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The Assessment of Research Quality: Peer Review or Metrics?

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Abstract

This paper investigates the extent to which the outcomes of the 2008 Research Assessment Exercise, determined by peer review, can be explained by a set of quantitative indicators, some of which were made available to the review panels. Three cognate units of assessment are examined in detail: business & management, economics & econometrics, and accounting & finance. The paper focuses on the extent to which the quality of research output, as determined by the RAE panel, can be explained by the journal quality indicator published by the Association of Business Schools. The main finding is that although a high proportion of the variation between universities in their RAE outcomes can be explained by quantitative indicators, there is insufficient evidence to support the claim by the ABS that its Journal Quality Guide is a sufficiently accurate predictor of research quality to justify a predominant role in the research assessment process. A further finding is that there appears to be an element of bias in the decisions reached by the business & management panel and by the economics & econometrics panel.

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The Assessment of Research Quality: Peer Review or Metrics?

1. Introduction

There has been intense debate for over two decades about how best to measure research quality in UK universities. The significance of this debate is heightened by the fact that the allocation of research funds by the UK's higher education funding bodies is based upon the outcome of intermittent Research Assessment Exercises (RAE). This process, which has been in operation since 1989, is based upon judgments made by an appointed panel of experts in each major subject area.[2] The role of the panel in each designated subject area is to assess selected publications of those academic staff in all UK universities whose research has been submitted for assessment.[3] Peer assessment has come under fire, however, for being too costly in terms of time and resources. An inter-departmental discussion paper led by the UK Treasury, for example, highlighted the high costs of the RAE process imposed on universities and has asserted the need for a more efficient system to be introduced (HM Treasury 2006a).[4]

Although the merits or otherwise of the peer review system have been extensively discussed within the academic community for as long as the RAE has existed, it was not until the intervention of the Science and Technology Committee of the House of Commons that the funding bodies were forced to seriously consider greater reliance on 'metrics'. The Science and Technology Committee not only accused the funding councils of shying away from radical change in its assessment of research quality, but also came down heavily in favour of using metrics to support, *or even replace*, the peer review process (HC 2004a: p.3). It subsequently advocated "a more radical approach, employing a range of metrics to reduce the bureaucratic burden on universities" (HC 2004b: p.5). It was this recommendation by the Science and Technology Committee that captured the imagination of the Government, which subsequently asserted its preference for a metrics-based system of assessment in future appraisals of research by the funding councils (HM Treasury 2006a).

One of the principles of the funding mechanism enunciated by the Government was that the assessment and allocation processes "should be simple and cost-effective" (HM Treasury 2006a: p.31). In considering the cost-cutting options available for reducing the need for a peer review process,

[2] The five RAEs were in 1989, 1992, 1996, 2001 and 2008. A pilot exercise was also undertaken in 1986 by the then University Grants Commission (replaced by the Universities Funding Council in 1988, which in turn was replaced by the Higher Education Funding Council in 1992).

[3] The 2008 RAE subdivided disciplines into 15 main panels and 67 sub-panels. The three sub-panels which are the focus of this paper are business & management, economics & econometrics, and accounting & finance. These sub-panels had 18, 13 and 11 members respectively, 38 of whom were drawn from UK universities, with 4 from public bodies.

[4] The total cost of the 2008 RAE, was expected to be at least £45 million (HM Treasury 2006a: p.30). For the 2001 RAE, the total costs were estimated at just over 1% of HEFCE's total research budget (House of Commons 2004b: p.27).

the Government's clear preference has been for identifying one or more metrics that could be used to assess research quality. It goes further by identifying research income, citations of publications and research student numbers as examples of what might be appropriate metrics. Indeed, the report states that "the close correlation between Research Council income and QR income [i.e. block grants from the funding councils] may provide an opportunity for allocating QR using a radically simpler system" (p.31).The report concludes that "...after 20 years of relying on the RAE to allocate these [QR] funds the Government thinks there is now sufficient evidence to support moving towards a simpler and less burdensome system of allocation" based on quantitative data (HM Treasury 2006a: p.33). The Government's position was made clear: it stated that after the 2008 RAE, "the system for assessing research quality and allocating QR funding will be mainly metrics-based" (HM Treasury 2006a: p.30). On consulting with the higher education sector, however, the Government recognized that the appropriateness of metrics for measuring research assessment differed across disciplines. A bibliometric index to assess research was deemed to be appropriate for science, engineering and technology, but for other disciplines "a significantly reduced, light-touch peer review process informed by a range of discipline-specific indicators" should be adopted (HM Treasury 2006b: p.57).

The funding bodies themselves had, in the meantime, been proactive in investigating the potential value of using metrics more directly. Following the 2001 RAE, the Higher Education Funding Council for England (HEFCE) commissioned a review of the RAE process. The Roberts Report (2003) considered whether there was scope for assessing research performance based on metrics, such as research income, research students and bibliometric data, as an alternative to the complex and labour-intensive peer review process. Replacing the peer review process with one based upon metrics was firmly rejected by Roberts, who came to the conclusion that "the only system which will enjoy both the confidence and the consent of the academic community is one based ultimately upon expert review" (Roberts 2003: p.7). This was qualified, however, in the very first recommendation of the Roberts Report, which proposed that: "Any system of research assessment designed to identify the best research must be based upon the judgement of experts, who may, if they choose, employ performance indicators to inform their judgement" (Roberts 2003: p.7). This view is generally supported by the academic community, which has expressed a preference that metrics should play a greater role in supporting, but not replacing, the work of expert reviewers (Roberts 2003: p.82). The funding bodies' response to the Roberts' proposal, however, was somewhat more guarded. The use of discipline specific metrics was supported "provided it does not take the place of *or unduly influence the judgement* of experts". (HEFCE 2003: p.1, own italics)

In view of the Government's insistence that metrics should play a bigger part in the research review process, and following the completion of the 2008 RAE, HEFCE began a review of how bibliometric data based on citation counts of publications might be used in future research assessments. Clarifying how bibliometric data will be used in the next RAE in 2013 (now re-named the Research Excellence

Framework) needs to be done well in advance of the start of the process so that universities know how their research output in the current period will be assessed. After considering several different research performance indicators based on citations, HEFCE's preliminary view was that "bibliometrics are not sufficiently mature to be used formulaically or to replace expert review, but there is considerable scope for citation indicators to inform expert review in the REF". The review also recommends that citation indicators should be used only for "selected papers by the staff in each submission, rather than attempt to capture all papers" (HEFCE 2009: p.2/3).

A critical problem with using citations data in the research assessment process is that it is not consistently appropriate across different disciplines. There is widespread agreement, for example, that the use of citations data is more appropriate for sciences and technology than for the arts, humanities and social sciences.[5] It is with this in mind that the Association of Business Schools (ABS) has made a forceful case for using an alternative system based on the quality of journals in which researchers in the business and management area are most likely to publish. The ABS has produced (and tested) a Journal Quality Guide which categorizes journals in business and management (defined to include a wide range of disciplines) into four distinct quality groups (Kelly *et al.*2009a). In a forward to Kelly *et al.*, the Chair of the ABS Research Committee states that: "An authoritative Guide to the relative quality of the many hundreds of journals that publish the results of academic research has become necessary for several reasons." The first of these is that: "Those who fund research and evaluate the outcomes need a guide to the academic quality of the outlets in which it is published."[6] According to the ABS, its Journal Quality Guide has two major advantages over journal impact factors: first, its coverage is considerably wider than citation indices (since many academic journals are not present in any of the citation lists); second, the Journal Quality Guide is subjected to ongoing peer review through a nominated panel of experts. This peer review process has the added advantage that the panel of experts considers feedback from the research community on any revisions made to the current guide.

The use of journal quality ratings, however, has not received universal support. Commenting on the assessment of the quality of publications in the 1996 RAE, Cooper and Otley (1998) confirmed that the business and management panel relied heavily on the individual judgement of the panel's members. Although recognising that the perceived quality of journals can provide useful additional information, they argued that journal rankings are unreliable and should not replace the peer review

[5] Scepticism over the use of metric-based systems is also evident in the sciences and is not confined to the arts and social sciences (Hobbs and Stewart 2006).

[6] Three further reasons for producing the Journal Quality Guide are, first, to provide universities with "a reliable means of assessing the achievement of their academic staff"; second, to assist university libraries with information useful for their purchasing decisions; and third, to provide individual researchers with information that may be helpful in deciding on appropriate outlets for their work (perhaps with their career in mind). See also Geary, Marriott and Rowlinson (2004) for further discussion of journal rankings in business and management and their relevance to the research assessment process.

process.[7] A further problem is that it would be difficult to produce an acceptable rating of journals that would have general support across the broad range of disciplines covered by the business and management panel. They could see no viable alternative to relying on the expert advice of subject specialists (see also Otley 2002).

This policy was continued in the 2008 RAE, when the business and management panel decided not to use journal quality ratings *at any stage* in their assessment of publications. This was also the case for cognate panels in the same main group (i.e. economics & econometrics and accounting & finance).[8] The panels noted that top-quality work could be found in lower quality journals, and vice-versa. In drawing implications for future research assessments, it was noted that "It would therefore be inappropriate *in the future* to use assessments of journal quality alone to assign ratings to individual items of work" (HEFCE 2009b, own italics).

An intermediate position was taken by Doyle *et al*. (1995) following the 1992 RAE. They argued that data collected for the 1992 RAE could have been used much more effectively by the business and management panel to inform their judgments, thereby saving time and effort in addition to improving the quality of the decision-making process. Using data collected for the 1992 RAE, Doyle *et al*. show that 87% of the variation in decisions reached by the business and management panel can be accounted for by a set of nine variables, all of which are statistically significant at 5% or less.[9] Having identified the factors that 'explain', in a statistical sense, the decisions reached by the panel, Doyle *et al*. then demonstrate how the data can be used to assess the research performance of individual units of assessment based on linear programming techniques. They argue that this would allow the panel to focus on deciding what special factors needed to be considered to adjust the initial quantitative estimate of each unit's research performance in reaching its own final decision on research quality.

Despite the length and complexity of the debate over the use of quantitative indicators in the research assessment process, there is still no clear view about the role that such indicators should play in the REF. Academic researchers, the funding bodies and politicians have all been keen to express their views about the potential role of quantitative indicators such as journal quality indices and citations, but a consensus has still to emerge regarding the way in which such indicators should be used and whether or not they should supplement or replace the peer review process. This choice has been

[7] More recently, Paul (2008) has argued that journal rankings are not only an unreliable indicator of the quality of individual articles within any specific journal but also that the combined quality of all papers is not necessarily accurately reflected in the journal rankings. In other words, the journal rankings themselves cannot be trusted.

[8] The Chair of Main Panel I (David Otley) stated that: "The sub-panels assessed virtually all the submitted work by examining it, and did not use its place of publication as an evaluative criterion." (HEFCE 2009b)

[9] These are as follows: number of staff submitted, number of publications (journal articles, popular articles and book reviews), Research Council income, research studentships, and three binary variables (old/new university, panel member/or not, and located in England/other UK country). See also Johnes, Taylor and Francis (1993) and Taylor (1994, 1995, 1996) for more studies of the statistical relationship between RAE outcomes and quantitative data.

highlighted in the business and management area by the recent claim that "simple volume and quality indicators offer a sound metric for QR allocations" (Kelly *et al*. 2009b: p.15). More specifically, the ABS Research Committee strongly recommends the use of its Journal Quality Guide by HEFCE to measure research quality in business and management in the REF.

The primary aim of this paper is to investigate the extent to which the 2008 RAE outcome in three cognate units of assessment can be explained by quantitative indicators related to research activity. The three cognate units are: business & management, economics & econometrics, and accounting & finance. Regression methods are used to evaluate the relationship between: (a) the outcomes determined by peer review in these three units of assessment, and (b) a set of quantitative indicators. Specifically, since the RAE outcome is a weighted average of three separately identifiable but related components (namely: research output, esteem and research environment), the statistical relationship between these separate components and a set of quantitative indicators is estimated using seemingly-unrelated regression (SUR). These estimated relationships are then used to assess the potential value of the quantitative indicators for measuring the research quality of individual institutions within these three units of assessment.

The main findings of this paper are as follows. First, a substantial proportion of the variation (between departments[10]) in the RAE panel's overall assessment of research quality is explained by several quantitative indicators. Second, the explanatory power of a measure of journal quality derived from the ABS Journal Quality Guide is high and exceeds that of all other quantitative indicators. Third, although journal quality is the main explanatory variable, the explanatory power of the regressions is significantly enhanced by several other variables. Finally, the very high explanatory power of the estimated equations is dependent on the inclusion in the regression models of a department's size and by a small number of outliers (predominantly at the lower end of the research quality scale). This paper therefore challenges the view that research quality can be accurately estimated from quantitative indicators. In particular, there is insufficient evidence to justify the claim by the ABS Research Committee that its Journal Quality Guide is a sufficiently accurate predictor of research quality to justify a *predominant* role in the research assessment process. The main policy implication is therefore that the peer review process should continue to play the critical role in the assessment of research quality in the units of assessment examined in this paper.

The remainder of this paper is organized as follows. Section II provides some background data relating to the RAE outcomes of the three units of assessment. In addition to comparing the outcomes between the three autonomous units of assessment, comparisons are made between the economics groups in the business & management unit and the autonomous economics & econometrics unit; and similarly for

[10] Throughout, we refer to 'departments' even though business & management units are normally referred to as 'business schools'.

accounting & finance. Identifying economics groups within the business & management unit turns out to throw some light on differences between the panels in their judgment of research quality. Section III outlines a model of the research assessment process in order to specify the variables that may have been expected to influence the decisions reached by the three panels. Section IV presents the results of an empirical analysis of the research ratings awarded by the panels. Section V investigates the potential role of the Journal Quality Guide in the research assessment process. Section VI concludes.

II. Peer review: the outcomes

In the first four RAEs, an expert panel awarded each institution a single score (on a 7-point scale in the 2001 RAE) reflecting the quality of the institution's research in each unit of assessment. This was abandoned in the 2008 RAE and replaced by profiling, whereby all research output was distributed between five classes according to the degree to which the research met certain standards (4*=world-leading, 3*=internationally excellent, 2*=international, 1*=national, 0=unclassified). Moreover, this criterion was applied to three separate aspects of research performance: research output, esteem and research environment. An overall research profile was then obtained by calculating the weighted average of these three categories.

As shown in Table 1, the research profile for the three units of assessment investigated here are very different. Economics & econometrics, for example, has 76% of its researchers in the combined 3* and 4* classes in the overall classification, compared to only 53% for business & management and 44% for accounting & finance. The same disparities are evident in the other three research quality categories. In the esteem indicators category, for example, economics & econometrics classifies 88% of its researchers in the combined 4* and 3* categories compared to 60% in business & management and 49% in accounting and finance.

A more succinct way of expressing the RAE outcomes is provided in Table 2, which compresses the profiles into a single score by applying arbitrary weights to each of the five classes (see notes to Table 2). This way of presenting the RAE outcomes has the disadvantage that arbitrary weights have to be assigned to the five classes, which in this case are assumed to be equidistant from each other (e.g. a world-leading research publication is assumed to be 'worth' four times as much as a publication ranked at 'national' level). Nevertheless, this mechanism does allow some simple statistical tests to be undertaken.

III. Model, data and variables

It is necessary to note at the outset that the purpose of modeling the RAE outcome is to investigate the extent to which quantitative data relating to each institution's research activities is capable of replicating the research quality decisions reached by the subject panels. The model is therefore

'statistical' and is not meant to imply causality. In other words, the model is an attempt to explain the actual RAE research outcome and not some theoretical 'true' research quality. Furthermore, since the RAE outcome is a weighted average of three separately identifiable components, it is appropriate to model these components separately. The components and their weights are as follows: research output (70%), esteem (20%) and research quality (10%). The RAE panels rated all institutions (within each unit of assessment) on each of these three components separately, as explained in section II above.

Research output

A schematic illustration of the model is provided in Figure 1. The first and major component of the RAE outcome is the quality of research output, which is itself determined by the quality of the publications submitted for appraisal to the RAE panel. Since there is no direct measure of the quality of research output, it is necessary to use an indirect measure, such as the number of times in which a publication is cited, or the quality of the journals in which research is published. The potential problems with constructing citation indices, particularly for the non-sciences (HEFCE 2009a), have led to the use of journal quality indices as a proxy for the quality of the research itself, as explained in section I above. The method adopted in the present paper is based on the journal rating exercise undertaken by the ABS (Kelly *et al*. 2009a). The estimated quality of publications is therefore based entirely on the designated quality of the journal in which each article is published. The two major disadvantages of this approach are, first, that the method is applicable only to research published in journals. There is no mechanism for assessing the quality of books, chapters in books or other forms of publication. The second major problem is that not all publications in highly rated journals are necessarily of high quality; and conversely for publications in lower quality journals. The fact that over 90% of the publications in the RAE were journal articles helps to overcome the first of the two problems but there is no obvious way of overcoming the second problem.[11]

Two indicators based on the ABS journal quality scores are provided in Table 3: the first is the mean journal quality score per Category A staff; the second is the mean journal quality score per publication.[12] The latter measure of journal quality is used in the next section as the index of journal quality (following Kelly *et* al. 2009b). The differences in the journal quality scores between the three units of assessment are consistent, at least in aggregate, with the research output profiles given in Table 2. For example, the economics & econometrics unit of assessment has a significantly greater score than the other two units at the 1% level in the case of the journal quality score per publication. It is also interesting to note that when researchers in economics groups within business & management are considered separately, the journal quality score per publication is not significantly different from that for the autonomous economics & econometrics unit of assessment (F=1.5 with a p-value of 0.23).

[11] In business & management, 90.5% of submissions were in journals, 6.4% were books or book chapters and 2.5% were 'internet publications', most of which were papers pending publication in journals.

[12] In both cases, any submitted research which is not covered by the ABS journal quality guide is given an arbitrary score of unity. These two measures of journal quality are very highly correlated (r=0.90).

This finding is not therefore consistent with the view of the economics & econometrics panel that the outputs in economics & econometrics were of higher quality than those cross-referenced from the business & management group (HEFCE 2009b), though this does not necessarily mean that the panel's judgment was wrong.

A second factor which may influence the productivity of researchers is the presence of scale economies (Johnes, Taylor and Francis 1993; Taylor 1994, 1995). Larger units may offer advantages in the form of access to more expertise from colleagues working in close proximity to each other, especially if this also engenders greater competition between fellow researchers. As in previous studies, the size of a unit is measured here by the number of research staff submitted for assessment. But in so far as scale economies do have a positive impact on the quality of research output, this should be captured by the journal quality indicator. This suggests that departmental size should not be included as an explanatory unless it can be shown to have an independent effect on research quality. A more plausible reason for including departmental size to explain the panel's assessment of research output is that the panel's judgment of research quality may have been biased in favour of large departments due to their 'visibility'. We return to this issue in section IV.

A further factor that may influence a panel's judgment about a unit's research quality is the international reputation and status of the institution to which it belongs. In other words, individual departments may benefit from a halo effect independently of the quality of its research output (Johnes, Taylor and Francis 1993). Universities can be distinguished, for example, by their membership of well-defined groups, such as the Russell Group, which includes *inter alia* large institutions with a long-established international reputation for research, such as Oxford, Cambridge and UCL. A further group of institutions aspiring to be recognized for their research excellence is the 1994 Group of research-intensive universities. Binary variables are therefore included to identify universities which are members of these two 'research-led' groups. These binary dummies are also included as explanatory variables in the esteem and research reputation regressions below.

Esteem

The esteem bestowed on individual units is inevitably subjective and is likely to be correlated with research performance over several years. Since the panel's judgment over a department's esteem is likely to be reflected, to some extent, by previous RAE outcomes, and since esteem is time-related, the 'amount' of esteem in 2008 may be expected to be positively related to the previous RAE outcome in 2001. One reason this may occur is that success breeds further success through recruitment of the 'best' researchers by the most prestigious departments. This process of cumulative causation may be reinforced by the further growth in the size of departments with high esteem. The size of a department may therefore be expected to be positively related to esteem because of two-way causation.

Research environment

The RAE panel's view of the quality of a department's research environment is likely to be influenced by two main factors: the number of research students (especially those working towards a doctorate) and the amount of research income brought in (especially from the Research Councils). Table 4 shows the number of research students and the value of research grants expressed as a proportion of a department's research staff. There are wide variations in the amount of research income between the three units of assessment within some of the categories, such as Research Council income, this being much higher for economics & econometrics than for the other two units of assessment. Research income per staff is especially low for accounting & finance. Differences in research students per staff are less divergent between the three units. The number of research staff may also affect the quality of the research environment in so far as there may be a critical mass affect, in which case a non-linear relationship may be expected.

Equations to be estimated

The equations to be estimated are as follows:

$$\text{Output}_i = \alpha_0 + \alpha_1 \text{ABS\_score}_i + \alpha_2 \text{Res\_staff}_i + \alpha_3 \text{Russell}_i + \alpha_4 \text{Group94}_i + \varepsilon_{1i} \quad (1)$$

$$\text{Esteem}_i = \beta_0 + \beta_1 \text{RAE01}_i + \beta_2 \text{Res\_staff}_i + \beta_3 \text{Russell}_i + \beta_4 \text{ Group94}_i + \varepsilon_{2i} \quad (2)$$

$$\text{Environment}_i = \gamma_0 + \gamma_1 \text{Res\_inc}_i + \gamma_2 \text{Res\_studs}_i + \gamma_3 \text{Res\_staff}_i + \gamma_4 \text{Res\_staff}_i^2 + \gamma_5 \text{Russell}_i + \gamma_6 \text{ Group94}_i + \varepsilon_{3i} \quad (3)$$

where:

Output = RAE panel's assessment of each department's research output (see notes to Table 2)
Esteem = RAE panel's assessment of each department's esteem
Environment = RAE panel's assessment of each department's research environment
ABS_score = ABS journal rating score (see notes to Table 3 for details of its construction)
Res_staff = Number of Category A staff submitted to the RAE
RAE01 = RAE rating in 2001
Res_inc = income from Research Councils
Res_studs = number of research students
Russell = member of Russell Group of universities (=1 and zero otherwise)
Group94 = member of 1994 Group of universities (=1 and zero otherwise)
i = university

Since the three dependent variables are the consequence of decisions reached by the same panel of experts, the equations are jointly estimated using seemingly-unrelated regressions (SUR) in order to

allow for correlated errors. A problem with SUR estimation is that it eliminates any observations not common to all equations and its application leads to a reduction in the number of observations in the present statistical analysis. This is due to missing values for the 2001 RAE ratings for those departments not assessed in both 2001 and 2008. The equations were therefore also estimated for the full sample using OLS and WLS to check that the results were robust to the method of estimation and to the inclusion of the missing observations. The results were substantively unchanged (see Table C in the appendix).

IV. Results

The three equations specified in section III are estimated for two units of assessment, namely, business & management and economics & econometrics. Since the number of observations is too small in accounting and finance (i.e. 14) for reliable estimates to be obtained, the three equations have also been estimated for a combined group including all three units of assessment. Two binary variables are therefore added, one for economics & econometrics and the other for accounting & finance in the 'all units' equations. This allows us to investigate whether there are any differences between the three panels in their assessments (for each of the three dependent variables) *after accounting for the other explanatory variables*. The results for the seemingly-unrelated regressions are given in Table 6. The corresponding estimates using OLS and WLS are given in the appendix (Table C). We note at the outset that the substantive results are very similar regardless of the regression method used.[13]

Research output

The outstanding result in the research output equations is the high degree of explanatory power of the journal quality score. In all estimated equations, journal quality is highly significant and accounts for a high proportion of the explained variation in the RAE research output score. Moreover, the magnitude of the estimated coefficient is very similar across the three equations. It is clear that the quality of journals is the dominating explanatory variable for a department's research output. There is also strong evidence that a department's size (in terms of the number of research staff) is highly correlated with the RAE research output score. This result is discussed more fully in section V below.

Esteem

The esteem of a department, as judged by the RAE panel, is significantly correlated with its 2001 RAE rating in all three regressions, though the significance level is only 10% in two regressions. The main explanatory variable in all three regressions is a department's size. This may be due to a two-way relationship between esteem and size, since a good RAE rating in 2001 could have led to the

[13] We also note that the results are substantively unchanged when the regressions are estimated using the rank of each of the dependent variables and the rank of the ABS journal quality score rather than the actual values of these variables.

expansion in the size of a department through the extra resources acquired as a consequence of a high RAE rating in 2001. We return to this point in section V below.

Research environment

There is only limited evidence that the research environment score is related to either research income or the number of research students. In all three equations, a department's size is the predominating variable and accounts for most of the explanatory power. Hence, the size of a department once again plays a substantial role in accounting for the variation in the RAE panel's assessment of a department's research performance.

So far, we have not referred to the binary variables. Dummies have been added to identify whether a department belongs to either the Russell Group or the 1994 Group of universities. In most cases, the estimated coefficients on these dummies are statistically significant. The magnitude of these coefficients, however, is greater (and their statistical significance higher) for the esteem and research environment regressions than for research output. For business & management, for example, the RAE panel rated departments in the Russell Group and 1994 Group by around 0.5 points higher (for esteem and research environment) than departments not in these two university groupings. This shift of 0.5 points is substantial given the mean of 2.7 (and a standard deviation of around 0.7) for both esteem and the research environment. The estimated coefficients for these two dummies are lower for economics & econometrics and are statistically significant in fewer cases. There is nevertheless evidence that departments located in the Russell Group and 1994 Group of universities have gained from a reputation effect relative to departments in neither of these two groups.

There is also evidence that the economics & econometrics panel rated departments higher than the business & management panel, even after controlling for the influence of other variables. Thus, the economics & econometrics panel rated departments 0.34 points higher for their research output than was the case for business & management (and 0.55 and 0.63 points higher for esteem and research environment respectively). All three of these estimated coefficients are highly statistically significant and are large in magnitude relative to the means of the three outcome categories. A possible explanation for the higher scores awarded by the economics & econometrics panel is that the subject dummy is capturing the impact of (unknown) missing variables. On the other hand, it could also mean that the economics & econometrics panel was simply more generous in its assessments than the business & management panel despite mechanisms built into the RAE process to achieve comparable standards across cognate subject areas.[14]

[14] The Main Panel "acted as a coordinating mechanism to help ensure comparability of standards across its sub-panels." Furthermore, a combination of mechanisms "gave substantial assurance that the results are comparable across the range of disciplines covered by the sub-panels." (HEFCE 2009b)

Finally, a panel membership dummy was added to the model to test for the possibility of bias in favour of the home institution of panel members. Each department with a staff member on the panel was identified by a binary variable. The estimated coefficient on the panel membership dummy was found to be very close to zero (and was not statistically significant) in all cases, thus supporting the null of zero bias across all three research profiles for both business & management and economics & econometrics.

V. Discussion

The claim by the ABS that the ABS Journal Quality Guide is "validated by its ability to mirror the quality judgments made by RAE panel members" and that "simple volume and quality indicators offer a sound metric for QR allocations" (Kelly *et* al. 2009b: p.15) appear at first sight to be strongly supported by the regression analysis reported in section IV. But this claim ignores two important factors.

First, the regression models reported here, and those estimated by Kelly *et al*., include other variables in addition to the journal quality guide, most of which are inappropriate for assessing a department's research quality. One of the main findings in the regression analysis was the importance of a department's size in accounting for the variation in research performance. This result was common to all three indicators of research performance (output, esteem and environment). It is equally applicable to the regression results obtained by Kelly *et al*, who use the overall RAE outcome as their dependent variable. The justification for including 'size' as a regressor is that it may capture benefits arising from scale economies in so far as a critical mass of researchers in specific areas of activity may improve research productivity. Additionally, large departments may allow individual researchers to gain from a wider spread of research expertise than can be found in small departments. But if size does have a beneficial effect on research quality, this should be captured by the quality of the publications as indicated by the ABS score. It is not clear why size should have any additional effect on the quality of research output independent of the journal quality indicator. An alternative, and perhaps more plausible, explanation for the highly significant coefficient on departmental size is that the RAE panel inadvertently regarded large departments as being more likely to produce high quality research. In other words, there may have existed some bias in the minds of panel members in favour of larger and hence more 'visible' departments.

A further problem with including departmental size as an explanatory variable is that it is endogenous since there is likely to be a two-way relationship between research performance and size. Departments which perform well in the RAE, for example, will benefit from extra funding, some of which may be used to recruit extra research staff. In addition, the 'best' researchers may be expected to gravitate towards those departments which have the best research reputation. There is therefore a strong case for omitting the size of a department from the regression models. Moreover, it would clearly be

inappropriate to reward departments simply for their 'bigness'. There is no clear justification for discriminating against 'smallness' in the allocation of research funds.

The second critical problem with using the journal quality score to allocate research funds is that the high degree of explanatory power is partly the consequence of spurious correlation due to a small number of outliers. Omitting these outliers from the estimated regression equations, results in a significant reduction in explanatory power. For example, regressing the overall RAE outcome on the journal quality score for business & management, together with the number of Category A staff and research income per Category A staff, we obtain a coefficient of variation of 0.87. This falls to 0.71 when the number of Category A staff is dropped from the model and when six of the ninety observations are omitted (i.e. those departments with an overall research outcome score of less than 1.4 or greater than 3.2). The corresponding reduction in the coefficient of variation for economics & econometrics is from 0.91 to 0.67 when the number of Category A staff and four outliers are omitted.

The problem with using the journal quality score for allocating research funds can be demonstrated by considering the scatter diagrams shown in Figures 2 to 4. In Figure 2, for example, two universities with virtually the same journal quality score in business & management (e.g. Manchester=2.45 and Bristol=2.35) can have very different RAE scores (Manchester=2.85 and Bristol=2.0). Conversely, two universities with virtually the same RAE score (e.g. Keele=2.30 and Swansea=2.35) can have very different journal quality scores (Keele=1.94 and Swansea=2.85). Similar examples can be found for economics & econometrics and for accounting & finance in Figures 3 and 4. These examples aptly demonstrate the need for considerable caution in using the journal quality score in the research assessment process. This does not mean that it should not be used, but rather that it should be regarded at most as a supplementary tool to be used with discretion by the panels and is certainly not a substitute for peer review.

This conclusion that the journal quality score does not sufficiently mirror the RAE outcome to warrant its substitution for peer review rests on the assumption that the RAE panels were accurate in their judgments. Bence and Oppenheim (2004) challenge this assumption. They argue that panel members are unlikely to possess the range of expertise that is available to journal editors who select referees for their specific expertise within their respective disciplines. There is no way that a small panel of experts can match the wide range of expertise available to journal editors. This leads Bence and Oppenheim to the view that the review process should rely more on metrics and less on RAE panels. The contrary view is that the use of journal quality indicators to assess the quality of research output could have a distorting and undesirable influence on future research strategies.[15] Books and chapters in books, for example, allow researchers to be more innovative and controversial than is often possible within the

[15] In a hard-hitting article, Adler and Harzing (2009) argue that the use of journal rankings in assessing the value of research is having a seriously harmful effect on the type and usefulness of research that is being undertaken. See also MacDonald and Kam (2007) for a bitter, but entertaining, attack on the whole world of games played in order to publish in 'quality journals'.

tight confines of established methodology adopted by journals through the refereeing process. Researchers aiming for publication in journals may feel more constrained to take a more traditional approach in order to reduce the probability of rejection.[16]

A half-way house which is probably appealing to most academics whose work is subject to assessment would be to carry on with peer review as in the past, but to make more explicit use of quantitative data than has hitherto been the case. Exactly how the journal quality score would be used would be a decision made by the panel well in advance of the next assessment due in 2013.

VI. Conclusion

The primary aim of this paper has been to investigate the role that quantitative indicators should play in the research assessment process undertaken by the UK's higher education funding bodies in order to determine the allocation of research funds between universities. Regression methods have been used to explore the statistical relationship between the outcomes of the 2008 RAE and a set of quantitative indicators, including a journal quality score. The statistical analysis was undertaken on data covering three cognate units of assessment: business & management, economics & econometrics, and accounting & finance.

The four main findings are as follows:

i. A highly significant statistical relationship exists between *each of the three components* of research quality (i.e. research output, esteem and research environment) and various quantitative indicators, such as a journal quality score, departmental size, research grant income and the number of research students.

ii. A substantial proportion of the variation in the RAE panel's *overall assessment* of research quality is explained by these quantitative indicators; and the indicator with most explanatory power is the ABS journal quality score.

iii. The explanatory power of the estimated regression equations falls considerably, however, when departmental size is omitted from the model and when a handful of outliers are also excluded.

iv. The inclusion of several dummy variables indicates that departments which are members of the Russell Group or the 1994 Group of universities experienced substantially higher research quality scores than non-members, even after controlling for other variables such as the journal quality score and size. The reasons for this are not known, but it seems likely that these institutions benefit from a reputational effect. If this is the case, the implication is that there has been some bias in the decisions reached by both the business & management panel and the economics & econometrics panel in determining the overall research outcomes.

[16] This view is rejected by Clarke and Wright (2007), who argue that journals develop and change in response to innovative approaches.

v. There is evidence that the economics & econometrics panel was more generous in its assessment of research quality than the business & management panel. This suggests an element of bias in the decisions reached by the economics & econometrics panel relative to the business & management panel.

On the basis of these findings, it seems appropriate to issue a word of warning about the potential use of quantitative indicators, such as journal quality scores, for allocating scarce research funds to the UK's universities. There is insufficient evidence to support the ABS claim that its Journal Quality Guide should have a central role in the REF, as proposed by Kelly, Morris and Harvey (2009). There is therefore no clear alternative at this time to continuing with the peer review process. But this does not mean that there is no place for quantitative data, such as journal quality indices, in future research assessments in the business, economics and accounting areas. Indeed, greater use of journal quality indicators or citations data by the REF panels could help to mitigate the apparent bias suggested by the empirical analysis summarised in this paper.

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TABLE 1 Percent of designated staff in each research quality category (weighted by the number of Category A staff in each assessed unit)

Unit of assessment	Overall research quality profile (weighted): % of staff in each category				
	4*	3*	2*	1*	Unclassified
Research output (weight=0.7)					
Business & Management	13.8	36.2	35.4	13.5	1.0
Economics & Econometrics	26.5	47.2	24.1	2.1	0.1
Accounting & Finance	6.0	36.4	40.7	15.9	1.0
Esteem (weight=0.2)					
Business & Management	26.7	34.5	25.3	10.7	2.8
Economics & Econometrics	20.4	68.1	11.3	0.3	0.0
Accounting & Finance	18.9	35.3	33.1	12.7	0.0
Research environment (weight=0.1)					
Business & Management	23.0	37.4	27.9	10.1	1.6
Economics & Econometrics	30.1	49.1	20.4	0.3	0.0
Accounting & Finance	7.3	41.9	34.4	14.1	2.3
Overall RAE classification					
Business & Management	16.6	36.6	32.9	12.8	1.0
Economics & Econometrics	26.6	49.3	22.9	1.2	0.0
Accounting & Finance	7.7	36.6	39.3	15.0	1.3

Notes:
4* = world-leading in terms of originality, significance and rigour.
3* = internationally excellent in terms of originality, significance and rigour but falls short of the highest standards of excellence.
2* = internationally recognised in terms of originality, significance and rigour.
1* = nationally recognised in terms of originality, significance and rigour.
Unclassified = falls below the standard of nationally recognised work
Source: RAE2008 (http://www.rae.ac.uk/results/).

TABLE 2 Mean RAE score by quality profile category
(weighted by number of Category A staff in each assessed unit)

Unit of assessment	Mean scores in each quality profile category			
	Research output	Esteem	Research environment	Overall score
Business & Management	2.48	2.71	2.70	2.55
Economics & Econometrics	2.98	3.09	3.09	3.01
Accounting & Finance	2.31	2.60	2.38	2.34

Notes:
The scores for the three research profiles (research output, research esteem and research environment) are calculated as follows:
i. Each of the five quality profile categories is given a score ranging from 0 to 4 (unclassified=0, 1*=1, 2*=2, 3*=3 and 4*=4).
ii. The score in each of the five categories is then multiplied by the proportion of research staff attributed to each category by the panel and summed to obtain the weighted mean for the specific quality profile.
iii. The overall RAE score (which is a combination of the three quality profiles) is obtained by using weights of 0.7, 0.2 and 0.1 for research output, research esteem and research environment respectively (as used in the RAE).
Source: RAE2008 (http://www.rae.ac.uk/results/).

TABLE 3 Publications points score
(weighted by number of Category A staff in each assessed unit)

Unit of assessment	Mean ABS journal score per category A staff	Mean ABS journal score per publication
Business & Management	9.33	2.49
Economics & Econometrics	9.87	2.75
Accounting & Finance	8.57	2.41
Groups in Business & Management		
Economics groups in B&M	8.99	2.63
Accounting & Finance groups in B&M	9.09	2.64

Notes:
The ABS score is based upon a division of journals into four groups, each being given a score of between 1 and 4. A journal in the bottom group is given a score of 1 and a journal in the top group is given a score of 4. An ABS journal score is available for 13226 (82%) of the 16165 publications submitted by all three units of assessment. Publications not in the ABS list (including books and chapters in books as well as unlisted journals) were given an arbitrary score of unity. For all three units, the proportion of publications in journals was over 90% (including papers accepted for publication but still pending).
Source: Association of Business Schools, *Journal Quality Guide*, 2009.

Table 4 Research income in £1000 and research students per Category A staff

(weighted by number of Category A staff in each assessed unit)

	Business & management	Economics & econometrics	Accounting & finance
Sources of income per Category A staff			
Research councils	26.7	58.0	3.0
Charities	6.2	12.1	3.9
Government	34.7	13.5	1.1
Industry	16.9	3.1	1.9
EU and other	22.1	17.0	6.7
Total	106.7	103.7	16.6
Research students per Category A staff			
Research students	2.1	1.7	1.2
PhDs awarded	1.0	0.6	0.7

TABLE 5 Correlation between ABS score per publication and research profile scores

Unit of assessment	Coefficient of determination			
	Research output	Esteem	Research environment	Overall score
Business & Management	0.85	0.56	0.53	0.74
Economics & Econometrics	0.79	0.69	0.71	0.81
Accounting & Finance	0.62	0.12	0.14	0.38

TABLE 6 Seemingly-unrelated regressions for research output, esteem and research environment

Explanatory variables	Business & Management	Economics & Econometrics	B&M, Economics, Acc./Finance
Research output			
Publications score	**0.660*****	**0.617*****	**0.636*****
	(0.046)	(0.077)	(0.039)
Number of Category A staff	**0.0022*****	**0.0060****	**0.0026*****
	(0.0006)	(0.0022)	(0.0006)
Economics & Econometrics dummy			**0.34*****
			(0.05)
Accounting & Finance dummy			0.02
			(0.05)
Russell group	**0.11***	0.07	**0.12*****
	(0.05)	(0.09)	(0.04)
Group 94	**0.10**#	-0.05	0.05
	(0.05)	(0.08)	(0.04)
Constant	0.73	1.20	0.77
	(0.10)	(0.19)	(0.09)
R-squared	0.87	0.86	0.90
n	81	30	121
Esteem			
RAE rating 2001	**0.242****	0.117#	0.121#
	(0.073)	(0.056)	(0.051)
Number of staff	**0.0087*****	**0.0078***	**0.0112*****
	(0.0023)	(0.0037)	(0.0019)
Economics & Econometrics dummy			**0.55*****
			(0.11)
Accounting & Finance dummy			0.27
			(0.17)
Russell group	**0.56*****	**0.46*****	**0.60*****
	(0.14)	(0.13)	(0.11)
Group 94	**0.49*****	**0.21#**	**0.46*****
	(0.15)	(0.11)	(0.11)
Constant	1.20	2.30	1.54
	(0.25)	(0.20)	(0.17)
R-squared	0.73	0.71	0.72
n	81	30	121
Research environment			
Research Council income (£m)	**0.080***	0.019	0.025
	(0.034)	(0.014)	(0.017)
Research grants from charities (£m)	0.072	0.097	0.095
	(0.122)	(0.059)	(0.068)
Research students	**0.0008****	-0.0001	0.0004
	(0.0003)	(0.0004)	(0.0003)
Number of Category A staff	**0.022*****	**0.023***	**0.019*****
	(0.003)	(0.010)	(0.003)
Number of Category A staff squared	-0.0001***	-0.0002	-0.0001***
	(0.0000)	(0.0001)	(0.0000)
Economics & Econometrics dummy			**0.63*****
			(0.09)
Accounting & Finance dummy			**0.41*****
			(0.12)
Russell group	**0.51*****	**0.30***	**0.46*****
	(0.10)	(0.15)	(0.09)
Group 94	**0.47*****	**0.19***	**0.40*****
	(0.11)	(0.12)	(0.09)
Constant	1.34	2.30	1.47
	(0.08)	(0.13)	(0.08)

R-squared	0.81	0.70	0.77
n	81	30	121

Notes: ( ) = standard errors; #, *, **, *** refer to significance at the 10%, 5%, 1% and 0.1% levels respectively. The computation of the covariance matrix for the equation residuals uses the small-sample adjustment procedure available in STATA. The Breusch-Pagan test rejects the null that the errors are uncorrelated for business & management but not for economics & econometrics. The OLS and WLS results, however, are not substantively different to the SURE estimates provided in this table (see appendix).

APPENDIX

TABLE A Mean values of variables used in regression analysis
(weighted by number of Category A staff in each assessed unit)

	Business & Management	Economics & Econometrics	Accounting & Finance	Combined group
Overall RAE score	2.55	3.01	2.34	2.63
Research output	2.48	2.98	2.31	2.57
Research esteem	2.72	3.09	2.60	2.78
Research environment	2.70	3.09	2.38	2.77
Mean ABS points score / category A staff	9.33	9.87	8.57	9.41
Mean ABS points score / publication	2.49	2.75	2.41	2.53
RAE 2001 rating	4.19	4.65	4.81	4.30
Research Council income (total 2001/7 in £m)	2.17	2.43	0.06	2.14
Research income from charities (total 2001/7 in £m)	0.44	0.41	0.06	0.42
Research students (total 2001/7)	383.82	208.88	83.88	338.96

Notes:
Binary variables were included in the regressions to identify whether or not a unit belonged to a Russell Group or 1994 Group university. The membership of these two groups is as follows:
Russell Group: Cardiff, ICL, KCL, LSE, Queen's Belfast, UCL, Birmingham, Bristol, Cambridge, Edinburgh, Glasgow, Leeds, Liverpool, Manchester, Newcastle, Nottingham, Oxford, Sheffield, Southampton, Warwick.
1994 Group: Birkbeck College, Lancaster, Loughborough, Queen Mary, Royal Holloway, SOAS, Bath, Durham, East Anglia, Essex, Exeter, Leicester, Reading, St Andrews, Surrey, Sussex, York.

TABLE B Mean values of variables used in regression analysis (unweighted)

	Business & Management	Economics & Econometrics	Accounting & Finance	Combined group
Overall RAE score	2.29	2.86	2.20	2.42
Research output	2.30	2.83	2.20	2.43
Research esteem	2.25	2.89	2.38	2.43
Research environment	2.29	2.90	2.17	2.43
Mean ABS points score / category A staff	8.88	9.77	8.73	9.09
Mean ABS points score / publication	2.32	2.62	2.34	2.40
Category A staff	37.09	23.95	11.40	31.19
RAE 2001 rating	3.38	4.18	4.65	3.76
Research Council income (total 2001/7 in £m)	0.99	1.39	0.03	0.99
Research income from charities (total 2001/7 in £m)	0.23	0.29	0.04	0.23
Research students (total 2001/7)	198.70	144.66	34.30	161.99

TABLE C OLS and WLS estimates of the three components of the 2008 RAE outcome

(a) *Research output*

	Business & Management		Economics & Econometrics		B&M, Econ & Acc/fin	
	OLS	WLS	OLS	WLS	OLS	WLS
Publications score	0.68***	0.75***	0.64***	0.67***	0.68***	0.75***
	(0.05)	(0.06)	(0.06)	(0.08)	(0.04)	(0.054)
	[0.77]	[0.83]	[0.74]	[0.69]	[0.68]	[0.72]
Number of Category A staff	0.0021***	0.0013***	0.0055**	0.0046***	0.0023***	0.0013**
	(0.0006)	(0.0004)	(0.0018)	(0.0013)	(0.0006)	(0.0004)
	[0.17]	[0.16]	[0.22]	[0.25]	[0.39]	[0.14]
Econ dummy					0.33***	0.33***
					(0.03)	(0.04)
Acc/fin dummy					-0.04	-0.05
					(0.05)	(0.04)
Russell group	0.10*	0.05	0.11	0.13	0.13***	0.07#
	(0.04)	(0.05)	(0.09)	(0.09)	(0.03)	(0.04)
Group 94	0.09#	0.03	-0.03	-0.13	0.05	0.01
	(0.05)	(0.05)	(0.07)	(0.08)	(0.04)	(0.04)
Constant	0.61	0.51	0.98	0.92	0.61	0.52
	(0.11)	(0.14)	(0.13)	(0.20)	(0.09)	(0.12)
R-squared	0.88	0.87	0.87	0.85	0.90	0.89
n	89	89	35	35	137	137

Notes: ( ) = standard errors; [ ] = beta coefficients; #, *, **, *** = significant at 10%, 5%, 1% and 0.1% respectively. The University of Buckingham is omitted due to the very small number of Category A staff. Omitting institutions with less than 10 Category A staff has little effect on the estimated coefficients.

(b) *Esteem*

	Business & Management		Economics & Econometrics		B&M, Econ & Acc/fin	
	OLS	WLS	OLS	WLS	OLS	WLS
RAE rating 2001	0.42**	0.43***	0.18***	0.17***	0.30***	0.36***
	(0.08)	(0.06)	(0.04)	(0.04)	(0.06)	(0.05)
	[0.53]	[0.63]	[0.42]	[0.43]	[0.41]	[0.55]
Number of Category A staff	0.0048*	0.0028**	0.0065*	0.0066**	0.0074***	0.0040***
	(0.0023)	(0.0010)	(0.0027)	(0.0021)	(0.0023)	(0.0010)
	[0.19]	[0.17]	[0.10]	[0.34]	[0.27]	[0.25]
Econ dummy					0.38***	0.22**
					(0.10)	(0.08)
Acc/fin dummy					-0.04	-0.09
					(0.20)	(0.14)
Russell group	0.46***	0.33***	0.32*	0.26*	0.47***	0.34***
	(0.10)	(0.09)	(0.20)	(0.10)	(0.09)	(0.08)
Group 94	0.38**	0.25*	0.15	0.07	0.37***	0.24**
	(0.13)	(0.11)	(0.12)	(0.08)	(0.09)	(0.09)
Constant	0.43	0.58	1.84	1.94	0.76	0.82
	(0.22)	(0.19)	(0.21)	(0.14)	(0.17)	(0.16)
R-squared	0.74	0.80	0.67	0.75	0.74	0.78
n	81	81	33	33	124	124

Notes: See notes to Table C(a) above.

(c) *Research environment*

	Business & Management		Economics & Econometrics		B&M, Econ & Acc/fin	
	OLS	WLS	OLS	WLS	OLS	WLS
Number of Category A staff	0.025***	0.021***	0.033*	0.023**	0.024***	0.019***
	(0.003)	(0.003)	(0.012)	(0.008)	(0.003)	(0.003)
Number of Category A staff squared	-0.00015***	-0.00013***	-0.00029*	-.00019**	-0.00012***	-0.00010***
	(0.00002)	(0.00002)	(0.00012)	(0.00007)	(0.00002)	(0.00001)
Research Council income (£1000)	0.077**	0.072**	0.037*	0.039***	0.026#	0.035*
	(0.029)	(0.026)	(0.014)	(0.009)	(0.016)	(0.015)
	[0.20]	[0.30]	[0.25]	[0.38]	[0.08]	[0.16]
Research grants from charities	0.136	0.133	0.125***	0.108**	0.156*	0.188**
(£1000)	(0.125)	(0.101)	(0.041)	(0.037)	(0.068)	(0.064)
	[0.08]	[0.12]	[0.19]	[0.19]	[0.10]	[0.17]
Research students	0.0007**	0.0008***	-0.0001	0.0001	0.0006*	0.0006**
	(0.0003)	(0.0002)	(0.0004)	(0.0003)	(0.0003)	(0.0002)
	[0.23]	[0.42]	[-0.03]	[0.02]	[0.17]	[0.33]
Econ dummy					0.64***	0.48***
					(0.08)	(0.008)
Acc/fin dummy					0.40**	0.34*
					(0.15)	(0.13)
Russell group	0.46***	0.41***	0.22#	0.21*	0.40***	0.39***
	(0.09)	(0.08)	(0.11)	(0.10)	(0.07)	(0.07)
Group 94	0.50***	0.40***	0.18	0.12	0.42***	0.38***
	(0.08)	(0.07)	(0.11)	(0.09)	(0.07)	(0.06)
Constant	1.26	1.40	2.13	2.32	1.33	1.51
	(0.09)	(0.09)	(0.20)	(0.13)	(0.09)	(0.09)
R-squared	0.81	0.85	0.75	0.81	0.78	0.82
n	89	89	35	35	137	137

Notes: See notes to Table C(a) above.

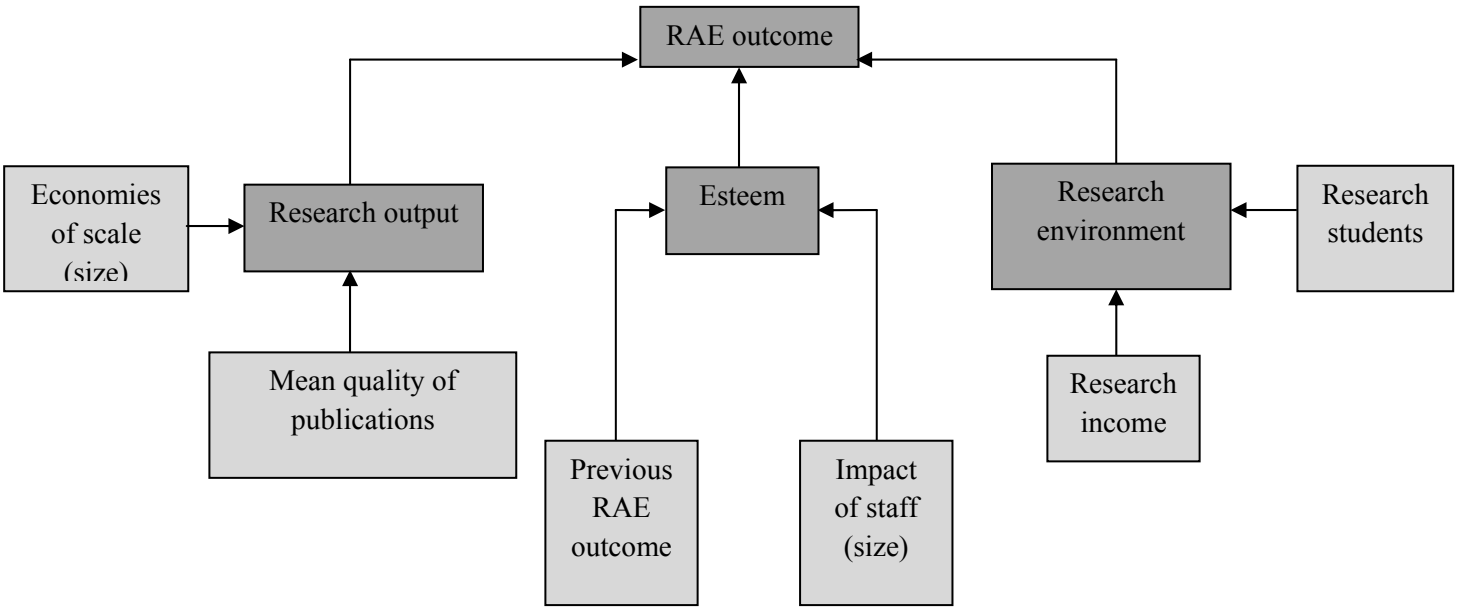

Figure 1 Determinants of the RAE outcome: research output, esteem and research environment

Figure 2 RAE research outcome score v ABS journal quality score: Business & Management

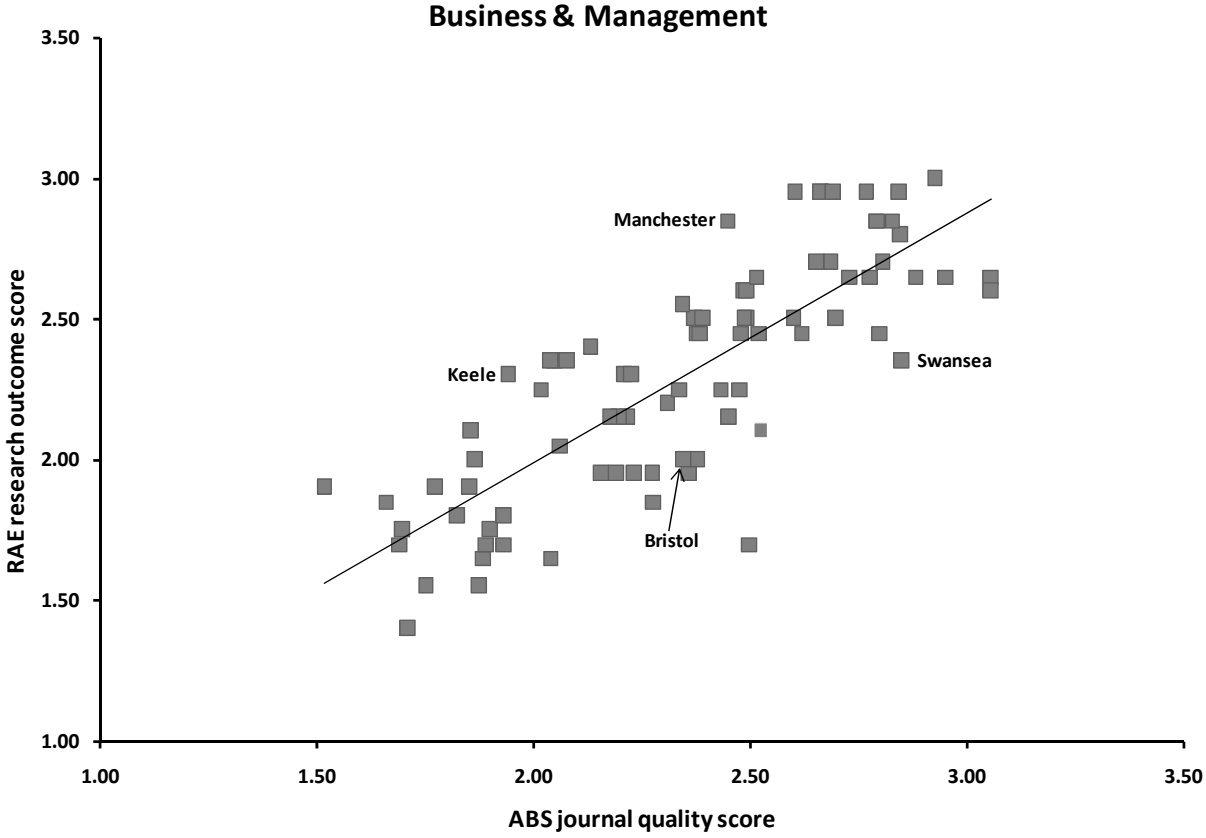

Figure 3 RAE research outcome score v ABS journal quality score: Economics & Econometrics

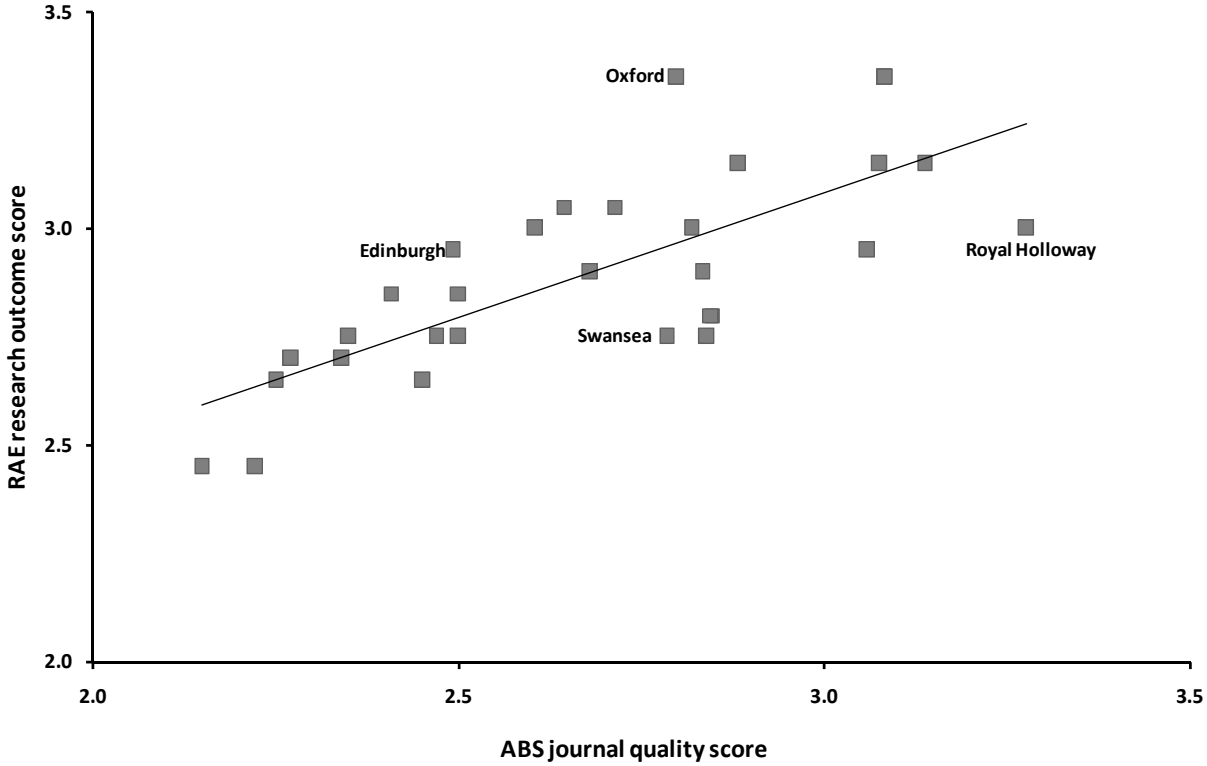

Figure 4 RAE research outcome score v ABS journal quality score: Accounting & Finance