contentious issue. The literature contains two approaches to devising weights to reflect the quality, or at least the impact, of journals. The first approach uses subjective perceptions of journal quality, either the perceptions of the authors undertaking a particular study (Combes and Linnemer, 2003; Lubrano *et al.*, 2003) or those of economists canvassed in a survey (National Research Council, 1995). The alternative approach is based on the number of citations of the journal’s contents. Weights for 159 journals were calculated by Kalaitzidakis, *et al.* (2003), based on 1998 citations of articles published from 1994 to 1998 and taking account of the prestige of the journal in which the citation appears. Other journals receive a weight of zero.

The weights of Kalaitzidakis, *et al.* (2003), which are updated versions of weights computed by Laband and Piette (1994) and Liebowitz and Palmer (1984), are regarded by some as the 'industry standard' (Macri and Sinha, 2006, p.122) but they place heavy emphasis on a small set of prestigious journals. The AER is the top journal with a weight of 1.0. Five journals receive weights between 0.5 and 1.0, another eight between 0.25 and 0.5, fifteen more between 0.1 and 0.25. The remaining 130 journals receive a weight less than 0.1. Pomfret and Wang (2003, p.432) argue that such weights constitute a poor basis for ranking most Australian economics departments, whose members publish few articles in leading journals. We agree. Furthermore, we contend that any article in a refereed journal is better than no article at all and should contribute *something* in a publication tally. Accordingly, in addition to using the weights of Kalaitzidakis, *et al.* (2003) we also conducted our analysis using Gibson's (2000) weights of 1.00, 0.64, 0.34 and 0.05 for journals classified into four quality categories, the first three of which are Towe and Wright's (1995) Groups 1, 2 and 3 journals, respectively. The fourth category is a residual category containing all other journals in the EconLit data base in early 2003. Gibson (2000) derived his set of quality-related weights for Towe and Wright's four quality-related groups using an ordinal-logit model of academic rank with the number of pages in journals of each group, plus a set of control variables, as explanatory variables. Although this provides a rationale for using Gibson's weights, we acknowledge that our decision to do so is subjective.

Our major source of journal publications was the on-line version of EconLit, which we searched by author for every academic on our staff lists. A limitation of

EconLit is that it records multi-authored articles using the '*et al.*' convention. Consequently, relevant articles will be missed unless the first author is included in the study and a supplementary search is undertaken to reveal the other authors, a practice which we followed in every case. An advantage of EconLit is its coverage, which has expanded in recent years. At the time of this study, it referenced articles in over 600 journals. We cross-checked our list of publications from EconLit with those compiled, and made available to us, by Pomfret and Wang using individuals' curriculum vitae. Where possible, we also cross-checked our data with publication lists contained in annual reports, handbooks, calendars and research reports. We added any references that we had missed, such as those where the first author was not on our staff lists but another author was.

Two sets of productivity statistics are presented in Table 2. Columns 1 and 2 list average annual productivities of academic economists in the 29 departments, measured in AER-standard-sized pages, adjusted for quality using the weights of Kalaitzidakis, *et al.* (2003). This measure of productivity is referred to hereafter as Q1-pages. The proportion of academic economists who published any Q1-pages from 1998 through 2002 is given in Column 3 and the productivity of these research-active staff is listed in Column 4. It is apparent from Columns 1 through 4 that productivity based on Q1-pages is low and varies little within large subsets of departments, which justifies our decision to repeat our analysis with productivity measured in AER-standard-sized pages, adjusted for quality using the weights of Gibson (2000). The latter measure is referred to hereafter as Q2-pages. Columns 5 and 6 list the average annual number of Q2-pages published by staff in the various departments. Column 7 gives the proportion of academic economists with positive Q2-output during the period 1998 through 2002 and their productivity is given in Column 8.

Many departments have such low levels of productivity – particularly in terms of Q1-pages – that a complete ranking from one through 29 would be misleading. However, certain departments are more research productive than others. The ANU, Western Australia and Melbourne are among the most research-productive departments according to both Q1 and Q2 measures. Tasmania is also relatively productive in terms of Q2-pages per staff per year. These results are consistent with Pomfret's (2003, p.436) results based on the stock of publications per capita. However, the appearance of James Cook, which was not included in Pomfret's study, towards the top of the rankings is unexpected and demonstrates the impact that one or two productive researchers can have on a department's ranking, particularly when research output is measured per capita. The economics department at James Cook is very small and its productivity is heavily influenced by the presence of John Quiggin from 1996 through 1999 and, to a lesser extent, by the presence of Jae Hoon Kim in 1998 and 1999. Without Quiggin, James Cook's productivity is 0.25 Q1-pages and 0.37 Q2-pages, both of which are still heavily influenced by Kim's productivity.[5]

### *IV Measuring Human Capital: Conventions and Data Sources*

Individuals' academic qualifications were collected from a variety of sources including annual reports, handbooks, calendars, ProQuest Dissertations and Theses, Libraries Australia (accessed through the data base, Kinetica), on-line library catalogues at individual universities, the online directory of the American Economic Association and Edwards and Sullivan (1997). In several cases we contacted individual academics to obtain missing data. For 873 of the 876 academics on our

[5] Flinders' productivity is substantially influenced by the presence of Jacob Madsen in 1996, whose output in 1998 was 3.5 Q1-pages and 27.2 Q2-pages. Without Madsen, Flinders' productivity is 0.03 Q1-pages and 0.31 Q2-pages. Madsen returned to the UK prior to 2002, so he was not included in Pomfret's study.

staff lists, we were able to establish whether the individual had a PhD and, if so, the university which granted it and the year in which it was conferred. The other three academics, all of whom had zero Q1- and Q2-pages, were excluded from our analysis.

As reported in Section II, overseas studies have found that top-rated graduate schools produce the most research-productive academics. There are several possible reasons. The top graduate schools provide training in economic theory and methodology that is at the discipline's frontier, often via a rigorous, mandatory, coursework component to their PhD programs. Students at the top graduate schools are exposed to a 'culture' that values high-quality research. These schools also attract the best students. Those who complete their doctorates and seek academic careers themselves are likely to be the most highly research-motivated individuals. We investigate whether Australians with qualifications from top-rated graduate schools are the most research productive.

To capture the differences in the quality of the PhD qualification, we classified each of the 873 academics in our data set into one of four groups according to the highest educational qualification held in the first year between 1996 and 2000 that the individual was in his or her department. The first two groups consist of academics with PhD degrees from graduate schools that were ranked 1-50 and 51-150, respectively, according to the world-wide rankings of economics departments by Kalaitzidakis, *et al.* (2003). The third group is comprised of academics who have a PhD degree from another university. Academics without a PhD comprise the control group.

The ranking of economics departments by Kalaitzidakis, *et al.* (2003) is based on the number of quality-adjusted pages published in the top 30 journals during the period 1995 to 1999. Most of the academics in our study received their PhDs prior to

1995 so our representation of the quality of the PhD assumes that membership of the three groups of PhD-granting departments has remained stable over time. This appears to be so. The ranking of Kalaitzidakis *et al.* (2003) is similar to that of Hirsch *et al.* (1984), who ranked 240 US and 40 non-US economics departments based on research publications from 1978 to 1983.[6]

Section II noted that US studies have found that research productivity declines after tenure and also with age. To test whether the same applies in Australia, each academic with a PhD was classified according to the number of years that had lapsed between the year in which the PhD degree was conferred and the last year between 1996 and 2000 that the individual was in his or her department. Recent PhDs are those conferred no more than five years before the individual's last year in the department. Middle-vintage PhDs are those conferred between five and 15 years earlier. Mature PhDs are more than 15 years old.

Table 3 (Columns 1 to 11) summarises the human capital employed in the various departments from 1996 through 2000. Nineteen per cent of academic economists in our data set have a PhD from a top-50 graduate school, the heaviest concentrations being in Adelaide, ANU, Melbourne, NSW, Sydney and Western Australia. Sixteen per cent of academics have doctorates from graduate schools that ranked 51 through 150. At least 30 per cent of academics at NSW and Tasmania have PhDs from these graduate schools. Twenty-eight per cent of academics have PhDs from other graduate schools. Economics departments at James Cook, Murdoch and Queensland universities have large proportions of academic staff who have a PhD from another graduate school. Thirty-six percent of academic economists do not have

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[6] Forty two of Kalaitzidakis *et al.*'s top 50 departments were ranked between 1 and 50 and another four were ranked 56, 64, 101, 112 by Hirsch *et al.*. Of the 100 departments ranked 51-150 by Kalaitzidakis *et al.*, Hirsch *et al.* ranked eight between 1 and 50 and 40 between 51 and 150. The remainder of Kalaitzidakis *et al.*'s top 150 departments were not included in Hirsch *et al.*'s lists of top departments.

a PhD qualification. More than 50 per cent of academic economists at Canberra, Deakin, Edith Cowan, Flinders, QUT, RMIT, Southern Queensland, UTS, VUT and Western Sydney do not have a PhD. The departments with the largest concentrations of recent PhDs are Adelaide, LaTrobe and Melbourne, whereas Adelaide, ADFA, James Cook, New England, Queensland and Western Australia have the largest concentrations of mature PhDs. The last column of Table 3 lists the proportion of academics in each department who are female. Across all departments 17 per cent of academic economists are female.

## *V The Econometric Model and its Coefficients*

We hypothesize that an individual's research productivity is a function of his or her human capital and an unobserved department-specific effect. As there are a large number of zero observations on the dependent variable, we use a standard censored Tobit model of the form:

$$Y_{ij}^{*} = \sum_{j=1}^{29} \alpha_j D_{ij} + \sum_{k=1}^{9} \beta_k H_{kij} + \gamma F_{ij} + u_{ij} \qquad (1)$$

$$Y_{ij} = \max(0, Y_{ij}^{*}) \qquad (2)$$

where $-\infty < Y_{ij}^{*} < \infty$ is a latent variable representing the '*desired*' research output per year of Individual i in Department j, and $Y_{ij} \geq 0$ is the *observed* research output per year of Individual i in Department j. The $D_{ij}$ are 29 dummy variables, each of which equals one if Individual i is in Department j (j=1,2,…29), zero otherwise. The human capital of Individual i in Department j is measured using nine dummy variables, $H_{kij}$ (k=1,2,…9), that specify from which of the three quality groups of graduate school the PhD was obtained and how long ago it was conferred. $F_{ij}$ is gender, which equals one if Individual i in Department j is a female, zero otherwise.

The $\alpha_j$s reflect unobserved heterogeneity among departments. A fixed-effects model is chosen in preference to a random-effects model because we are focusing on a specific set of 29 departments. Furthermore, it seems likely that departments that are more (less) supportive of research would hire staff with higher (lower) levels of human capital. If a random-effects model were to be used there would be correlation between the disturbance term and the human-capital variables, leading to bias in the estimated effect of human capital.

Two versions of the model were estimated: one with productivity measured in Q1-pages, the other with productivity measured in Q2-pages. Maximum likelihood estimates of the parameters, and P-values are given in Columns 2 through 5 of Table 4. The *relative* size of the fixed-effect coefficients help to identify departments with environments that are more, or less, conducive to research productivity. Whether measured in Q1-pages or Q2-pages, departments at the ANU, Melbourne and Western Australia have the largest fixed effects, suggesting that they provide the most productive research environments.

The parameters, $\beta_k$ (k=1,2,…9), in Equation (1) measure the effects of human capital on latent research productivity, compared with no PhD. Their estimates in Columns 2 and 4 of Table 4 have appropriate positive signs and all but one are statistically significant. The magnitudes of the coefficients indicate that a PhD qualification is important for research productivity. Their *relative* magnitudes indicate that research productivity is related to the quality rating of the graduate school from which the PhD was obtained. The vintage of the PhD also matters. The most productive period is the first five years after the PhD is conferred. Beyond that, research productivity declines although those with PhDs from the top 50 universities are more productive than the other two groups even 15 years after graduating. These results could reflect a cohort effect although, as noted in Section II, overseas studies that have tracked individuals' research output through time have found evidence that on average research productivity declines with age.

### *VI Human-Capital and Fixed Effects on Actual Research Productivity*

The $\alpha$ and $\beta$ parameters measure the department-specific and human-capital effects on the expected value of the latent variable, *desired* research productivity,

$$E(Y_{ij}^{*} \mid D_{ij}, H_{kij}, F_{kij}) = \sum_{j=1}^{29} \alpha_j D_{ij} + \sum_{k=1}^{9} \beta_k H_{kij} + \gamma F_{ij} \quad (3)$$

but not on the expected value of *actual* research productivity. The latter, which cannot be negative, is a non-linear function of the form (Wooldridge, 2002, pp.521-523):

$$E(Y_{ij} \mid D_{ij}, H_{kij}, F_{kij}) = \Phi(Z_{ij})(Z_{ij}) + \sigma\phi(Z_{ij}) \quad (4)$$

where $Z_{ij}$ is given by the right-hand side of Equation (3), $\Phi$ is the cumulative normal distribution function and $\phi$ is the standard normal density function.

The estimated effect of human-capital on *actual* research productivity varies by department (and gender) because of the nonlinear nature of Equation (4). In Department J, the effect on productivity of human capital of Type K is obtained by calculating the difference between the predicted productivity of an academic of given gender in Department J with qualification K ($D_{iJ} = 1$, $D_{ij} = 0$, $j \neq J$; $H_{KiJ} = 1$, $H_{kiJ} = 0$, $k \neq K$) and that of an academic of the same gender, in the same department, with no PhD ($D_{iJ} = 1$, $D_{ij} = 0$, $j \neq J$; $H_{kiJ} = 0$, all k). The total effect of human capital on the expected value of actual productivity of a given department is measured as the difference between the predicted productivity of each academic in that department and the predicted productivity of a department member of the same gender with no Ph.D degree, averaged across all academics in the department.

These estimates appear in Table 5, with research productivity measured in both Q1-pages and Q2-pages per staff per year, respectively. Departments have been ordered according to the magnitude of the human-capital effects in Columns 4 and 8. Although the human-capital effects are approximately the same for whole subgroups of departments, the departments with the largest human-capital effects, whether measured in Q1-pages or Q2-pages are (in alphabetical order) Adelaide, the ANU, La Trobe, Melbourne, NSW, Tasmania and Western Australia. These are among the most research-productive departments.

Across all departments, the human-capital effect accounts for 51 per cent of predicted productivity, measured in Q1-pages (Column 4 divided by Column 2), and 43 per cent of predicted productivity, measured in Q2-pages (Column 8 divided by Column 6). In all but seven departments the human-capital effect accounts for at least 40 per cent of Q1-productivity and in all but six departments the human-capital effect accounts for at least 30 percent of Q2-productivity. In every department the proportionate effect of human capital is larger when research productivity is measured in Q1-pages, which emphasizes journal quality, than when it is measured in Q2-pages.

The department-specific effects on *actual* research productivity are conceptualised as follows. Each individual's predicted productivity in his or her own department is compared with a prediction of what his or her productivity would be, on average, in the other 28 departments. We call the latter the individual's 'counterfactual' productivity. The counterfactual may be viewed as a 'fictitious' department that is an average of all but the individual's own department. In this fictitious department the individual's human capital and gender are unchanged. Therefore, the difference between the individual's predicted and counterfactual research productivities measures the effect on his or her research productivity of the other variable in Equation (4), namely the dummy variable representing his or her own department.

The algorithm used to calculate the department-specific effects is as follows:

Step 1: Consider Individual i in Department J.

Step 2: Individual i's predicted research productivity in his or her own department is found by substituting the individual's own human-capital and gender dummy variables into Equation (4) and setting $D_{iJ} = 1$ and $D_{ij} = 0$ ($j \neq J$).

Step 3: Individual i's predicted research productivity in another department (say, Department Q) is found by substituting the individual's own human-capital and gender dummy variables into Equation (4) and setting $D_{iQ} = 1$ and $D_{ij} = 0$ ($j \neq Q$). This step is repeated for Individual i in all other departments.

Step 4: Individual i's counterfactual research productivity is calculated as his or her predicted research productivity averaged across all departments other than his or her own department.

Step 5: The effect of Department J on Individual i equals the individual's predicted research productivity in his or her own department (from Step 2) minus his or her counterfactual research productivity (from Step 4).

*Steps 1 through 4 are repeated for all individuals in Department J.*

Step 6: The overall effect of Department J on research productivity equals its average effect on all individuals employed in that department.

The above six-step procedure is repeated for all 29 departments to produce a set of department-specific effects on *actual* research productivity.

These results are presented in Table 6, with research productivity measured in both Q1-pages and Q2-pages per staff per year. Departments have been ordered according to the magnitude of the department-specific effects in Columns 4 and 8.

Counterfactual productivities are given in Columns 3 and 7. Approximately half the departments have positive department-specific effects, indicating that a typical staff member would be less research-productive in the fictitious counterfactual department than in his or her own department. The remaining departments have negative department-specific effects, implying that a typical member is predicted to be more research-productive in the fictitious counterfactual department than in his or her own department. Although many departments have similar department-specific effects, some differences are evident. The departments with the largest department-specific effects, measured in Q1-pages or Q2-pages, are the ANU, Melbourne and Western Australia. Tasmania has a large positive department-specific effect when productivity is measured in Q2-pages.

There is a strong positive correlation across departments between the department-specific effects and the human-capital effects ($r = 0.92$ for Q1-pages and $r = 0.89$ for Q2-pages) on actual productivity. Furthermore, most of the more research-productive departments have relatively large human-capital effects *and* relatively large department-specific effects. In particular, the ANU, Melbourne, Western Australia and NSW rank highly according to both department-specific effects and human-capital effects, whether research productivity is measured in Q1-pages or Q2-pages. Tasmania, which is relatively productive in terms of Q2-pages, has the fourth-highest human-capital effect (see Column 8 of Table 5) and the second largest department-specific effect (see Column 8 of Table 6).

Consistent with the findings of Fox and Milbourne (1999), the department-specific effects could be capturing the effects of teaching loads. Another possibility, consistent with Harris (1990a), is that they reflect the effects of department size. We investigated these possibilities using the only publicly available data on teaching loads we could find: the student-staff ratios from 1993-1999 available on the web site of the Department of Education, Science and Training (DEST). Unfortunately, they apply to ‘Administration, Business, Economics and Law’, a level beyond the ‘department’. Nevertheless, we repeated our analysis with the departmental dummies replaced by the DEST student-staff ratios averaged over the years 1996-1999 and the number of academic staff in each department averaged over the period 1996-2000. These two variables are given in Columns 2 and 3 of Table 7. Maximum likelihood estimates of the parameters in the Tobit model and their P-values are listed in Columns 4 and 5 (based on Q1-pages) and in Columns 6 and 7 (based on Q2-pages).

The results in Table 7 provide no evidence that department size affects research productivity. Nor is there evidence of a negative relationship between research productivity and the student-staff ratio. The most research productive departments are both large (Melbourne) and small (Tasmania). They also have high (Melbourne), medium (the ANU) and low (NSW) student-staff ratios. These results could change if student-staff ratios were to be measured at the level of the individual, because teaching loads often vary substantially within departments and, not infrequently, for individuals through time. The larger human-capital coefficients in the Tobit model reported in Table 7, compared with those in Table 4, indicate that the fixed-effects model has reduced upwards bias in the effects of human capital on research productivity.

We conjecture that the department-specific effects reported in Table 6 at least partially reflect heterogeneity among departments in institutional conditions that are confronted by all academic staff in a given department and that contribute to the environment in which (to paraphrase Harris, 1990a, p.81) the desire to do research does, or does not, flourish. The department-specific effects provide information on the extent to which an institution (to paraphrase Pomfret and Wang, 2003, p.439-440) values research output, provides working conditions conducive to undertaking research and uses incentives and sanctions to encourage publishable research.

Our results do not identify what makes certain departments more (or less) conducive to research. Unearthing the underlying cause(s) would require research beyond the scope of this paper but a possible line of investigation could be based on Manski's (2000) hypotheses as to why individuals belonging to the same group tend to display similar behaviour. One hypothesis is that academics in the same department face similar working conditions, university regulations, incentives and sanctions, student expectations, *etc*., that are exogenous to the department. A second hypothesis is that an academic's research productivity affects, and is affected by, the productivity of his or her departmental colleagues via collaboration, academic discourse, peer expectations, peer pressure, *etc*.. A third possibility is that an individual's productivity is affected by certain exogenous attributes of his or her colleagues – attributes such as ability, integrity, professionalism, *etc*.. The idea here is that the individual will have more time and energy for research in a department where his or her colleagues do their jobs well.[7] The three hypotheses have quite different implications for the type of policies that would improve research productivity. Unfortunately, as Manski (2000, p.128) himself concedes, distinguishing between them is extremely difficult given the available data.

## *VI Conclusions*

Our study was based on the proposition that the research productivity of an economics department depends upon the ability of its members to produce

[7] These are our interpretations of Manski's 'correlated effects', 'endogenous interactions' and 'contextual interactions', respectively, as applied to this paper.

publishable research, which is related to the quantity and quality of their academic training, and upon certain unobserved department-specific effects that characterise the environment in which an academic works.

We used a fixed-effects Tobit model to estimate the human-capital and department-specific effects on the research productivity of academics in 29 Australian economics departments. Both effects were found to be important. The most research-productive individuals were those with PhDs from the top graduate schools world-wide and recent graduates from these institutions tended to be more productive than mature graduates. The human-capital effects undoubtedly reflect more than just the knowledge gained from acquiring a PhD from a given institution: graduates from the top graduate schools are also likely to have high levels of innate ability and motivation to do research. The most research-productive departments also had large department-specific effects and there is evidence that their staff would have been less productive had they been employed in an economics department at another Australian university. Our analysis does not identify what it is about these departments that make them more (or less) conducive to research; conceivably, different conditions could lead to similar outcomes in different departments. We could find no evidence that department size or student-staff ratios are contributing factors, although our data on the latter were likely at too aggregated a level to provide a definitive result. This important topic requires further research.

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Table 1: Academic units included in the study

| University | Name of the academic unit | Years | No. of staff present in 1996 | 1997 | 1998 | 1999 | 2000 | No. of staff present during at least one year in 1996-2000 |
|---|---|---|---|---|---|---|---|---|
| Adelaide | School of Economics | 1996-2000 | 20 | 20 | 21 | 21 | 21 | 28 |
| ADFA | School of Economics & Management | 1996-2000 | 16 | 14 | 14 | 15 | 15 | 23 |
| ANU | Departments of Economics, Economic History & Statistics[1]<br>Departments of Economics, Economic History, and Statistics[1] & Econometrics | 1996<br>1997-2000 | 26 | 27 | 28 | 27 | 25 | 31 |
| Canberra | School of Economics, Banking & Marketing[2]<br>School of Economics & Marketing[2] | 1996<br>1997-2000 | 11 | 12 | 14 | 12 | 10 | 14 |
| Curtin | Department of Economics | 1996-2000 | 14 | 15 | 15 | 15 | 14 | 16 |
| Deakin | School of Economics | 1996-2000 | 17 | 17 | 19 | 16 | 17 | 22 |
| Edith Cowan | School of Finance & Business Economics | 1996-2000 | 19 | 20 | 19 | 19 | 18 | 25 |
| Flinders | School of Economics | 1996-2000 | 14 | 12 | 14 | 14 | 13 | 19 |
| Griffith | School of Economics (Check 1996, 1997) | 1996-2000 | 9 | 9 | 9 | 10 | 10 | 10 |
| James Cook | Department of Economics<br>School of Economics, Commerce & Administration[2] | 1996-1997<br>1998-2000 | 8 | 7 | 8 | 6 | 3 | 10 |
| LaTrobe | School of Economics<br>Department of Economics & Finance | 1996-1997<br>1998-2000 | 26 | 28 | 29 | 26 | 22 | 41 |
| Macquarie | Department of Economics | 1996-2000 | 26 | 22 | 23 | 20 | 19 | 26 |
| Melbourne | Department of Economics | 1996-2000 | 32 | 39 | 39 | 42 | 35 | 50 |
| Monash | Departments of Economics, Econometrics & Business Statistics | 1996-2000 | 52 | 53 | 53 | 52 | 53 | 77 |
| Murdoch | Department of Economics | 1996-2000 | 13 | 13 | 12 | 11 | 11 | 14 |
| Newcastle | School of Economics | 1996-2000 | 25 | 16 | 14 | 13 | 14 | 28 |
| New England | Schools of Economics, Economic History & Econometrics<br>School of Economic Studies | 1996-1998<br>1999-2000 | 35 | 35 | 34 | 32 | 32 | 39 |
| NSW | Departments of Economics, Economic History & Econometrics<br>School of Economics | 1996-1997<br>1998-2000 | 43 | 40 | 40 | 41 | 40 | 49 |

Table 1 (continued) Academic units included in the study

| University | Name of the academic unit | Years | No. of staff present in 1996 | 1997 | 1998 | 1999 | 2000 | No. of staff present during at least one year in 1996-2000 |
|---|---|---|---|---|---|---|---|---|
| Queensland | School of Economics | 1996-2000 | 26 | 28 | 28 | 33 | 33 | 35 |
| QUT | School of Economics & Finance | 1996-2000 | 21 | 22 | 20 | 18 | 18 | 32 |
| RMIT | School of Economics & Finance | 1996-2000 | 27 | 32 | 33 | 34 | 37 | 45 |
| Southern Queensland | Faculty of Business & Faculty of Commerce[2]<br>School of Economics & Resource Management[2] | 1996-1998<br>1999-2000 | 4 | 4 | 5 | 5 | 5 | 5 |
| Sydney | Departments of Economics, Economic History & Econometrics<br>School of Economics & Political Science[3] | 1996-1999<br>2000 | 43 | 44 | 43 | 42 | 45 | 53 |
| Tasmania | Department of Economics<br>School of Economics | 1996-1997<br>1998-2000 | 13 | 10 | 9 | 8 | 8 | 13 |
| UTS | School of Finance & Economics | 1996-2000 | 25 | 26 | 27 | 29 | 34 | 40 |
| VUT | School of Applied Economics | 1996-2000 | 46 | 37 | 36 | 37 | 38 | 53 |
| Western Australia | Department of Economics | 1996-2000 | 12 | 15 | 15 | 15 | 16 | 17 |
| Western Sydney | Faculty of Business & Technology[2]<br>Faculty of Business[2] | 1996-1998<br>1999-2000 | 27 | 26 | 28 | 29 | 31 | 33 |
| Wollongong | Economics Department | 1996-2000 | 23 | 23 | 24 | 23 | 21 | 25 |

*Source:* University Handbooks, Annual Reports and Calendars, Commonwealth Universities Yearbooks, private correspondence with individuals from Universities of Adelaide, Canberra, Newcastle, RMIT, Southern Queensland and Western Sydney.

*Notes:*
1. Grant Fleming, Michael Martin, Don Nicholls, Terry O'Neill, David Service and Steve Stern were in one of the three departments sometime between 1996 and 2000 but were excluded from the study because they later moved to the School of Finance and Applied Statistics. Pierre van der Eng was excluded because he later moved to the School of Business and Information Management.
2. Only those academics identified as economists were included in the study.
3. Excluding those in the Discipline of Government & International Relations.

Table 2: Descriptive Statistics: Research Productivity[1], 1998-2002

| Q1-pages per staff per year[2] | | | | Q2-pages per staff per year[3] | | | |
|---|---|---|---|---|---|---|---|
| Economics department (1) | Output per staff per year (2) | Proportion of staff with output >0 (3) | Productivity given positive output (4) | Economics department (5) | Output per staff per year (6) | Proportion of staff with output >0 (7) | Productivity given positive output (8) |
| ANU | 0.66 | 0.83 | 0.80 | Melbourne | 2.77 | 0.87 | 3.18 |
| Western Aust | 0.66 | 0.58 | 1.14 | Tasmania | 2.18 | 0.81 | 2.69 |
| James Cook | 0.50 | 0.19 | 2.68 | Western Aust | 2.15 | 0.70 | 3.08 |
| Melbourne | 0.40 | 0.72 | 0.55 | James Cook | 1.86 | 0.34 | 5.40 |
| NSW | 0.38 | 0.55 | 0.69 | ANU | 1.73 | 0.86 | 2.01 |
| Adelaide | 0.20 | 0.50 | 0.40 | NSW | 1.55 | 0.69 | 2.24 |
| Monash | 0.19 | 0.40 | 0.48 | Adelaide | 1.33 | 0.65 | 2.05 |
| Tasmania | 0.17 | 0.69 | 0.24 | La Trobe | 1.18 | 0.68 | 1.74 |
| La Trobe | 0.15 | 0.58 | 0.25 | Queensland | 0.83 | 0.77 | 1.07 |
| Flinders | 0.08 | 0.30 | 0.26 | Curtin | 0.80 | 0.82 | 0.97 |
| Deakin | 0.08 | 0.43 | 0.18 | Deakin | 0.75 | 0.59 | 1.27 |
| Curtin | 0.07 | 0.54 | 0.14 | Monash | 0.73 | 0.54 | 1.34 |
| New England | 0.05 | 0.62 | 0.08 | Murdoch | 0.72 | 0.55 | 1.31 |
| Sydney | 0.04 | 0.32 | 0.13 | Flinders | 0.72 | 0.30 | 2.37 |
| Queensland | 0.03 | 0.39 | 0.08 | Sydney | 0.52 | 0.66 | 0.80 |
| UTS | 0.03 | 0.13 | 0.22 | New England | 0.44 | 0.86 | 0.50 |
| West Sydney | 0.02 | 0.29 | 0.08 | West Sydney | 0.34 | 0.53 | 0.64 |
| QUT | 0.01 | 0.13 | 0.10 | RMIT | 0.32 | 0.30 | 1.08 |
| ADFA | 0.01 | 0.28 | 0.05 | Wollongong | 0.32 | 0.61 | 0.53 |
| Macquarie | 0.01 | 0.14 | 0.07 | Macquarie | 0.29 | 0.41 | 0.72 |
| Wollongong | 0.01 | 0.15 | 0.06 | QUT | 0.28 | 0.35 | 0.78 |
| Murdoch | 0.01 | 0.25 | 0.03 | Newcastle | 0.21 | 0.59 | 0.35 |
| Griffith | 0.01 | 0.21 | 0.03 | UTS | 0.20 | 0.49 | 0.40 |
| VUT | 0.01 | 0.12 | 0.05 | ADFA | 0.18 | 0.35 | 0.52 |
| RMIT | 0.01 | 0.19 | 0.03 | Griffith | 0.18 | 0.64 | 0.28 |
| Newcastle | 0.01 | 0.13 | 0.04 | VUT | 0.11 | 0.28 | 0.38 |
| Edith Cowan | 0.00 | 0.07 | 0.03 | Edith Cowan | 0.08 | 0.13 | 0.64 |
| Southern Qld | 0.00 | 0.13 | 0.00 | Canberra | 0.05 | 0.25 | 0.19 |
| Canberra | 0.00 | 0.17 | 0.00 | Southern Qld | 0.01 | 0.13 | 0.06 |
| All Depts | 0.14 | 0.37 | 0.37 | All Depts | 0.81 | 0.57 | 1.41 |

[1] A department's productivity is calculated as a weighted average of the productivities of its academic staff, the weights being the number of years out of five (1996-2000) that the individual was present in the department.

[2] Research output consists of AER-standard-size pages published in journals included in EconLit and adjusted for quality using the weights of Kalaitzidakis, *et al.* (2003).

[3] Research output consists of AER-standard-size pages published in journals included in EconLit and adjusted for quality using the weights of Gibson (2000).

Table 3: Descriptive Statistics: Human Capital and Gender, 1996-2000

| Economics department | Proportion of staff with a PhD from: top 50 uni, <5 yrs ago | top 50 uni, 5 to 15 yrs ago | top 50 uni, >15 yrs ago | 51-150 uni, <5 yrs ago | 51-150 uni, 5 to 15 yrs ago | 51-150 uni, >15 yrs ago | other uni, <5 yrs ago | other uni, 5 to 15 yrs ago | other uni, >15 yrs ago | Proportion of staff without a PhD | Proportion of staff who are female |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| Adelaide | 0.13 | 0.04 | 0.19 | 0.10 | 0.00 | 0.18 | 0.04 | 0.02 | 0.10 | 0.20 | 0.26 |
| ADFA | 0.00 | 0.00 | 0.12 | 0.00 | 0.08 | 0.20 | 0.03 | 0.00 | 0.26 | 0.31 | 0.14 |
| ANU | 0.02 | 0.26 | 0.11 | 0.01 | 0.11 | 0.15 | 0.02 | 0.05 | 0.08 | 0.20 | 0.00 |
| Canberra | 0.00 | 0.00 | 0.08 | 0.00 | 0.19 | 0.00 | 0.00 | 0.08 | 0.00 | 0.64 | 0.47 |
| Curtin | 0.00 | 0.00 | 0.06 | 0.00 | 0.14 | 0.07 | 0.00 | 0.42 | 0.00 | 0.31 | 0.20 |
| Deakin | 0.00 | 0.06 | 0.04 | 0.05 | 0.00 | 0.00 | 0.10 | 0.10 | 0.06 | 0.60 | 0.33 |
| Edith Cowan | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.05 | 0.05 | 0.00 | 0.07 | 0.80 | 0.18 |
| Flinders | 0.00 | 0.00 | 0.15 | 0.05 | 0.00 | 0.08 | 0.05 | 0.12 | 0.05 | 0.52 | 0.02 |
| Griffith | 0.00 | 0.00 | 0.11 | 0.00 | 0.00 | 0.21 | 0.00 | 0.21 | 0.11 | 0.36 | 0.36 |
| James Cook | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 | 0.16 | 0.06 | 0.13 | 0.34 | 0.22 | 0.06 |
| La Trobe | 0.08 | 0.10 | 0.10 | 0.04 | 0.05 | 0.08 | 0.10 | 0.11 | 0.11 | 0.24 | 0.14 |
| Macquarie | 0.00 | 0.10 | 0.19 | 0.00 | 0.05 | 0.09 | 0.00 | 0.09 | 0.07 | 0.40 | 0.19 |
| Melbourne | 0.16 | 0.12 | 0.19 | 0.01 | 0.02 | 0.08 | 0.07 | 0.13 | 0.07 | 0.14 | 0.22 |
| Monash | 0.05 | 0.05 | 0.14 | 0.02 | 0.05 | 0.04 | 0.11 | 0.07 | 0.19 | 0.30 | 0.25 |
| Murdoch | 0.00 | 0.00 | 0.05 | 0.00 | 0.00 | 0.17 | 0.08 | 0.47 | 0.08 | 0.15 | 0.08 |
| Newcastle | 0.00 | 0.01 | 0.07 | 0.00 | 0.01 | 0.06 | 0.12 | 0.16 | 0.16 | 0.40 | 0.13 |
| New England | 0.01 | 0.08 | 0.10 | 0.02 | 0.01 | 0.18 | 0.03 | 0.21 | 0.18 | 0.18 | 0.07 |
| NSW | 0.12 | 0.11 | 0.12 | 0.04 | 0.05 | 0.26 | 0.00 | 0.02 | 0.10 | 0.17 | 0.12 |
| Queensland | 0.00 | 0.00 | 0.10 | 0.07 | 0.03 | 0.07 | 0.07 | 0.20 | 0.30 | 0.16 | 0.03 |
| QUT | 0.00 | 0.03 | 0.00 | 0.00 | 0.05 | 0.00 | 0.07 | 0.13 | 0.05 | 0.67 | 0.15 |
| RMIT | 0.00 | 0.03 | 0.00 | 0.00 | 0.06 | 0.00 | 0.06 | 0.08 | 0.00 | 0.77 | 0.33 |
| Southern Qld | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.22 | 0.13 | 0.65 | 0.00 |
| Sydney | 0.01 | 0.12 | 0.23 | 0.01 | 0.09 | 0.10 | 0.03 | 0.11 | 0.16 | 0.13 | 0.19 |
| Tasmania | 0.00 | 0.13 | 0.15 | 0.10 | 0.21 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.15 |
| UTS | 0.01 | 0.01 | 0.04 | 0.00 | 0.10 | 0.11 | 0.01 | 0.01 | 0.11 | 0.62 | 0.16 |
| VUT | 0.01 | 0.03 | 0.00 | 0.00 | 0.05 | 0.05 | 0.01 | 0.17 | 0.03 | 0.66 | 0.17 |
| Western Aust | 0.00 | 0.07 | 0.33 | 0.05 | 0.05 | 0.07 | 0.00 | 0.12 | 0.14 | 0.16 | 0.12 |
| West Sydney | 0.00 | 0.00 | 0.04 | 0.04 | 0.01 | 0.06 | 0.05 | 0.05 | 0.21 | 0.55 | 0.15 |
| Wollongong | 0.00 | 0.09 | 0.04 | 0.00 | 0.16 | 0.00 | 0.04 | 0.13 | 0.25 | 0.29 | 0.22 |
| All Depts | 0.03 | 0.06 | 0.10 | 0.02 | 0.05 | 0.09 | 0.05 | 0.11 | 0.12 | 0.36 | 0.17 |

In computing each proportion, the 0-1 observations were weighted by the number of years out of five (1996-2000) that the individual was present in the department.

Table 4: Tobit Estimation of Research Productivity

| | Q1-pages per staff per year | | Q2-pages per staff per year | |
|---|---|---|---|---|
| Dummy Variable (1) | Coeff (2) | P-value (3) | Coeff (4) | P-value (5) |
| Adelaide | -0.55 | 0.006 | -0.38 | 0.460 |
| ADFA | -0.85 | 0.000 | -1.74 | 0.000 |
| ANU | 0.16 | 0.459 | 0.53 | 0.207 |
| Canberra | -1.04 | 0.152 | -2.10 | 0.002 |
| Curtin | -0.55 | 0.012 | -0.08 | 0.865 |
| Deakin | -0.63 | 0.000 | -0.39 | 0.420 |
| Edith Cowan | -1.38 | 0.261 | -2.71 | 0.256 |
| Flinders | -0.75 | 0.009 | -1.20 | 0.166 |
| Griffith | -0.93 | 0.524 | -0.82 | 0.139 |
| James Cook | -0.29 | 0.855 | 0.33 | 0.857 |
| La Trobe | -0.54 | 0.002 | -0.34 | 0.508 |
| Macquarie | -1.29 | 0.022 | -1.48 | 0.002 |
| Melbourne | -0.21 | 0.210 | 1.34 | 0.031 |
| Monash | -0.56 | 0.001 | -0.85 | 0.011 |
| Murdoch | -1.10 | 0.098 | -0.81 | 0.189 |
| Newcastle | -1.24 | 0.205 | -1.17 | 0.001 |
| New England | -0.53 | 0.001 | -0.55 | 0.046 |
| NSW | -0.31 | 0.047 | -0.10 | 0.781 |
| Queensland | -0.82 | 0.000 | -0.32 | 0.411 |
| QUT | -1.19 | 0.071 | -1.46 | 0.016 |
| RMIT | -1.01 | 0.000 | -1.47 | 0.001 |
| Southern Qld | -1.22 | 0.528 | -3.17 | 0.524 |
| Sydney | -0.96 | 0.000 | -0.90 | 0.012 |
| Tasmania | -0.49 | 0.073 | 0.87 | 0.262 |
| UTS | -1.16 | 0.000 | -1.18 | 0.000 |
| VUT | -1.26 | 0.000 | -2.10 | 0.000 |
| Western Aust | 0.10 | 0.786 | 0.94 | 0.239 |
| Western Sydney | -0.85 | 0.000 | -0.96 | 0.011 |
| Wollongong | -1.28 | 0.283 | -1.05 | 0.009 |
| PhD from | | | | |
| top 50 uni, <5 yrs ago | 1.10 | 0.000 | 4.22 | 0.000 |
| top 50 uni, 5 to 15 yrs ago | 0.83 | 0.000 | 2.02 | 0.000 |
| top 50 uni, >15 yrs ago | 0.36 | 0.018 | 0.84 | 0.004 |
| 51-150 uni, <5 yrs ago | 1.06 | 0.002 | 2.94 | 0.000 |
| 51-150 uni, 5 to 15 yrs ago | 0.61 | 0.008 | 1.21 | 0.001 |
| 51-150 uni, >15 yrs ago | 0.06 | 0.696 | 0.45 | 0.231 |
| other uni, <5 yrs ago | 0.50 | 0.002 | 1.15 | 0.002 |
| other uni, 5 to 15 yrs ago | 0.46 | 0.001 | 1.06 | 0.002 |
| other uni, >15 yrs ago | 0.22 | 0.058 | 0.56 | 0.042 |
| Female | -0.24 | 0.019 | -0.62 | 0.009 |
| Estimate of sigma | 0.82 | | 2.17 | |
| Log-likelihood | -597.56 | | -1301.84 | |
| Correlation coefficient | 0.41 | | 0.48 | |
| Proportion uncensored | 0.37 | | 0.57 | |
| No. of observations | 873 | | 873 | |

P-values were bootstrapped using LIMDEP and apply to two-sided hypotheses.

Table 5: Human-Capital Effects

| Q1-pages per staff per year | | | | Q2-pages per staff per year | | | |
|---|---|---|---|---|---|---|---|
| Economics department | Predicted Productivity | Productivity given no PhD | Human-capital effect | Economics department | Predicted Productivity | Productivity given no PhD | Human-capital effect |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| ANU | 0.74 | 0.41 | 0.32 | Melbourne | 2.99 | 1.59 | 1.40 |
| Melbourne | 0.51 | 0.21 | 0.30 | ANU | 2.01 | 1.15 | 0.85 |
| Western Aust | 0.58 | 0.36 | 0.22 | NSW | 1.62 | 0.78 | 0.84 |
| NSW | 0.40 | 0.18 | 0.21 | Tasmania | 2.14 | 1.31 | 0.82 |
| Tasmania | 0.32 | 0.13 | 0.18 | Adelaide | 1.39 | 0.61 | 0.78 |
| Adelaide | 0.27 | 0.11 | 0.17 | La Trobe | 1.36 | 0.68 | 0.69 |
| La Trobe | 0.28 | 0.12 | 0.16 | Western Aust | 1.99 | 1.37 | 0.62 |
| New England | 0.25 | 0.12 | 0.12 | Queensland | 1.24 | 0.70 | 0.53 |
| Monash | 0.23 | 0.11 | 0.12 | NewEngland | 1.06 | 0.60 | 0.46 |
| James Cook | 0.31 | 0.19 | 0.11 | Sydney | 0.91 | 0.45 | 0.45 |
| Queensland | 0.16 | 0.07 | 0.10 | Monash | 0.90 | 0.46 | 0.44 |
| Deakin | 0.18 | 0.09 | 0.09 | James Cook | 1.39 | 1.01 | 0.39 |
| Curtin | 0.21 | 0.11 | 0.09 | Deakin | 0.98 | 0.61 | 0.37 |
| Flinders | 0.16 | 0.08 | 0.08 | Curtin | 1.13 | 0.78 | 0.35 |
| Sydney | 0.12 | 0.04 | 0.08 | Murdoch | 0.80 | 0.49 | 0.30 |
| West Sydney | 0.10 | 0.06 | 0.04 | Flinders | 0.68 | 0.38 | 0.30 |
| Murdoch | 0.07 | 0.03 | 0.04 | Wollongong | 0.70 | 0.40 | 0.30 |
| Wollongong | 0.05 | 0.02 | 0.03 | Newcastle | 0.59 | 0.38 | 0.22 |
| ADFA | 0.09 | 0.06 | 0.03 | Macquarie | 0.49 | 0.29 | 0.20 |
| Canberra | 0.06 | 0.03 | 0.03 | UTS | 0.57 | 0.37 | 0.20 |
| Griffith | 0.07 | 0.04 | 0.03 | West Sydney | 0.64 | 0.45 | 0.20 |
| Newcastle | 0.05 | 0.02 | 0.03 | Griffith | 0.62 | 0.44 | 0.18 |
| UTS | 0.05 | 0.03 | 0.03 | QUT | 0.43 | 0.30 | 0.13 |
| Macquarie | 0.04 | 0.02 | 0.02 | ADFA | 0.35 | 0.24 | 0.11 |
| QUT | 0.05 | 0.02 | 0.02 | VUT | 0.27 | 0.17 | 0.10 |
| RMIT | 0.05 | 0.04 | 0.02 | Canberra | 0.24 | 0.15 | 0.09 |
| VUT | 0.04 | 0.02 | 0.02 | RMIT | 0.36 | 0.28 | 0.08 |
| Southern Qld | 0.04 | 0.02 | 0.01 | Southern Qld | 0.10 | 0.07 | 0.03 |
| Edith Cowan | 0.02 | 0.01 | 0.00 | Edith Cowan | 0.12 | 0.10 | 0.03 |
| All Depts | 0.20 | 0.10 | 0.10 | All Depts | 1.01 | 0.57 | 0.44 |

Table 6: Department-Specific Effects

| Q1-pages per staff per year | | | | Q2-pages per staff per year | | | |
|---|---|---|---|---|---|---|---|
| Economics department (1) | Predicted Productivity (2) | Counter-factual productivity (3) | Depart-ment effect (4) | Economics department (5) | Predicted Productivity (6) | Counter-factual productivity (7) | Depart-ment effect (8) |
| ANU | 0.74 | 0.23 | 0.51 | Melbourne | 2.99 | 1.44 | 1.55 |
| Western Aust | 0.58 | 0.18 | 0.41 | Tasmania | 2.14 | 1.07 | 1.06 |
| Melbourne | 0.51 | 0.26 | 0.26 | Western Aust | 1.99 | 0.93 | 1.06 |
| NSW | 0.40 | 0.23 | 0.17 | ANU | 2.01 | 1.18 | 0.82 |
| James Cook | 0.31 | 0.16 | 0.15 | James Cook | 1.39 | 0.84 | 0.56 |
| Tasmania | 0.32 | 0.23 | 0.09 | NSW | 1.62 | 1.28 | 0.35 |
| La Trobe | 0.28 | 0.22 | 0.06 | Curtin | 1.13 | 0.83 | 0.29 |
| New England | 0.25 | 0.19 | 0.06 | La Trobe | 1.36 | 1.17 | 0.19 |
| Adelaide | 0.27 | 0.22 | 0.05 | Queensland | 1.24 | 1.05 | 0.19 |
| Monash | 0.23 | 0.19 | 0.04 | Adelaide | 1.39 | 1.22 | 0.16 |
| Curtin | 0.21 | 0.17 | 0.04 | Deakin | 0.98 | 0.87 | 0.11 |
| Deakin | 0.18 | 0.17 | 0.01 | NewEngland | 1.06 | 1.01 | 0.05 |
| Flinders | 0.16 | 0.18 | -0.02 | Murdoch | 0.80 | 0.89 | -0.09 |
| West Sydney | 0.10 | 0.15 | -0.05 | Griffith | 0.62 | 0.72 | -0.10 |
| ADFA | 0.09 | 0.14 | -0.05 | Monash | 0.90 | 1.01 | -0.11 |
| Queensland | 0.16 | 0.21 | -0.05 | Sydney | 0.91 | 1.05 | -0.14 |
| Griffith | 0.07 | 0.13 | -0.06 | West Sydney | 0.64 | 0.80 | -0.16 |
| RMIT | 0.05 | 0.12 | -0.07 | Wollongong | 0.70 | 0.91 | -0.21 |
| Canberra | 0.06 | 0.14 | -0.08 | UTS | 0.57 | 0.80 | -0.24 |
| Sydney | 0.12 | 0.21 | -0.09 | Newcastle | 0.59 | 0.84 | -0.24 |
| UTS | 0.05 | 0.15 | -0.10 | Flinders | 0.68 | 0.95 | -0.27 |
| Edith Cowan | 0.02 | 0.12 | -0.10 | RMIT | 0.36 | 0.66 | -0.31 |
| VUT | 0.04 | 0.14 | -0.10 | QUT | 0.43 | 0.76 | -0.33 |
| QUT | 0.05 | 0.15 | -0.10 | Macquarie | 0.49 | 0.86 | -0.36 |
| Southern Qld | 0.04 | 0.14 | -0.10 | ADFA | 0.35 | 0.76 | -0.41 |
| Murdoch | 0.07 | 0.17 | -0.10 | Canberra | 0.24 | 0.71 | -0.47 |
| Newcastle | 0.05 | 0.16 | -0.12 | VUT | 0.27 | 0.75 | -0.48 |
| Macquarie | 0.04 | 0.17 | -0.12 | Edith Cowan | 0.12 | 0.66 | -0.54 |
| Wollongong | 0.05 | 0.19 | -0.14 | Southern Qld | 0.10 | 0.77 | -0.67 |
| All Depts | 0.20 | 0.18 | 0.02 | All Depts | 1.01 | 0.96 | 0.05 |

Table 7: Student-Staff Ratios and Department Size

| Variable | Student-staff ratio | Mean no. of staff in dept, 1996-2000 | Q1-pages per staff per year | | Q2-pages per staff per year | |
|---|---|---|---|---|---|---|
| | | | Coeff | P-value | Coeff | P-value |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Adelaide | 22.50 | 20.6 | | | | |
| ADFA | 10.25 | 14.8 | | | | |
| ANU | 22.50 | 26.6 | | | | |
| Canberra | 23.33 | 11.8 | | | | |
| Curtin | 28.00 | 14.6 | | | | |
| Deakin | 30.75 | 17.2 | | | | |
| Edith Cowan | 22.25 | 19.0 | | | | |
| Flinders | 21.25 | 13.2 | | | | |
| Griffith | 25.25 | 9.4 | | | | |
| James Cook | 26.25 | 6.4 | | | | |
| La Trobe | 22.75 | 26.2 | | | | |
| Macquarie | 25.50 | 22.0 | | | | |
| Melbourne | 27.00 | 37.4 | | | | |
| Monash | 24.00 | 52.6 | | | | |
| Murdoch | 22.00 | 12.0 | | | | |
| Newcastle | 24.25 | 16.4 | | | | |
| New England | 27.50 | 33.6 | | | | |
| NSW | 18.75 | 40.8 | | | | |
| Queensland | 23.25 | 29.6 | | | | |
| QUT | 27.00 | 19.8 | | | | |
| RMIT | 23.25 | 32.6 | | | | |
| Southern Qld | 25.75 | 4.6 | | | | |
| Sydney | 21.25 | 43.4 | | | | |
| Tasmania | 24.75 | 9.6 | | | | |
| UTS | 25.00 | 28.2 | | | | |
| VUT | 20.75 | 38.8 | | | | |
| Western Aust | 22.00 | 14.6 | | | | |
| Western Sydney | 24.50 | 28.2 | | | | |
| Wollongong | 23.25 | 22.8 | | | | |
| Constant | | | -1.27 | 0.000 | -3.17 | 0.000 |
| Student-staff ratio | | | 0.01 | 0.252 | 0.08 | 0.002 |
| Mean dept size, 1996-2000 | | | 0.00 | 0.354 | 0.00 | 0.655 |
| PhD from | | | | | | |
| top 50 uni, <5 yrs ago | | | 1.58 | 0.000 | 5.48 | 0.000 |
| top 50 uni, 5 to 15 yrs ago | | | 1.21 | 0.000 | 2.92 | 0.000 |
| top 50 uni, >15 yrs ago | | | 0.66 | 0.000 | 1.60 | 0.000 |
| 51-150 uni, <5 yrs ago | | | 1.39 | 0.000 | 3.84 | 0.000 |
| 51-150 uni, 5 to 15 yrs ago | | | 0.75 | 0.001 | 1.64 | 0.000 |
| 51-150 uni, >15 yrs ago | | | 0.38 | 0.007 | 1.14 | 0.000 |
| other uni, <5 yrs ago | | | 0.61 | 0.000 | 1.50 | 0.000 |
| other uni, 5 to 15 yrs ago | | | 0.56 | 0.000 | 1.47 | 0.000 |
| other uni, >15 yrs ago | | | 0.35 | 0.003 | 1.00 | 0.000 |
| Female | | | -0.28 | 0.010 | -0.69 | 0.003 |
| Estimate of sigma | | | 0.89 | | 2.31 | |
| Log-likelihood | | | -655.78 | | -1350.21 | |
| Correlation coefficient | | | 0.31 | | 0.42 | |

P-values were bootstrapped using LIMDEP and apply to two-sided hypotheses.