Communicating knowledge: How and why researchers publish and disseminate their findings

Supporting paper 4: Literature review

Jenny Fry; Charles Oppenheim - DIS, Loughborough University
Claire Creaser; William Johnson; Mark Summers; Sonya White - LISU, Loughborough University
Geoff Butters; Jenny Craven; Jill Griffiths; Dick Hartley - CERLIM, Manchester Metropolitan University

September 2009

Table of Contents

Acknowledgements

The research on which this report is based was undertaken by a team from Loughborough University and Manchester Metropolitan University.

The research team would like to thank:

- Aaron Griffiths and Michael Jubb from the Research Information Network
- The RIN Expert Panel - Michael Anderson; Bob Campbell; Hannah Chaplin; Alison Holt; Neil Jacobs
- All those researchers who gave their time to attend and contribute to the focus groups, and who completed the survey
- Mary Ashworth & Sharon Fletcher from LISU, who provided invaluable administrative support
- The bibliometric data collectors – Karen Davies; Tracy Forskitt; Vicki Jackson; Amy Beeston
- The focus group contacts collectors – Evgenia Vassilakaki, Magda Vassiliou and Ioanna Zorba

1. Introduction

This study was commissioned by the Research Information Network (RIN), in collaboration with the Joint Information Systems Committee (JISC), in December 2008, to gather and analyse evidence about:

- The motivations, incentives and constraints that lead researchers in the UK in different subjects and disciplines to publish and disseminate their work in different ways
- How and why researchers cite other researchers' work
- In particular, how researchers' decisions on publication and citation are influenced (or not) by considerations arising from research assessment

The following key issues were investigated, covering three broad areas:

Publication and dissemination behaviour:

- What factors make a scholar prefer one dissemination medium over another?
- Has the trend towards electronic publishing, and open access to scholarly outputs of all types affected their preferences, and how?
- To what extent does collaboration across institutions or disciplines affect these behaviours?
- What motivates scholars to publish, and what constrains them?
- What impact will the advent of electronic publishing have in the future on scholars' dissemination activities?

Citation behaviour:

- Why do scholars cite the way they do?
- Are scholars' reading behaviours, and therefore their knowledge of the prior literature, changing?

The perceived influence of research assessment (past and anticipated):

- What pressures are scholars feeling regarding dissemination because of the increasing importance of the RAE/REF, and how is that pressure manifesting?
- Have pressures from the RAE/REF affected publishing behaviours?

Four complementary methodologies were used, and the detailed methods and outcomes are described in a series of four supporting papers to the main project report. These supporting papers are all available from the RIN web site:

1. Bibliometric analysis

2. Report of focus group findings

3. Report and analysis of researcher survey

4. Literature review

This mixed methods approach has been used to help ensure an holistic view is provided of the publication, dissemination and citation behaviour of researchers across subject disciplines. It will also establish a baseline for further studies in this area. Consequently, the individual reports should not be read in isolation, but in conjunction with the main RIN report *Communicating knowledge: How and why UK researchers publish and disseminate their findings* (September

2009). Each individual report provides further detail and supporting evidence for the material presented in the main report.

1.1 Scope

The literature review is arranged according to five main themes: disciplinary cultures, dissemination and publication behaviours; citation practices; collaboration and authorship; perceived impact of the UK Research Assessment Exercise (RAE) and attitudes towards the proposed Research Excellence Framework (REF). There are a number of cross-cutting issues that interlink these themes, namely: perceptions and motivations, reputational systems and individual/institutional strategies with regard to research assessment methods.

Whilst the literature review reports findings from bibliometric based studies and attitudes towards bibliometrics as a mechanism for evaluating research impact, it does not discuss the methodological details of bibliometric techniques themselves; this topic has been covered by a substantial body of literature in the fields of bibliometrics and scientometrics (see for example Moed, 2005).

2. Disciplinary cultures

There have been a number of landmark studies demonstrating that distinct differences exist between disciplines in terms of patterns of scholarly dissemination and publication (Crane, 1972; Garvey, Lin & Nelson, 1979). Before going on to discuss recent studies of this nature in Section 3 it is relevant to look at a separate body of literature that has sought to explore the fundamental cultural characteristics underpinning disciplinary identities and behaviours. These studies are particularly relevant because they have examined the relationship between disciplinary work organisation and institutional factors, such as research assessment policy. Becher (1994) devised a fourfold typology to distinguish broad disciplinary groupings based on their knowledge structures and reputational concerns *(Figure 1).*

Figure 1 Broad disciplinary groupings

Biglan's groupings	Kolb's groupings	Disciplinary areas
Hard pure	Abstract reflective	Natural sciences
Soft pure	Concrete reflective	Humanities and social sciences
Hard applied	Abstract active	Science-based professions
Soft applied	Concrete active	Social professions

Adapted from Becher 1994, p.152

Fry and Talja (2004) found that broad disciplinary categories, such as biological and medical sciences, social sciences, humantities etc., do not necessarily signify similarities amongst disciplines within those boundaries, indeed some disciplines are more likely to share cultural characteristics across boundaries than within them. Becher (1994) argued that understanding disciplinary culture at the macro (institutional context), meso (audience) and micro (practice) levels was '*helpful, and even in some cases essential, to the conduct of research and the development of policy in higher education*' (*ibid*, p.159). Evaluation of productitivity of researchers or the impact of their work on any single level inherently overlooks the cultural differences highlighted in Becher's typology. For example, at the meso level, value judgements based on the amount of research income would favour such areas as physics over, for example, philosophy. Whereas, if career progressions were based solely on evaluation of numbers of published titles, then chemists, who have a tradition of publishing a high-number of short articles per year, would have the advantage over historians for whom monographs, which can take many years to publish, are the predominant mode of communication. Becher also argues that academics in the professional subjects would also be disadvantaged, because they tend to produce reports, rather than journal articles. Becher observed that '*[v]irtually every performance indicator for both research and teaching can in fact be shown to operate unevenly across the range of disciplines*' (*ibid*, p.157).

Becher and Trowler (2001) categorised academic researchers as 'urban' or 'rural'. The 'urban' researcher had a narrow area of study, containing discrete and separable problems, *'clustered around a few salient topics'* (*ibid*, p106), whereas the 'rural' researcher typically covered a broader area of intellectual territory in which problems were not sharply demarcated or delineated, but *'spread out across a wide range of themes'* (*ibid)*. The 'rural' researcher would generally be involved more in long term qualitative work, producing books, such as in the areas of history and modern languages. The 'urban' researcher, for example in the areas of physics, chemistry, engineering and pharmacy in the pure and applied sciences, would publish more short term quantitative work in articles. Becher and Trowler (2001) placed the monographs of

mathematics and biology between the ‘rural’ and ‘urban’ categories. They also looked at some of the data behind studies of the length of the publication process. The need for chemistry, physics and biochemistry to disseminate their results quickly explained their tendency for short papers, often limiting their output to three or four pages in order to cut the gap between submission and publication to three months. This need for fast publications within a research area was also seen in the use of preprint networks. The length of time taken to have a full scale article published depended on the size of the relevant research community and the urban / rural characteristics was documented as follows:

- Physics 9 – 12 months
- Economics 9 – 18 months
- Engineering 1 – 2 years
- Linguistics 2 – 3 years, (although publication in a less prestigious journal could reduce this to 6 months)
- History 18 months – 2 years
- Sociology 18 months – 2 years. (Becher & Trowler 2001, p.112)

The delay in getting work published was seen as indicative of the level of competitive pressure within a research area, whereas the nature and scale of research topics were reflected in the length and frequency of research output:

- Biologists, one to two articles a year of around four to six thousand words, with the pressure to occasionally produce a twenty thousand word monograph
- Specialisms within biology, such as biochemistry, ten or more papers of less than two thousand words, with multiple authorship
- Mechanical engineers, a career total of thirty to sixty papers of around four to six thousand words (yearly total of one or two papers), with a lot of additional output in the form of consultancy and reports
- Chemistry, a yearly output of ten to twelve papers of usually less than four thousand words, with multiple authors
- Mathematics, fewer co-authors and a yearly output of around six papers of six to eight thousand words each
- Active economists, if not writing a book, then two to four papers a year with an upper limit of around eight thousand words
- Historians and modern linguists, an annual output of eight to twelve thousand words, while also working on a book (Becher & Trowler 2001, p.113)

Fry and Talja (2004) used Whitley’s (2000) typology *‘as an explanatory model of e-journal usage within specialist fields’* (*ibid*, p.5). Fry (2006) has furthered the argument that Whitley’s theory can be used as a framework to explain disciplinary differences in terms of style of communication and information behaviours. Owing to the diversity within broad disciplinary groupings typically used as units of analysis there has been a limited *’understanding of information practices amongst scholarly communities that inhabit interdisciplinary, multidisciplinary and trans-epistemic fields’* (*ibid*, p.302).

3. Dissemination and publication behaviours

3.1 Disciplinary differences in patterns of communication

There are discernable differences between disciplines with regard to predominant modes of dissemination and publication, and the rate and speed at which they publish. Different disciplines also produce and publish different types of outputs from datasets and conference proceedings to monographs. It is important to note, therefore, that academic knowledge production and dissemination should not be seen only in terms of published research, especially in applied research areas. For example, a recent study for the Arts and Humanities Research Council (AHRC) on the economic impact of UK Arts and Humanities, stated that,

> *'Typical activities of arts and humanities academics include researching all the various dimensions of culture and the arts; publishing the fruits of such research in books, journal articles, essays in edited collections or in promulgating them in practice-led outputs in the visual and performing arts, or in design; engaging in dissemination (including by contributions to press, radio and TV); engaging in specific knowledge transfer activities, such as exhibitions, public policies development or business improvements; and teaching and supervising arts and humanities undergraduates and postgraduates'* (AHRC 2009, p.9)

Using an example of the various ways music researchers at the University of Edinburgh are involved in dissemination and knowledge transfer, the report lists 14 activities: (1) giving performances, (2) writing film scores, (3) directing church music, (4) reviewing concerts, (5) directing music festivals, (6) recording new works, (7) conducting student ensembles, (8) writing operas, (9) building musical instruments, (10) writing CD notes, (11) giving radio and TV interviews, (12) giving public lectures, (13) judging music competitions, and (14) writing books. (*ibid*, p.19). Oppenheim and Summers (2008) looked at the music submissions made to the 2001 RAE and documented that out of the 2680 submissions, 1025 (38%) were 'Written research', 1386 (52%) were 'Practiced-based research' and 269 (10%) 'Other' *(Figure 2).* The RAE 2008 submissions[1] for music indicate that written research outputs have risen to just over 49%, with a corresponding decrease in practice-based and other outputs.

Figure 2 RAE 2001 Unit of assessment 67 (music), submission types

Written research	Instances	Practice-based research	Instances	Other	Instances
Authored book	178	Composition	650	Chapter / software	1
Chapter in book	367	Performance	429	Exhibition	3
Edited book	35	Artefact	8	Internet publication	28
Journal article	445	Other (CD)	221	Other (not CD)	50
		Design	1	Report	1
		Conference contribution	77	Scholarly edition	76
				Software	9
				- (no submission)	101
				Total	2,680

(Oppenheim & Summers 2008)

[1] Available at http://www.rae.ac.uk/submissions/

Disciplinary differences necessitate cultural sensitivity in evaluating research impact, and issues have often emerged where attempts have been made to evaluate research outputs across diverse disciplines using a uniform set of indicators.For example, Bernard (2000) highlighted a tension between the research culture within history and the then RAE criteria, as historians generally work on highly specialized topics in what Becher and Trowler (2001) would term sparsely populated specialisms, so that, more often than not, they work by themselves. This is in contrast to high-energy physics where physicists also work on highly specialized topics, but within densely populated specialisms where there is a high degree of dependency (Whitley, 2000) and work is typically organized within collaborative groups (Traweek, 1988). Bernard (2000) described RAE returns in history as 'games' where astute institutions or departments can benefit, and historians are put under pressure to produce one monograph per RAE cycle, which can be problematic as it is not untypical for the production of a single-authored monograph to take longer than one RAE cycle and Bernard concludes that*, '[w]e are being harried to produce publications in … the 'angst-ridden world' of RAE'* (*ibid*, p.106).

Monographs have also traditionally been an important mode of dissemination in geography, but in contrast with history the predominance of single-authored monographs appears to be in decline. *'[I]t seemed pretty plain to me that the art of writing monographs of this sort (substantive as opposed to theoretical or ideational treatises) has largely disappeared amongst the younger generation of British geographers'* (Harvey 2006, p.410).

This observation is corroborated by Ward *et al* (2009), who have more recently noted a decline in the production of monographs by UK human and physical geographers. Highlighting the close interrelationship between publication practices and perceptions of research assessment criteria Baggaley (2007) relates the decline in the production of monographs to the need amongst young researchers to establish their reputations in an evolving institutional and technological environment. *'Would Richard Dawkins, if starting out in his research career right now, sit down to pen* The Selfish Gene*? He tells me the answer is definitely "no".' (Baggaley 2007)*

Another perspective, however, is that the monograph might not be so much in decline, rather that its characteristics are changing. For example, within the environmental sciences there has been a proliferation of edited collections (Richards in Ward *et al*, 2009, p.105), and McDowell (in Ward *et al*, 2009, p.122), writing in the context of human geography, explains that there are important pedagogic and scholarly reasons that underlie the continued importance of monographs and edited collections.

Based on a review of the literature Hicks (2004) compared differences in the types and frequencies of outputs published across the sciences, social sciences and arts and humanities disciplines. He documented the findings of a series of previous studies: an Australian study recorded 85% in journals or published conference papers for natural science, compared to the 61% for social scientists and the humanities with similar results from a Spanish study which recorded journal output at 81% for natural science academics compared to 54% for social scientists and the humanities. Hicks explained that, while natural scientists did write popular science books in order to earn money, their initial research output was generally not of interest to the public and, more importantly, needed to be published as quickly as possible before it was pre-empted by someone else. The social scientist did not have this worry and could take *'the time to write books'* (*ibid*, p.197).

3.2 Motivations to publish

Motivations underlying what and where to publish vary, including attempting to reach target audiences (Cheung, 2008), receiving recognition from peers and responding to external pressures, such as research assessment criteria (as interpreted by employing institutions and individual researchers). Luukkonen's (1992) study of Finnish researchers and levels of reward seeking motivations underlying their publishing behaviours suggested that reaching target audiences was important, but that this was achieved differently across disciplines, with a particular tension between reaching international as opposed to local (e.g. national) audiences. For example, Luukkonen (1992, p.316) found that, publication in international fora is a predominant trend across all authors in biomedicine, whereas in zoology there was a stronger national context underlying publication behaviours.

Pressure to publish can be perceived by researchers as a barrier to disseminating research findings informally to their target audiences via seminars, colloquia etc., and perhaps more topically can be a disincentive to disseminate using new communication media such as open access repositories. The consequence of this is that authors may seek to publish in fora not typically read by their target audiences, which may be non-academic, owing to pressures to publish in high-impact factor journals, as Rowlands and Nicholas (2005) found in their survey of journal authors behaviours and attitudes. Sønderstrup-Andersen and Sønderstrup-Andersen's (2008) investigation of diabetes researchers' perceptions of Journal Impact Factors illustrates this tension further:

> *'First of all, we found that the impact factor of a series of journals correlates significantly to the respondents' preferences for publication – the higher the JIF [Journal Impact Factor] the more the researchers wish to publish in those journals. Secondly, we found a correlation between the respondents' preferences as a source for catching up with the newest knowledge on Diabetes research and the journals where the researchers would prefer to publish their work. In relation to this finding we found no correlation between the researchers' actual publication records and their preferences for publication. Perhaps this is an indicator for the actual motivational influence on the publication behaviour of the researchers*.' (Sønderstrup-Andersen and Sønderstrup-Andersen 2008, p.401)

Swan's (2008) study for the JISC Scholarly Communications Group found that, rather than this being a tension, researchers could find reward both in reaching their target audience and in publishing in a journal with a high impact factor. A major motivation for disseminating research was gaining peer esteem regardless of whether or not the channel was a high impact factor journal:

> *'Significantly, almost all researchers say that when they are choosing a journal in which to publish their work they wish to publish in one that has the right audience. They also say that this does not always tally with journals that have the highest impact factors in the field. Publishing in high-JIF journals brings greater rewards in terms of formalised research assessment processes but publishing in journals that reach the right audience brings reward in terms of recognition by peers.* (Swan 2008, p.62)'

3.3 Competition and collaboration

The competition for resources is a fact of life for researchers and research communities and this is especially so when it comes to an author having an article accepted by a high impact factor journal. However, an author can become established in a specific journal or set of journals and

can gainthe cumulative advantage that gravitates towards certain authors both in terms of access to the means of dissemination and also in terms of receiving citations to articles. Merton (1968) coined the phase the 'Matthew effect' to refer to this. Such an effect leads to a self-perpetuating disparity between the 'haves' and 'have-nots' within research communities. Tol (2007) noted *'abundant anecdotal support for the Matthew effect'* (ibid, p420), and sought to provide empirical data to confirm its hypothesis. He looked at the 100 most prolific economists and used the statistical theory of the growth of firms to show that the Matthew effect, in terms of numbers of citations was supported by the empirical data for this group.

The difficulty and consequences of trying to publish in a journal with a high impact factor is illustrated by Van Teijlingen and Hundley (2002), and their experience of trying to get a methodological paper published. They submitted to six different academic journals before it was accepted. Van Teijlingen and Hundley reported that a number of the rejections referred to the UK orientation of their paper, which is a further illustration of the point made by Luukkonen (1992) regarding differences between national and international audiences across disciplines. Their initial attempt to get published in a 'high end' journal, in addition to the a major re-write for the eventual publisher, led to a delay of around a year so that the work was published too late for inclusion in the RAE. Van Teijlingen and Hundley's reported experience is reflected by Macdonald and Kam (2007a; 2007b) who reiterate the correlation between high impact factor and international orientation amongst journals. Articles must be tailored to fit the scope determined by high impact factor journals, and this can potentially lead to a marginalization of novel research, research that challenges standard theories and interdisciplinary research, since authors have to seek alternative less prestigious fora in order to publish.

In terms of trends in publication patterns Kyvik (2003) studied publication behaviours amongst academics in Norway based on faculty surveys conducted in 1982, 1992 and 2001 and identified that: co-authorship had become more common; there had been an increase in publications aimed at an international audience; scientific articles published in international journals had become the dominant type of publication; and the number of publications per academic staff had increased. He surmised that these four main trends may be the result of an increased emphasis on collaboration in research funding both nationally and at the EU level, improved computer-mediated communication technologies that have facilitated inter-institutional and international collaboration, and an almost universal pressure amongst researchers to publish in international peer-reviewed journals. Kyvik also observed a decline in the production of grey literature, such as published reports.

3.4 Open access, the internet and dissemination habits

A recent report on open access to research outputs and its impact on pay-to-publish and self-archiving publishing models found that while funder mandates were held by the stakeholders consulted as having been a major reason for an increase in self-archiving, a survey of researchers produced contradictory evidence (SQW Consulting & LISU 2009). The study found that *'the RAE and the need to publish in high impact journals'* was given as the most frequent reason for a researcher not publishing in open access outlets (*ibid*, p.6). The report stated that 21% of researchers believed that the emphasis given to publications by interviewing panels meant that, *'publishing in Open Access journals might adversely affect their careers'* (*ibid*, p.52). However, this did not lessen the drift towards open access, one of the key issues being the *'perception of OA journal impact'* in relation to the REF and how such outputs might feature in any bibliometric analysis (*ibid*, p.45). The report also found that *'co-authors were most likely to have influenced respondents' decisions whether to publish Open Access*

research in the last five years' and that 74% of the respondents rated the speed of dissemination as being important (*ibid*, p.51).

In their study of the citation of Web-based information in scientific publications, Wouters & de Vries (2004) considered how the Web had changed scholarly communication, stating that the Web was not only influencing how *'scientific and scholarly researchers are organizing their work'* (*ibid*, p.1251), but also that it is *'clearly becoming the dominant medium for scientific authors and scholars'* (*ibid*, p.1258). Palmer's (2005) study of scholarly work and digital access gives a broader view, stating how previous work had shown that while the quick uptake of preprint services by physicists was largely due to how it fitted in with the way they traditionally disseminated, *'it has not replaced formal journal publication, but instead serves as an additional means of distribution'* (*ibid*, p.1143). Palmer concluded that digital access has enabled scholars to build new networks that provide, amongst other things, collegial support and means of scholarly communication, maintaining that this is an *'essential counterpart to the massive e-journal bundles, preprint servers, and institutional repositories under development'* (*ibid*, p.1150).

Studies have shown that disciplinary differences persist in the context of digital forms of communication (e.g. Kling & McKim, 2000). Cronin (2003) outlined how tradition has perpetuated the importance of the monograph in the promotion process for humanities, even though other outlets, such as e-books, might better facilitate communication of their research. Cronin reported how a survey on the usage of preprint services had shown that chemists were reluctant to use such services, whereas physicists regularly used it – *'even allowing for concerns about the reliability [of the survey], these figures reinforce the anecdotal evidence that adoption rates for e-print archiving vary appreciably from discipline to discipline'* (Cronin 2003, p.11). This was later confirmed by Brown (2004; 2007) regarding the different attitude to e-prints between chemists and physicists, Cronin went on to document how computer scientists value refereed conferences as much as, if not more than, peer-reviewed journals; how linguists generally publish in journals, whereas historians use monographs. He also noted the difference in the level of co-authorship, with the historian and the humanities academic generally writing alone, compared to the levels of co-authorship that can be seen in some of the sciences. The changes that Cronin saw in the habits of the humanities, such as smaller projects within history lending themselves to shorter articles rather than monographs or the use of electronic publishing by some *'pioneers and enthusiasts to be found in the humanities'* (*ibid*, p.12), were not that significant. *'In the humanities, career advancement depends on conformance with an essentially individualistic model of scholarly production'* (*ibid*).

There is a general perception amongst authors that greater visibility leads to a greater number of citations and therefore open access publishing and repositories are a positive influence. A recent study into whether open access articles receive more citations than subscription or paid per access articles showed that this was indeed the case, but concluded that the complexity of such factors as the *'different levels of authorship and citation practices'* within the various subjects made it *'difficult to explain the cause of any OA citation advantage'* (Norris *et al.* 2008, p.1970).

3.5 Grey literature and patents

There is a long and enduring tradition of scholars publishing their results using a variety of different dissemination channels. These vary from the traditional scholarly journal, through conference papers, monographs, 'grey' literature such as reports, to outputs such as patents,

performances and compositions. Various motivations have been ascribed to such behaviours, but arguably the most important is that it is part of the reward mechanism in scholarly activity, with greater numbers of publications (and citations to those publications) typically leading to tenure, promotion and recognition. The types of channel used vary greatly according to discipline, but analysis of the types of materials returned in successive RAEs indicates a steady trend in favour of the journal article and away from alternative forms of dissemination. A particular feature of these output types is the great (and increasing) importance of peer review or refereeing.

Published and unpublished forms of communication, however, serve different functions in terms of the dissemination of knowledge and in some disciplines unpublished reports, working papers and conference presentations remain important sources of information. For example, working papers (or pre-prints) in economics have been adopted as a timely way to disseminate the latest research findings (Mili, 2001). Publication lags in economics are notoriously lengthy and the circulation of working papers continues to be an important form of dissemination particulary given the increased opportunities to self-publish that open access repositories such as RePec[2] facilitate.

The Internet has facilited the dissemination and greater availability of grey literature, but for some this has raised the issue of quality, given that grey literature is broadly understood not to be peer-reviewed (Weintraub, 2000).

A number of studies have considered the role of grey literature in meta-analysis, a technique that has come to prominence in evidence based medicine, where the results of a series of studies that cover related research hypotheses are combined (McAuley *et al* 2000, Conn *et al* 2000, Hopwell *et al* 2007). They found that published trials were *'more likely to contain results that are statistically significant'* (Conn *et al* 2000,p.256). The importance and established use of grey literature in some disciplines led Banks (2004) to comment that grey literature needed *'bibliographic resources of comparable depth as those available for the peer-reviewed literature'* (*ibid*, p.164). In a later article, Banks (2006) continued his argument that *'valuable grey literature also deserves extensive exposure'* (*ibid*, p.4). He maintained that improved accessibility, such as institutional and subject-based open access repositories, would lead to at least a flattening of the distinction between grey and non-grey literature.

Frandsen (2009) highlights the blurred boundaries between published and unpublished materials arguing that, *'[g]rey literature is generally not peer reviewed, but can be, and un-refereed publications are not necessarily grey'* (*ibid*, p.129). Based on citation analyses within economics Frandsen found that grey literature in general receives few citations and that working papers in particular have low citation rates despite the popularity of working paper repositories. Frandsen and Wouters (2009) investigated the evolution of working papers into published articles and found that,

> *'An unpublished document will generally be cited in a paper only if it has actually been used in the research process. Its deletion [from the paper] means that scientific and scholarly journals tend to deemphasize the communicative role of (yet) unpublished documents. In other words, grey literature is made less visible in citation analysis of the formal literature.'* (*ibid*, p.734)

[2] http://repec.org

Patents are another measurable form of 'unpublished' dissemination, but their collective lack of structure makes them difficult to evaluate and reference. Attallah and Rodiguez (2006) suggest that the only real measure of value is to compare patents within a specific topic area and timeframe. Meyer and Tang (2007) looked at patent measures in universities and concluded that there is not sufficient data to provide the indicators necessary to base any funding on, unless the research process encourages departments or disciplines to better publish and record their patent activities.

3.6 Country of publication

Disciplines vary in their orientation to either a national or international audience. Taking business and management studies as an example, Doyle and Arthurs (1995) found that UK academics were inclined to publish in UK based journals, rather than in US ones. They proposed two possible reasons for this preference: UK academics produced work comparable to or even better than output from the US, but preferred to publish in a national context oriented to the way they thought and researched; or that *'the British are simply insular publishers'* (*ibid*, p.268). A later study of research in Business Schools by Jones *et al*. (1996), also identified a preference amongst UK academics' to not publish in US journals, concluding that this was because the focus of their research and personal networks were predominantly UK based.

Ormerod (1997) reviewed the findings from an analysis of US academic authors in European management science and operational research journals and suggested that the reasons proposed by Doyle and Arthurs (1995), and by Jones *et al* (1996) were not sufficient, concluding that more work was required. A recent survey of authorship in 56 renowned operation research journals between the years 1996-2005 also identified an inclination for researchers across a wide range of countries to publish nationally, rather than internationally, concluding, *'Interestingly, the results show that authors are inclined to publish papers in their home-country journals'* (Kao 2009, p.406).

4. Citation practices

It is well understood that bibliometric analysis is not a neutral evaluation tool. Current concerns about unintended positive or negative steering effects of bibliometric indicators (Weingart, 2005) and researchers' reactive tendencies (Frandsen & Nicolaisen, 2008) are not limited to the UK. International research in science policy and science dynamics[3] ('scientometrics') has been focused on issues relating to science indicators for quite some time. Adoption of evaluation policies across Europe similar to the RAE in the UK has also spurred studies into the effects of science indicators on productivity and academic careers (Makino, 1998).

Scientometric research has shown that, at the level of individual researchers, whilst positive steering effects might lead to increased motivation to collaborate, the possible negative effects might include exaggerated collaboration and behaviours that inflate citation impact, such as self-citation and citation cliques (Aksnes, 2003, Fowler & Aksnes, 2007). Whilst the impact of self-citation is not considered in detail in this review, the study by Fowler and Aksnes (2007) proposed that there is a larger reward than is generally estimated from self-citation due to the visibility gained to a specific author over a period of time, for example five years. Fowler and Aksnes argued that '*a self-cite may yield more citations to a particular author without yielding more citations to the paper in question*', creating what they term a '*dual effect of self-citation'* (*ibid*, p.434).

These social and cultural dimensions of publication practices also play out differently across disciplines. For example, whilst some disciplines, such as high-energy physics and economics, assign credit for authorship collectively by adopting alphabetical authorship practices, others depend upon first author for credit assignment (Frandsen & Nicolaisen, 2008). These socio-cultural norms evolve over time and are deeply rooted in the fundamental cultural characteristics of disciplines, i.e. the intellectual and social concerns of the scholarly communities that inhabit them (Becher & Trowler, 2001). In some disciplines, professional guidelines may also have an impact, influencing publishers' practice on authorship in selected journals. Furthermore, there is likely to be variation within disciplines, since it has been shown that patterns of communication and coordination of research vary across specialties that share the same parent discipline (Fry, 2006). For example, preliminary research by Frandsen and Nicolaisen (2008) has shown that while at the aggregate level of economics, articles assign credit based on alphabetical authorship in 89% of cases, the rate for agricultural economics is much lower at 44%. Bibliographic indicators therefore can intervene in the culture of disciplines.

There have been a number of studies concerned with the motivations underlying citation practices, but they have generally been limited in scope and have identified the methodological challenges associated with these types of study. Citation analyses involve at their heart an extremely complex system, the human author, but there remains an underlying assumption that dissemination and citation practices can be rationally and empirically explained. In fact, it is likely that there are multiple interrelated factors, some of them more tangible than others, that influence why and how an author cites, and how and where an author chooses to disseminate.

Bence and Oppenheim (2004) found that there has been an increase in the quantity of published research in business and management studies. This may be one outcome of the

[3] The term science is used here in its broadest sense to encompass all major disciplinary groupings e.g. life sciences, engineering, social sciences, arts and humanities.

imposition of tighter restrictions on the word count allowed for an article. Harwood (2008) held that such restrictions have had a direct affect on citation habits, both in using references to point to a detailed explanation of what is being summarised and by the careful and selective pruning of citations to provide maximum impact and relevance in the space provided.

One of the potential consequences of a reduction in the number of citations allowed per journal article is an increase in the Matthew effect. Bonitz (2005) argues that this cumulative advantage can be extrapolated from individual authors, to institutions, and to countries. The Matthew index was set up for the 'ranking of scientific nations'(*ibid*, p.376), with Matthew citations as the measuring unit; Matthew citations can be positive or negative, depending on the 'comparison of observed (given) citations and – according to the impact factor – expected citation' (*ibid*, p.378). Evidence of the Matthew effect has been documented in a number of studies, including Lindholm-Romantschuk's (1996) study of the role of monographs in scholarly communication, which concluded, 'citation patterns over time appeared to acquire a momentum (and this confirms the presence of the Matthew effect)' (*ibid*, p.402). In addition, Aksnes (2003) looked at the 'bandwagon effect' of a highly cited paper where 'its visibility increases and thereby the chances of getting even more citations. This is a variant of the "Matthew effect" (Merton 1968), stating that recognition is skewed in favour of established scientists' (*ibid*, p.168).

There has been an increase in the use of URLs to point to cited material, but there are potential issues over how long such links remain active. Brown (2004) reported a fivefold increase in URLs in biomedical and physical science *Annual Reviews* published between 1997 and 2001. She found that only 34% of the 1997 URLs, and 76% of the 2001 URLs remained viable in 2003. Brown speculated that this might affect the citation rate of authors who previously benefited from the Matthew effect.

In a similar, later, study Brown (2007) analysed over 800 articles from eight American Chemical Society (ACS) journals in the years 1996, 2000 and 2004, containing around 1,300 URLs. She found that, unlike physicists, chemists '*are reluctant to accept the e-print as a viable communication mode due to the lack of peer review of and confidence in the permanence of the digital archives'* (Brown 2007, p.2055). , Brown (2007) ascertained the viability in 2006 of these URLs overall as 77%, rising '*from 34% in 1996 to 73% in 2000, reaching a maximum of 83% in 2004*' (*ibid*, p.2059). Brown expressed concern that there seemed to be an erosion of the viability of a URL over time.

Wouters and de Vries (2004) confirmed the importance of networked databases in their study of 38 scientific journals in five different scientific and social scientific fields, where they found that *'the vast majority of hyperlinks in references do not point to the publicly accessible Web but to scientific databases and literature repositories'* (Wouters & Vries 2004, p.1257).

4.1 The motivation behind citation

The motivations behind citation are complex, and have been extensively studied in a variety of disciplines. Davis (2009) observed that, '*[t]he chief motivation of scientists is recognition from one's peers'* (*ibid*, p.3). He believed that as citation is the chief metric of peer-recognition, it is only logical to expect authors to be interested in maximizing citations to their articles (*ibid*).

Moed and Garfield (2004) analysed the percentage of 'authoritative' references within articles included in the 2001 Science Citation Index. Their focus was on four research fields, Molecular biology and biochemistry, Physics and astronomy, Applied physics and chemistry, and

Engineering. Moed and Garfield found that, contrary to what might have been expected, short articles with reduced bibliographies from the science research fields showed a reduction in the citation of 'authoritative' documents, leading them to conclude, *'[i]n this sense, persuasion is not the major motivation to cite'* (*ibid*, p.302). This is contrary to what Brooks (1985) found in his earlier studies of what motivated citation where he surveyed a small group of academic authors and ranked seven motivating factors – persuasiveness, positive credit, currency, reader alert, operational information, social consensus and negative credit. Brooks was surprised that persuasiveness featured so highly, *(Figure 3),* and concluded that a distinction between science and non-science authors was discernable, and that *'citer motivations are complex'* (*ibid*, p.228).

Figure 3 Citation motivation factors (ranked)

Rank	Full set	Science Set	Humanities Set
1	Persuasiveness	Currency	Persuasiveness
2	Positive Credit	Reader Alert	Positive Credit
3	Currency	Persuasiveness	Reader Alert
4	Reader Alert	Positive Credit	Currency
5	Operational Information	Social Consensus	Operational Information
6	Social Consensus	Operational Information	Negative Credit
7	Negative Credit	Negative Credit	Social Consensus

(Adapted from Brooks 1985)

Brooks (1986) revisited the latter point in a later study where he clustered the citer's motivations into three groupings:

- Persuasiveness, positive credit, currency, and social consensus
- Negative credit
- Reader alert and operation information (*ibid*, p.36)

In a US-based study of citation motivations Bonzi and Snyder (1991) examined the reasons for citing other authors provided by 51 self-citing authors within a selection of natural science disciplines. The 51 authors they surveyed were split across Chemistry (11 authors), Biology (10), Environmental and forest biology (8), Physics (5), Forestry (5), Geology (4), Paper science (3), Wood products engineering (2), Environmental studies (1), Forest engineering (1), and Landscape architecture (1). None of the authors responded that 'political pressure' or an attempt to raise their citation level acted as a motivating factor.

Case and Higgins (2000) replicated a study carried out by Shadish *et al* (1995), surveying all the authors who had cited the work of two highly cited authors in psychology. They then compared the results; firstly with reference to the most highly ranked reasons for citing another document *(Figure 4)* and secondly in terms of the response to questions about the relationship of citing author to cited author and document *(Figure 5).* Case and Higgins (2000) noted that such comparisons must be *'considered cautiously'* (*ibid*, p.641), as the instruments used were slightly different, and highlighted how the White and Wang (1997) also identified *'reasons implied for not citing a document'*, such as a document being too old or too specific, or taking too long to read and analyse (Case & Higgins 2000, p.644).

Figure 2 Most highly ranked reasons for citing another document

Item reflecting the reason for the citation *(Figures represent the % of respondents listing item as most important)*	Case & Higgins			Shadish et al.
	Less cited documents *(N=28)*	Highly cited document *(N=27)*	All documents *(N=56)*	First study *(N=192)*
This reference reviews prior work in this area	14%	33%	24%	3%
This reference is a 'concept marker' – it represents a genre of studies, or a particular concept in the field.	18%	22%	20%	16%
This reference documents the source of a method or design feature	11%	11%	11%	16%
This reference helps to establish the legitimacy of the topic of your article	18%	4%	11%	4%
This reference is authored by a recognized authority in the field	0%	11%	5%	1%
This reference supports an assertion in the sentence in which it occurred *(not used in the Case & Higgins study)*	-*	-*	-*	18%

(Adapted from Case & Higgins 2000, p. 640)

* Case and Higgins followed the lead taken by Shadish *et al* in their second study where they also dropped the question of whether a 'reference supports an assertion in the sentence in which it occurred'; the reason given is that the question is not specific enough and does not allow any indication of how the assertion in the sentence is supported by the reference (*ibid*, p.641).

Figure 3 Relationship of citing author to cited author and document

Questions about the relationship to cited author and document	Percentage of respondents answering yes to each item	
	Case & Higgins	Shadish *et al*
Have you ever spoken directly by phone (or e-mail) with the author?	46%	45%
Would you consider the author a personal friend?	23%	18%
Is the author a colleague at your institution?	2%	9%
Did the author work at an institution where you were trained?	20%	10%
Did a journal referee/reviewer ask you to include this particular reference….?	5%	3%
Have you ever co-authored a document with this author?	16%	-
Have you ever read this reference?	98%	95%
If so, how many months ago (mean)	44	29
Did this reference appear in the journal in which your article appeared?	13%	17%
Do you subscribe to the journal in which this reference appeared?	38%	28%
Do you currently possess a copy of this reference?	85%	85%

(Adapted from Case & Higgins 2000, p.640)

Case and Higgins found that personal contact and familiarity between an author and the person they cited was relevant *(Figure 5).* White (2001) refined the view that authors are familiar with the people they are citing, maintaining, *'While personal acquaintance may reinforce a tendency to cite, the fundamental determiner still is perceived relevance and utility in making a case'*

(*ibid*, p.99). In a later article White (2004) argued that the citations of an article generally showed an even distribution of citations to 'big names' and obscure ones, with the bulk going to authors whose reputations lay between the two; he held that the prevailing pattern of citation followed the 'Mertonian norm of universalism' which credited relevant sources on merit, rather than the constructivists' view that they were employed as a means of manipulating the reader through the gravitas of the citee's reputation. Scharnhorst *et al*. (2007) traced scientific careers through tracing self-citation networks, which can be seen as a more extreme form of citing authors with whom you are familiar.

Harwood's (2008) study focused on the effect of the publication outlet on citation habits, where journal style, space restrictions and the influence of editors and reviewers can all determine how an author needs to document their research. In a later study Harwood (2009) pointed out that it is not clear where earlier studies drew their lists of motivating factors from and, consequently, to what extent they masked opinions the authors might have expressed if interviewed. He does not provide a ranking of motivating factors, but instead outlines 11 citation functions:

- Signposting - helping and interesting less informed readers; keeping the argument on track; saving space
- Supporting – justifying the topic of research; justifying claims;
- Credit – writer debit; credit and self defence; credit and evaluating adjectives
- Position – exemplars of positions; detailed explications of position and results; tracing positions over time
- Engaging – prising but then identifying problems with the source; identifying inconsistency in source's position
- Building – building by citing own work or that of others
- Tying – tying in with others' method and methodology; tying in with schools of thought; tying in with specific debates
- Advertising – alerting readers to one's own work; advertising others' work
- Future – mapping out future work planned by writer
- Competence – displaying knowledge of the literature; displaying ability to conduct future research
- Topical (Harwood 2009, pp.501-511)

Evans (2008) held that citing habits are changing as more journals are available online, claiming that researchers tend to follow hyperlinks, leading to the use of fewer and more recent articles. This has been contested by Larivière *et al* (2009), who point out that empirical studies contradict Evans' assertion that citation of older literature is decreasing in the face of an increase in the citation of newer research. Their study *'shows very clearly that the proportion of uncited papers and the concentration of citations received are* decreasing *rather than increasing'* [authors' emphasis] (*ibid*, p.858). Larivière *et al*'s views are largely supported by Tenopir *et al* (2009), who observed that citing patterns have become more limited, and concluded their study of changes in scholarly article seeking and reading patterns with the observation that, while there has been an increase in the number of articles read by an academic, the number of citations made has remained fairly static. They also held that *'when backfiles of journals issues became*

widely available in this decade, the reading of older articles increased. Larger and deeper e-collections are used when they are made available' (*ibid*, p.28).

4.2 Disciplinary differences in citation practices

Many of the studies discussed above are based on single or narrow discipline groups. Within discipline groups that share similar cultural charcteristics there appears to be little difference in terms of citation patterns and their underlying motivations. Méndez and Gómez (1989) studied a selection of citation classics (highly cited books and papers) in three scientific fields: Life sciences, Physical, chemical and earth sciences, and Agriculture, biology and environmental sciences. Although it was not a primary objective of their study, Bonzi and Snyder (1991) also found no evidence that there was any substantive difference in motivation within the natural sciences disciplines they investigated. Their study involved 51 self citing authors spread across 11 academic disciplines, which they grouped, for purposes of looking at citation across disciplines, into Chemistry (11 authors), Biology (10 authors) and Others (30 authors).

Contrary to this, studies looking across faculties have found indications that there is a difference in citing habits between disciplines. Harwood (2009) references previous work to support his statement that, *'It seems likely that social sciences/humanities disciplines will feature a higher proportion of engaging citations [than computing] because of their discursive, disputational nature.'* (*ibid*, p.515)

According to (Lancaster *et al.* 1990) the country where an author publishes will also influence their citation behaviour. In two, small scale, studies of Phillipine scientists and Korean mathematicians, they found that publciatoins in internation journals contained more referecnes overall, and more references to international authors, than publciations in national journals.

5. Collaboration and co-authorship

There has been encouragement from funding bodies for collaboration between researchers, between disciplines and between national and international institutions (Levitt & Thelwall 2008). The evidence from studies of published research is that collaboration and co-authorship has increased (de Villiers 1984; Drenth 1998; Kyvik 2003; Madison 2003). De Villiers reviewed back copies of the *South African Medical Journal* and found a *'clear shift from predominantly single authorship in 1971 to multiple authorship in 1982'* (de Villers 1984, p.882). Maddison looked at 40 years of the *Journal of Speech, Language, and Hearing Research* from the 1960s to the 1990s,and found that,

> *'Consistent with other disciplines, there has been an increase in the number of authors per article, the number of female authors, and the number of foreign authors [non US]. The increase in the number of authors per article does not appear to have escalated to a point of concern, and may be best explained by an increasing complexity of the research and a healthy trend toward collaboration'* (Maddison 2003, p.3)

Drenth looked at the rise in the number of authors per articles in five-year intervals (1975, 1980, 1985, 1990 and 1995) in the *British Medical Journal* (BMJ), with reference to whether senior authors benefit from the increase the most; the conclusion was that original articles in the BMJ had seen an increase in the number of authors, *'mainly because of the rise of authorship among professors and department chairpersons'* (Drenth 1998, p.219). King (2007) examined the trends in the number of multi-authored papers published in physical sciences and biomedicine from 1993 to 2006, grouping papers into those with 50+, 100+, 200+ and 500+ authors. The trends had stabilised between 2000 and 2003, but showed a further sharp increase in 2004 and 2005. The highest levels recorded from 1993 to 2006 were in 2005, with nearly 750 papers having 50+ authors, 475 having 100+ authors, and 131 having 500+ authors. The maximum number of authors recorded for a single paper (2,512) was in physics, in 2006. Disciplinary differences were noted in the trend in the number of papers with 100+ authors, with physical sciences showing an increase, while biomedicine fell.

This rise in multi-authorship has not been free of controversy. There has been debate over problems created by some co-author lists, leading to questions concerning the responsibility for the validity of the research, the justification for inclusion as a co-author and the ordering of the co-authors on an individual paper (Shapiro *et al.* 1994; Kennedy 2003). It has been claimed that these problems have led to *'unscrupulous senior collaborators'* abusing and bullying junior researchers and using their seniority to *'distort the membership and order of authors on publications and conference presentations'* (Kwok 2005, p.554). The Pharmaceutical Research and Manufacturers of America (PhRMA) guidelines for clinical trials and the communication of clinical trial results have been aligned with those of the International Committee of Medical Journal Editors and major journals, stating that appropriate recognition should be given to contributors and *'individuals who do not contribute in this matter do not warrant authorship'* (PhRMA 2009).

Collaboration has also involved organisations outside of academia. Belkhodja and Landry (2007) looked at the extent to which natural sciences and engineering researchers in Canadian universities collaborated with industry and Government. They concluded that working by yourself or locally within your university increased the feeling of risk taking, which in turn increased the view that working with an external, non-academic partner can impose a less speculative and more restrictive approach. They found that collaboration with industry is greater

within the applied field, whereas speculative and theoretical work is harder to relate to a return on investment (ROI) approach. Engineering is seen as a *'field where the recognition by publication is supplemented by the professional recognition of the industry'* (*ibid*, p.324). Belkhodja and Landry conclude,

> *'The study confirmed that the sole use of an economic approach to explain the sciences and engineering researchers' collaboration is insufficient and does not take into account all the complexities that drive collaborative behaviour. Rather than focusing on a unique return-on-investment approach, we have demonstrated that collaboration is, in addition to being dependent on the field's values, a personal choice based on a strategic reasoning in addition to being based on economic calculations.'* (*ibid, p.325)*

Van Looy *et al.* (2003) looked at whether there is any truth in the perception that academia might be adversely affected by the pursuit of the *'application-oriented needs of industrial corporations'* (*ibid*, p.428). They concluded that there is no trade off between entrepreneurial and scientific activities within their sample (KU Leuven, Belgium); in fact scientific activity is stimulated, *'resulting in larger publication outputs'* (*ibid*, p.439). They speculated that this can lead to a Matthew effect, even a *'compound' ME – 'not only that the "rich get richer", but also that the "diversity" of their richness increases'* (*ibid*, p.439) – so they increase their share not only of the amount (quantity) of publications, but also of the range of the publications in which they publish.

5.1 Collaboration and citation levels

In their analysis of nearly half a million Science Citation Index (SCI) indexed and refereed UK research and development (R&D) publications between 1981 and 1994, Katz and Hicks (1997) found that *'the impact of UK papers in any discipline or sector are higher if there is a collaboration of any kind'* (*ibid*, p.554). This impact was greatest when foreign institutions were involved, where *'adding an author from a foreign institution to a paper earns an additional 1.60 citations per paper on average which is more than twice as much as adding an author from a domestic institution'* (*ibid*, p.552).

More recently, Moed (2005) concluded that seven out of ten international collaborations between scientifically advanced countries were likely to lead to a higher citation impact than *'purely domestic collaboration'* (*ibid*, p.290). However, A study of the scientific research publication of ten departmental areas at a Spanish university between 1997 and 2003 has raised questions over whether the link between multi-national co-authorship and increased citation levels is incidental, showing that while citation levels are raised by both multi-institutional and multi-national co-authorship, there is no direct relationship (Iribarren-Maestro *et al.* 2009). They also drew attention to the fact that in some papers in growing research areas *'multi-authorship is indicative more of researcher training than of cooperation among two or more experienced scientists'* (*ibid*, p.199).

In contrast to this, a positive link between international collaboration and citation levels has been found by Inzelt *et al* (2009) in their study of co-authorship in Hungarian higher education institutions, in which they concluded that international co-authorship had a positive effect on citation levels. Levitt and Thelwall (2009) found evidence that generally backed up the existence of this positive link; they listed eight studies that showed the positive link, and one that did not.

Other studies have focused less on international collaboration. Persson *et al*. (2004) carried out a major study on collaboration and citation within the sciences between 1980 and 2000. Their findings indicated that the frequency of co-authorship and citation networks had increased, but they were cautious about drawing any universal, cross-disciplinary conclusions between this intensification and the increase in *'publication activity and citation impact'* (*ibid*, p.432). Some differences were found between the areas of interdisciplinary and monodisciplinary research. Adams *et al* (2007) looked at the differences and found that interdisciplinary research did '*not receive systematically fewer citations than more monodisciplinary publication*s' (*ibid*, p.2).

Whether interdisciplinary or monodisciplianary, there is no agreement that more citations are gained through multi-authorship. In their study of psychological research on tourism, Barrios *et al.* (2008) found that, after self-citation had been taken into account, there was no evidence that multi-authored articles received more citations than single-authored ones. They did find that multi-authored articles had more self-citations, although it is not clear if the average number per author within the multi-author grouping is greater than the average per single author. Barrios *et al* (*ibid*) cite a number of previous studies that have looked at the number of citations and the number of authors mainly in the social and natural sciences, leading to contrary views as to the significance of the relationship between the number of citation an article receives based and whether it is multi or single authored.

The studies conducted by Levitt and Thelwall (2008; 2009) have thrown up contradictory findings on collaboration and citation levels. Their later study related how *'several studies have found it useful to investigate the relationship between collaboration and citation with a view to exploring the underlying relationship between collaboration and quality'* (Levitt & Thelwall 2009, p.434). Their own study of Information science and library science concluded, *'collaboration is clearly associated with higher citation'* and they *'hypothesise that, in general, collaborative research is becoming increasingly significant and influential in LIS. An implication for authorship is that it seems to have become increasingly difficult for a sole author to produce highly cited IS&LS research'* (*ibid*, p.441). Their earlier study of citation levels in multidisciplinary journals had found that their results did *'not support the assertion that in general, multidisciplinary articles are more highly cited that monodisciplinary articles'* (Levitt & Thelwall 2008, p.1982), with the citation levels nearly double for monodisicplinary articles in the fields of Life sciences, Health sciences and Physical sciences. They suggested that the difference with the results of their Information science and library science study was the higher quality of the Information science and library science research, *'it also is possible that multidisciplinarity is an advantage for the highest quality research, but not for "average" research'* (*ibid*).

5.2 National and international collaboration

A longitudinal study of the output over 14 years of 65 biomedical scientists in New Zealand concluded that both international and local collaboration had a significant bearing on the quality of an individual paper, and that while local collaboration was *'related to the future quantity of research output, only international collaboration is related to "real" research output of a scientist that takes quality and authorship into account*' (He *et al.* 2009, p.316). This confirmed the view reached by Griffith and Miller in 1970, that academics often preferred to collaborate internationally, rather than locally, despite the latter being easier – although they do not take into account the advances in communications that technology has brought about since Griffith and Miller's observation.

Bordons *et al* (1996) also looked at the effect of collaboration from an international, domestic (national) and local (within the local institution) aspect. They analysed the collaborative publications of Spanish authors in the three Biomedical subfields of Neuroscience, Gastroenterology and Cardiovascular systems during 1990-93. Their conclusion was that there was a positive connection at the author level between productivity and international, domestic and local (within-university) collaboration in Gastroenterology, and between productivity and international and domestic collaboration for Cardiovascular systems and Neuroscience. They found that international collaboration confirmed the view that *'collaboration has been said to enhance productivity and visibility'* (*ibid*, p.294).

6. Perceptions and steering affects of research assessment methods

6.1 The UK Research Assessment Exercise

Research assessment has long been a feature of UK Higher Education in a variety of forms, for example when decisions are taken regarding appointment and promotion. With the advent of the Research Assessment Exercise (RAE) in 1986 and, more recently, the new arrangements for the assessment and funding of research as embodied in the proposals for the Research Excellence Framework (REF), measuring the quality and impact of research has become particularly critical to all UK Higher Education Institutions. RAE (and in future REF) quality profiles will be crucial in both deciding the amount of funding a particular HEI receives from its funding agency under Quality Review, but the scores will also be a matter of public knowledge, and a high score is likely to be an attraction for potential staff, students and external research funders. The proposed REF will combine both quantitative and qualitative indicators, with a greater emphasis on measuring impact than the RAE, and it is intended that the balance between the two will be sensitive to disciplinary differences. The Higher Education Funding Council for England (HEFCE) are working in consultation with a range of stakeholders and using multiple approaches to develop the REF, which means that the actual 'look and feel' of the REF is still evolving and researchers' perceptions of it are also likely to change as it evolves.

Perceptions of research assessment methods and criteria can be highly influential in shaping researchers' behaviours. The reasons why different media types are preferred in some disciplines but not in others is rooted in a combination of a logical consequence of the types of research that occur in the various disciplines, historical traditions within the discipline and the length of text and other materials that are associated with research outputs in that discipline. Disciplines evolve over time, meaning that the evaluation of the researchers that inhabit them faces a moving target and there is a risk that indicators embedded in practice, such as bibliometrics, will in turn reify those shifting disciplines. This was the perception of the RAE in the mid-1990s when there was much debate about the fairness of the RAE in terms of its representativeness of the structure of disciplines and academic departments, particularly in respect of multidisciplinary and interdisciplinary research, with criticism being strongest in the social sciences, and the arts and humanities. In response to such criticisms, HEFCE commissioned a report (Evaluation Associates Ltd, 1999) which found that one third of HEI departments had adapted their research and application strategies as a result of the perceived treatment of interdisciplinary research by the RAE. Seventeen percent of Heads of Department reported that the RAE had discouraged their departments from pursuing interdisciplinary research, while 14% reported that it had encouraged interdisciplinary research, with the remaining 69% claiming that there had been no effect. Findings of the study highlighted that the RAE had encouraged researchers to concentrate on publishing more papers, particularly in peer reviewed journals, and on research that produced results in the shorter term, rather than the longer term.

Whilst concerns about the negative steering impact of the RAE on interdisciplinary research have not been proven, it is interesting to note that, on average, interdisciplinary journals have a lower impact factor than core disciplinary journals (Levitt & Thelwall, 2008). This is an area of uncertainty that commands attention given that the issues of the 21st Century are inherently interdisciplinary in their nature e.g., poverty, climate change and migration. This has been recognised by the Research Councils UK whose policies actively encourage interdisciplinary

collaboration, though institutional factors, including mechanisms for recognition and reward, are often cited by researchers as a barrier to such collaboration.

Moed reviewed the bibliometric patterns of the RAEs of 1992, 1996 and 2001, and found that the *'bibliometric pattern observed in the years prior to the RAE 2001 shows a much stronger resemblance to that observed during the years prior to the 1992 RAE, than it does to the pattern obtained for the years preceding the 1996 RAE'* (Moed, 2008 p.160), leading him to conclude that the move from quantity to quality in the 1996 RAE seemed to have been reversed in the 2001 RAE. There is a strong view that any gains brought by the RAE are at the long-term expense of some of the intrinsic values of academic research (Brown 2009). There has been agreement that universities and research activities have become more efficient, business like and business focused, with better accountability of the return on investment (ROI) that the public were to expect from the investment of their taxes in academia (Hare 2002). ROI can be pursued to extremes by the management practice of 'sweating your assets' (Redden 2008). A different perspective, however, is that the RAE is a threat with the encroachment of short-term business and management practices detrimentally impacting academic identity (Archer 2008), leading to the dropping of unproved areas of research (Lee 2006), or the closure of established areas that were perceived as failures under the evaluation system (Newman 2009a). There is also evidence to the contrary, that the reward in reputation and citation can be high for authors researching new unexplored fields of a discipline; Lancaster and Surrey were identified as the most improved universities, in terms of *'showing the highest increase'* in rank within the *Times Higher Education Supplement* (THES) world rankings (Researchtrends 2008a). The universities' two most cited papers *'came up with a new and original idea'* that *'opened up new ways of thinking'* according to one scientist who cited one of the articles (Researchtrends 2008b).

6.1.1 Early career researchers (ECRs)

There has been an expression of concern over how the RAE has rewarded past performance and, consequently, has impacted ECRs (Hare 2002). This impact is also reflected in the stress that the pressure to publish brings, the increasing reluctance for an established research institution to hire ECRs and the long-term effect of the change in the learning process and development for ECRs (*ibid*; Larkin 1999). In his brief correspondence, Larkin reported anecdotal evidence provided by a check he had carried out on ten of his contemporaries in the field of molecular microbiology, in which he found that

> *'The pattern of publication output over their careers is revealing. Generally they produced few papers over the first ten years, although the quality of the work was clearly outstanding. During that time, each one went for an average of 3.8 years without apparently publishing (or producing a cited paper) at all. In one case there was a five-year gap! The conclusion I reached from this simple exercise is that application of the current RAE exercise might have precluded all of them from appointments to academic posts.'* (Larkin 1999, p.467)

Wray (2004) looked at the contribution of young scientists in new fields. He found that middle-aged scientists made the most new discoveries, helped by the fact that they had greater experience and skill in communicating their ideas and findings to their peers. This is illustrative of how an ECR's research skills and the benefits gained from their research develop with experience and within the appropriate environment.

Archer (2008), in her pilot study, found that younger academics were under pressure from the need to publish for the RAE and build up a portfolio of published work. She documented how

'respondents recounted instances in their own department where "non-research-active" members of staff had had their academic contracts revoked' (*ibid*, p.391). One of her interviewees told of one piece of the advice given by someone who had successfully raised their department in the rankings from grade 3 to 5 in a couple of years, *'….don't buy potential, buy people in their mid-careers that have been successful, and buy their CV's, basically. Don't buy new ones.'* (*ibid*, p.390)

6.1.2 Researcher and institutional reputational strategies

Harley (2002) argues that *'there is growing evidence, both academic and anecdotal, to suggest that the periodic assessment exercises have come to dominate research activity in UK universities, despite some serious misgivings and qualms'* (*ibid*, p.188). Harley emphasises that *'the dual nature of the RAE as both a system of peer review and a managerial control strategy has rendered academics divided in their perceptions of and response to it'* (*ibid*, p.203) and despite the apparent distaste for the RAE, by responding strategically, academics have supported it and guaranteed the future of research assessments. Bence and Oppenheim (2004) also found that publication as an output had become the focus of researchers' activities, rather than as a medium for the dissemination of ideas and knowledge. Likewise, Loftus (2006) felt that the RAE dominated academic matters, proclaiming that by participating 'we have built ourselves into the body-walls of the system that encloses us', but concluded his polemic on the RAE with the hope that 'praxis might actually change reality' (ibid, p.112).

Institutions can take different approaches in order to improve the chances of a positive outcome from the RAE. There are instances at the discipline level where submissions to the RAE have been filtered down to the perceived best, or conversely where work from as many staff as possible has been submitted (Barker 2007). At the institutional level there have been strategies to bring in leading researchers or even Nobel Prize winners (Hare 2002; Georghiou 2009). Barker states that *'the incentives to perform are very strong and the consequences of failure severe. Thus, universities and academics have been drawn into a strategic game, and invest tremendous efforts in trying to win'* (Barker 2007).

Allowing institutions to be able to select the academics that they put forward for assessment has been noted as having an unfair impact on the RAE 2008 results (Newman 2009c) and it is something that is still being debated in reference to the REF. There is also a move to understand bibliometrics and recruit expertise (Harrison 2008; Smith 2009). The REF has been on the agenda of universities for some time, generally monitored by senior staff, such as the vice chancellor or dean for research. Disciplines within universities are actively monitoring and discussing the REF (MMU Library Services 2008; Smith 2009).

The preparation for RAE 2008 saw some institutes buy in world-class researchers to successfully boost their ranking (Hare 2002; Newman 2009c). Currently universities are investing in implementation or updating of repositories and management information systems recruiting the staff to manage them and to understand bibliometrics (Liverpool Hope University 2006; Manchester University 2008). There is some evidence that institutions will encourage, or even mandate, their academic researchers to place their publications in the institutional repositories:

> *'This new metrics-informed process, when fully implemented, is meant to reduce the burden of making submissions. For this to happen the SOAS research online has been implemented and it is therefore crucial that every member of staff systematically input in*

this new database their publications as soon as they are published.' (School of Oriental and African Studies, University of London website, n.d.)

The use of the term 'games playing' can be emotive and tinged with a sense of unfairness, but as quoted in a recent *Times Higher Education* article looking at the status of the proposed REF, *'To call it game-playing seems to miss the point. Any evaluation system will shape the behaviours of institutions and departments. The argument is how to shape the right kinds of behaviours'* (Corbyn 2009b).

6.2 Attitudes towards the proposed REF

One online summary of the Thomson Scientific organised event, Beyond the RAE 2008: Bibliometrics, League Tables and the REF, states that the consultation process carried out by HEFCE *'essentially found that most responses felt bibliometrics were indicative of quality'* (Overdue Ideas, 2008). However, the analysis summary produced by HEFCE does not appear to substantiate this (HEFCE 2008a). There is consensus that the measurement of quality and the basis of funding on quality is the path to take (ibid, HEFCE 2008b), but the suitability of bibliometrics to measure quality, or at the very least the identification of the appropriate indicators to use, remains the most voiced concern with the proposed REF (Armstrong 2008; Nolan 2008; Smith 2008; Surya et al. 2008; Nature editorial 2009). Many of the RAE 2008 panel chairpersons saw peer reviews as the core measure, with bibliometrics as a useful tool to inform the peer review process (Corbyn 2008b). Expert panel evaluation has its critics (Langfeldt 2004; Newman 2009b) and some see bibliometrics is a valued attempt to use some objective measures to compensate for any flaws in the potentially subjective peer review process. Some of the other areas of concern are:

1. *The analysis of multidisciplinary subjects:*
   There are concerns about how multidisciplinary research will be treated, both in terms of how it is assessed (Kerr 2008; Wilson 2008) and in how institutions classify it for assessment; there will still be differences in the assessment process between subject groupings, thus allowing institutions to place multidisciplinary research in the study group that gives them the better result. The emphasis from some sources is on multidisciplinary research, but both the RAE and the REF are *'grounded in teaching-based structures'* (Georghiou 2009, slide 24). Levitt and Thelwall (2008) conclude *'that at least in the sciences, multidisciplinary researchers should not be evaluated by citations on the same basis as monodisciplinary researchers'* (*ibid*, p.1973).
2. *The difference in output from subjects linked together in a subject group and the metrics to be used to measure them*:
   This has lead to concern regarding how the results will be averaged out, and the ability of a peer review panel to have all the subject knowledge required to cover all the subjects within a group (HEFCE 2008b).
3. *How early career researchers (ECRs) will be treated* (Kerr 2008):
   This includes both the continued pressure on ECRs to publish (Sloman 2008), and the fear that some institutions will be reluctant to take on ECRs as they will not have built up a body of cited work. In one *Times Higher Education* news article (Attwood *et al.* 2009) two universities, Aston and Brunel, explained that their lower than hoped for ranking in the RAE 2008 was partly due to their submission of a large percentage of the staff, of whom about 20% were ECRs.

4. *The effect on research policy*:
   The RAE was felt to have affected the research policy and staff recruitment of economics departments (Lee 2006). There are concerns that the REF will perpetuate this mainly through a reluctance to enter new areas of research that do not have a history of citations. This could lead to the focusing of a department's research on narrow, traditional areas, and even affect the hiring and firing strategy or the closure of departments (Newman 2009c).

5. *Suitability of Thomson Scientific's WoS database, especially as the only source* (Corbyn2008a):
   This concern not only covers the accuracy, and range of the WoS, but also the need to include monographs, grey literature and other non-journal output of research. This has taken a further turn as Thomson have recently acquired the company, Evidence Ltd, that has been employed by HEFCE as consultants to *'determine how citations should be used'* (Corbyn 2009a). The recent report for RIN (Research Information Network 2009) reviews the differences which can arise from the use of Wos and SCOPUS, and considers other factors which affect bibliometric studies.

6. *The time taken for research to be published and then cited in other articles:*
   This means that research funding could be based on research that is years old. This also raises the question of whether an academic's research follows them, or resides with the university (Brunel University 2008).

7. *The government's focus on STEM subjects (Science Technology Engineering and Mathematics)*:
   Many fear that the focus on STEM subjects and commercial return on investment (ROI) (Marshall 2008; Henderson 2009) will be at the expense of the Arts, Humanities and the 'soft' sciences.

A recent leader in the *Times Higher Education Supplement* suggested that the consultation process had moved the REF in a direction agreeable to most of the academic sector, but warned, *'there is still much at stake in the fine-tuning'*, especially if the current dual funding system is folded into one administered by the research councils and the universities lose *'true autonomy over how to spend research income'* (Mroz 2009).

6.3 The situation in Scotland

University research funding in Scotland is the responsibility of the Scottish Funding Council (SFC), and *'Research Pooling is a significant and unique feature of Scotland's world-leading academic research base'* (Scottish Funding Council 2005). The SFC website lists 12 current Pooling initiatives forming alliances between such disciplines as physics, chemistry, engineering and mathematics, engineering, and economics. It allows universities to unite to facilitate the collaboration and pooling of teaching resources and expertise, as well as gaining economies of scale in research training and increasing the scope for research initiatives and funding (Nature editorial 2007; Scottish Funding Council 2007; SUPA 2009).

The SFC is keeping the Scottish HEIs informed of the progress of the REF (Scottish Funding Council 2008). The same consultation was held in Scotland as conducted in England by HEFCE; SFC received 40 replies from individuals, organisations and Scottish HEIs. A recent update (Gani 2009) maintains the position that the SFC is not committed to implementing the REF, or to any timetable if they do choose to implement all or part of the REF.

7. Research assessment methods beyond the UK

The UK RAE process has been influential in the setting up of many international research assessment processes, whether as a template, or as an argument for an alternative or adapted approach (David 2008). The variety of, and sometimes lack of, assessment processes in other countries also illustrates some of the arguments for and against the UK current and proposed processes.

7.1 Australia

The experience in Australia, which has been reviewing its research assessment process over a number of years, is particularly pertinent. Its existing system is based on a quantitative measure of research output (Geuna & Martin 2003). The proposed replacement, the Research Quality Framework (RQF), was based on the Britain's RAE (Butler 2008), but it has been abandoned and a new Excellence in Research for Australia Initiative (ERA) is being introduced. The RQF received criticism for being based on an old research assessment model that was due to be replaced (Shewan & Coats 2006) and was

> *'Based on a 20th century concept of professional achievements which encourages actors in universities and government research organisations to move physically to larger centres to specialise rather than to diversify, and to move upwards through hierarchies of power and privilege whose apexes decide what counts and what should be rewarded.'* (Marinova & Newman 2008)

Hall's (2007) article on the RQF covered concerns that echo some of the views expressed in the UK over the REF, stating that 'research performance metrics, such as those based on publication rates, numbers of graduate students, or citation or usage data, often do not measure the research attributes that it is claimed they do' (ibid, p.30). Hall observed that trying to find universal performance metrics met with problems within some disciplines, as well as across disciplines. He felt that even if issues with the use of citation measurements were identified, attempts to correct them would fail. Hall concluded 'the use of research performance metrics is inevitably a crude and unreliable way of assessing actual research performance' (*ibid*, p.30). The intention is for the newly proposed ERA to be a 'progressive (rather than simultaneous) examination of discipline clusters by institution' using 'expert review and international comparison' on top of the existing quantitative system to 'focus on departmental comparison using metrics only' (Hicks 2009, p.400). Some of the disputes have, just as in the UK, been over the quantity, quality and impact of research output. Butler's (2003) review of the increase in publication output in Australia in the 1990s was influential in the initial proposal of the RQF. She held that there had been a 25% increase in the volume of publication, but a decrease in the impact, and concluded that it was a result of the Australian funding system being based on the quantity of output, rather than quality. Redden (2008) argued that Butler's conclusion was misleading. He maintained that Australian research had not seen a reduction in impact – 12 Australian universities (32%) were in the world's top 100 universities, compared to the 13 UK universities (10%). He felt that the fact the UK usually has four universities in the top 10 reflects the way the UK's RAE process rewarded the elite. Redden maintained that the limited number of slots in the top journals meant that an increase in research output would be spread across a burgeoning academic publishing industry. In his assessment the impact of Australian research had grown, but it 'was explained away as failure because the lower end grew faster than the upper' (*ibid*).

7.2 New Zealand

New Zealand has a system that includes a process that is more inclusive of direct peer evaluation than the UK. The first assessment was conducted in 2003, with a second assessment in 2006, but it did not include all university staff. The next is scheduled for 2012, but the process is under review (Tertiary Education Commission, 2008). The assessment is based on: the number of completed research degrees; the amount of external funding; and evaluation of teaching and research staff, via a personal Evidence Portfolio that documents their research output, their contribution to the general research environment and their peers' evaluation of their reputation in their research area (Tertiary Education Commission, 2006).

7.3 Hong Kong

In 1993 Hong Kong received advice on research assessment from UK experts. Their system was modelled on the UK's and also called the Research Assessment Exercise. Four assessments have been carried out in 1993, 1996, 1999 and 2006 and are usually run to synchronise with the universities' three-year strategic plans (Universities Grants Committee, 2007). The University Grants Committee announced in 2008 its intention to conduct a review of the system (Universities Grants Committee, 2008).

7.4 Germany

Germany's assessment model has not followed the UK's centralised model, arguably leading to closer links with industry. German universities have retained a fair amount of autonomy; traditionally, any assessment was an internal process and competition between universities was limited. The universities are generally funded by the Länder (federal states) or sometimes by industry. The law effectively blocked any attempt to centralise evaluation and funding until a change was passed in the Federal Framework Act in 1998, leading to a gradual introduction of performance assessment, rankings and competition (Geuna & Martin 2003). As an example, in 2005 the German Council of Science and Humanities commissioned a report on the *Research Performance of German Universities and non-university Institutions in Chemistry*, which assessed 77 units using informed peer review, covering research, promotion of young researchers and knowledge transfer (Steering Group for the Pilot Study Research Rating, 2008). The report highlighted that the research rankings were based solely on universities, which excluded the major contribution made by non-university research in Germany. The report concluded, 'The allocation of public funds should not be directly linked to any selective assessment' (*ibid*, p.8).

7.5 Netherlands

The Netherlands' system has two key differences to the UK; the first is the staggering of when the assessment cycle starts for different disciplines, the second is the proposed intention to evaluate for future strategy, rather than funding. The Netherlands introduced a temporary evaluation and funding model in 1999 called STABEK, a Dutch acronym for 'stable funding'; the intention is to eventually replace it with a model that focuses more on performance (Geuna & Martin 2003). The disciplines are not all assessed at the same time; individual committees, mainly made up of non-Dutch members, carry out their assessment over a five-year period using a single standard. The assessment looks at the academic staff, the mission and strategic plan, the content and results, the publications and any additional indicators of academic reputation and quality. The committees use four assessment dimensions: scientific quality; scientific productivity; scientific relevance; and long-term viability (*ibid*).

7.6 Denmark

Denmark's system answers some concerns expressed in the UK about teaching not being taken into sufficient account due to the RAE. Geuna and Martin (2003) documented that Denmark introduced a new funding system that distinguished between teaching and research in 1994, which awards funds based on *'volume of teaching and external research income'* (*ibid* p.288). A more recent report stated, *'The funding system of Danish Higher Education Institutes (HEIs) is under rapid change'* (Schmidt *et al*. 2006 p.i). The main source of funding for teaching is the *'taximeter system'*, which is based on how many students pass their exams. Research is funded through two systems. The first is a basic grant based on historical factors, rather than any performance evaluation. The second is from external grants, which involve a measure of competition and, consequently, performance evaluation.

7.7 Norway

Compared to the UK, Norway has managed to keep the cost of any assessment process down to the minimum, mainly by not implementing one. In 1993 Norway began to consider examination results when allocating funding, otherwise it has retained its system of block grant allocation without any consideration of research performance (Geuna & Martin 2003), although it has commissioned various studies into the efficiency of the research community (Research Council of Norway 2009a; 2009b).

7.8 Finland

Finland offers an example where the individuality of each institution is recognised, leading to the continued autonomy of its universities and a successful opposition to the imposition of a RAE-like system. The Finnish system is closer to the German model. Performance assessment has been used to guide a relatively small proportion of its funding allocation since 1994 (Geuna & Martin 2003). Geuna and Martin documented the 2002 split as 90% to basic funding, 7% to projects and 3% to performance-related – the last was scheduled to increase. Three types of evaluations are carried out, none of them specifically focused on research: institutional; programme / thematic; and accreditation (*ibid*, p.288). Each university is considered to be different, so there is no attempt to apply a common model across the universities. An attempt to bring in a performance-based system based on the UK's RAE that would link 35% of funding to research performance every three years, was opposed by virtually every university and subsequently dropped (*ibid*, p.290). The universities have traditionally carried out and reported on their own internal assessments. The University of Helsinki has gone one step further, in the late 1990s it decided that it needed to *'consolidate its position amongst leading research universities in Europe'* and *'decided to subject its research to international assessment every sixth year'* (Makarow & Haila 2006, p.7). This exercise has occurred twice, first in 1999 and more recently in 2005.

7.9 Poland

Poland also has a three year assessment cycle, which is overseen by a Committee for Scientific Research with a chairman appointed by parliament. One-third of the committee's members are government ministers and two-thirds are researchers elected by their peers. Funds are allocated in three ways: based on the number of students; grants awarded to individuals and teams via competition and peer-review; and 'statutory funding' given to faculties and based on *ex post* evaluations and future research plans (Geuna & Martin 2003, p.292) - the latter was originally assessed by expert panels. The Polish system has suffered from the problem of how

to measure quality, especially in a unified way across disciplines. Every three years the panels would classify each institute using a combination of quantitative and qualitative indicators, but the subjectivity of the qualitative aspect of the algorithm was criticised and in 1998 it changed to one that was virtually quantitative; Geuna and Martin (2003) felt that new criticism was likely to force the formula to change again.

7.10 Eastern Europe

Geuna and Martin's (2003) account of the state of research assessment in Eastern Europe is illustrative of the fears that any process could be used as a management cost cutting tool, *'Research evaluation has emerged as a tool to examine how and where to cut budgets without destroying research. Peer review has become the main instrument'* (*ibid*, p.290)

They point out that some of the power of the academies has survived the Soviet era and assessment is based on the institutes. Geuna and Martin (2003) related how the Academy of Sciences in Hungary conducts a comprehensive review of its institutes almost every year, while in the Slovak Republic an accreditation committee was set up in 1992 to carry out an assessment of the Academy of Sciences' institutes and departments every three years. The indicators for the university departments were quite extensive, especially in the context of such a short assessment cycle, consisting of: publications during the previous five years; citations in the Scientific Citation Index (SCI) during the five-year period; participation on editorial boards; participation in conferences and activities which had reputational value; qualifications of teaching staff; numbers of postgraduate students; research conducted by senior staff; and number of foreign students' applications and the subsequent employment of graduates. (*ibid*, p.291)

7.11 North America

Hicks (2009) termed the assessment of US university departments as a 'free-lance' exercise when compared to the UK and Australia. Individual states have implemented performance-based funding, starting with Tennessee in 1975 (Atkinson-Grosjean *et al.* 1999). The National Research Council has undertaken a series of ranking exercises, but no funding is linked to it.

Canada gives an example of some of the issues found when there is a lack of a cohesive research assessment process. A report by the Ontario Confederation of University Faculty Associations (OCUFA) showed that Canada does not have a unified research assessment research process (OCUFA Research Paper 2006). There are different performance indicators collected and used at the provincial government level, although not in every province. Alberta and Ontario are examples of provinces that 'use indicators to directly tie institutional performance to funding'; where there is a link it is usually rigidly applied (*ibid*, p.8). Where there is no link to funding the institutions themselves often participate in performance reporting. A report on a regrettable incident at Concordia University in 1992, *'Found a prevailing culture at the university of "production-driven research" which they compare to an auto industry driven by quantity, rather than quality.'* (Powell 1994) The report went on to state that the problems at Concordia were a widespread manifestation of the degeneration of research and scholarship activity across Canada.

8. Discussion and conclusions

There is evidence to suggest that publication in peer-reviewed fora, essentially journals, has increased over time and has become a primary dissemination objective of researchers in most disciplines. This appears to be the case even in those disciplines where journal articles have not been the predominant channel of communication. A barrier to publishing articles in high impact factor journals is competition for limited resources and subsequent publication lags, but none-the-less motivation to publish in as high-ranked journal as possible seems high amongst researchers.

There are noticeable differences in patterns of dissemination across disciplines; indeed differences can exist even within a single discipline. Disciplinary differences are also reflected in citation behaviours, with the difference being more noticeable at the boundaries between broad disciplinary groupings e.g. physical sciences, applied sciences, social sciences and humanities.

Researchers perceive that the Research Assessment Exercise has placed considerable pressure on academic authors, whose publication activities do not necessary match the perceived evaluation criteria, sometimes leading to publication in journals that are not the natural reading environment of the researchers' target audience. One way in which interpretation of research assessment criteria has manifested is in the pressure experienced by researchers to publish in journals with an international audience, when a national journal might be more appropriate for the area of research, and more accessible to the target audience.

Dissemination of research takes many forms aside from publication in books or journals. This is especially the case with applied research and, as a consequence, some valuable outputs, such as methodologies, artefacts and fora intended for a lay or practitioner audience, are not included in research assessment submissions. Applied research has more instances of collaboration with bodies outside of academia, which leads to a requirement, and preference, to publish in professional journals. Such outputs tend not to be regarded as highly as peer-reviewed journal articles by research managers, or in research assessment criteria. Patents and grey literature are two important types of dissemination that receive less credit than they might by authors themselves (due possibly to the perceptions highlighted above). Open access to research outputs is on the increase, but there is evidence that the perception and institutional implementation of the most recent RAE adversely affected the speed of its uptake by some academics. The changes being proposed for the REF seem to have removed that impediment.

There has been an increase in the use of URLs in published articles, mainly due to the increase of online databases and repositories, and the increase in open access to research outputs. The evidence suggests that pointers are usually to new or recent work within databases and repositories, which have become more established and should help to reduce even more the loss over time of URL viability that has been observed.

Collaboration and co-authorship has increased greatly over recent years, mainly through a shift in emphasis amongst funding bodies. The number of co-authored papers has levelled off in recent years, but remains high. Inter-institution collaboration is likely to be favoured over inter-department collaboration due to the perception that the latter can only be submitted to the RAE by one of the departmental authors. Despite some disagreement, there is evidence that co-authorship gains more citations than single authored papers and collaboration with an author

from another country increases it more. The drive for collaboration, especially international collaboration, can often be at the expense of good and inexpensive local collaboration.

There has been concern over the appropriateness of authorship attribution in a multi-authored paper. The Matthew effect is an indication of how including a leading expert could benefit all the other authors, while also continuing to enhance the reputation of the expert. The potential for self-citation to have a dual effect, both for the article cited and for the self-citing author over a period of time, could, it might be argued, be applied to citation and reputational gains received through being an ‘unwarranted’ author in a multi-authored paper.

There have been a number of generally narrowly focussed studies into the motivation behind what an author cites. The findings suggest that the main reasons for referencing are to establish the background and context of a topic, and to then provide supporting evidence. It would appear that personal contact or familiarity with an author can be a major factor in choosing to cite their material. This is likely to increase over time as an academic enlarges their circle of acquaintances within their research area, and is evident in work done on self-citation networks.

Concern has been expressed about the effect of the research assessment on Early Career Researchers, especially in terms of the process of learning to research and publish, and in relationship to recruitment and retention.

The term ‘games playing’ is somethimes used to imply criticism of what are essentially strategic decisions, and can be emotive. It would be inappropriate for a department or institute not to devise strategies to ensure their success in whatever performance indicators are set. It is inevitable that the more established and powerful institutions will have more resources to implement a wider range of strategies, such as attracting high profile staff with an established research portfolio. It could be debated whether the main drive behind any changes to academic dissemination and publication practices is the imposition of a research assessment process or the interpretation of the research assessment rules by the competing institutions. The REF, as would be expected, is receiving strategic consideration within institutions, especially in the area of understanding bibliometric techniques and in the establishment of institutional repositories. The question of whether to continue to try and level the playing field, or to recognise that there is more than one game that needs to be played, such as teaching and research, is unresolved. The research assessment processes used in the UK and in other countries give examples of both extremes. Common amongst them all is, perhaps, the crucial dilemma of not only how to measure quality, but how to measure quality across different disciplines at as low a cost as possible in both money and time, and with as little impact as possible on the actual quality of the research process itself.

9. Bibliography

Adams J., Jackson, L. and Marshall, S. (2007). Bibliometric analysis of interdisciplinary research. *Report to the Higher Education Funding Council*. Available from http://www.sheffield.ac.uk/content/1/c6/07/17/20/Evidence report on interdisciplinarity rd19_07.doc

AHRC. (2009). *Leading the world: the economic impact of UK arts and humanities research*. Available from http://www.ahrc.ac.uk/About/Policy/Documents/leadingtheworld.pdf

Aksnes, D.W. (2003). Characteristics of highly cited papers. *Research Evaluation*, 12(3), pp.159-170

Archer, L. (2008). Younger academics' constructions of 'authenticity', 'success' and professional identity. *Studies in Higher Education*. 33(4), pp.385-403

Armstrong, C. [jobs.ac.uk blog], (2008). *RIP to the RAE, hello to the REF*. Available from http://www.jobs.ac.uk/blogs/just-higher-ed/2008/05/29/rip-to-the-rae-hello-to-the-ref/

Atkinson-Grosjean, J., Grosjean, G., Fisher, D. and Rubenson, K. (1999). Consequence of performance models in higher education: an international pserspective – a study prepared for the Humanities and Social Science Federation of Canada. Available from http://www.fedcan.ca/english/fromold/perf-ind-literaturereviews-ubc.cfm

Attallah, G. and Rodíguez, G. (2006). Indirect patent citations. *Scientometrics*, 67(3), pp.437-465

Attwood, R., Newman, M., Corbyn, Z., and Gill, J., (2009). The rise and fall of research powers. *Times Higher Education*. 1 January. Available from http://www.timeshighereducation.co.uk/story.asp?sectioncode=26&storycode=404807&c=2

Baggaley, R. (2007). How RAE is smothering 'big idea' books. *Times Higher Education*, 25 May. Available from http://www.timeshighereducation.co.uk/story.asp?sectioncode=26&storycode=209113

Banks, M.A. (2004). Connections between open access publishing and access to gray literature. Journal of the Medical library Association, 92(2), pp.164-166

Banks, M.A. (2006). Towards a continuum of scholarship: the eventual collapse of the distinction between grey and non-grey literature. *Publishing Research Quarterly*, 22(1), pp.4-11

Barker, K. (2007). The UK research assessment exercise: the evolution of a national research evaluation system. *Research Evaluation*, 16(1), pp.3-12

Barrios, M., Borrego, A., Vilaginés, A., Ollé, C., Somoza, M. (2008). A bibliometric study of psychological research on tourism. *Scientometrics*, 77(3), pp.453-467

Becher, T. (1994). The significance of disciplinary differences. *Study in Higher Education*, 19(2), pp.151-161

Becher, T. and Trowler, P.R (2nd Revised Ed). (2001). *Academic tribes and territories: intellectual enquiry and the cultures of disciplines*. Buckingham: Open University Press

Belkhodja, O. and Landry, R. (2007). The Triple-Helix collaboration: Why do researchers collaborate with industry and the government? What are the factors that influence the perceived barriers? *Scientometrics*, 70(2), pp.301-332

Bence, V. and Oppenheim, C. (2004). The role of academic journal publications in UK research assessment exercise. *Learned Publishing*, 17(1).

Bernard, G.W. (2000), History and research assessment exercises. *Oxford Review of Education*, 26(1), pp.95-106

Bonitz, M. (2005). Ten years Matthew effect for countries. *Scientometrics*, 64(3), pp.375-379.

Bonzi, S. and Snyder, H.W. (1991). Motivations for citation: a comparison of self citation and citation to others. *Scientometrics*, 21(2), pp.245-254

Bordons, M., Gómez, I., Fernández, M.T., Zulueta, M.A. and Méndez, A. (1996). Local, domestic and international scientific collaboration in biomedical research. *Scientometrics*, 37(2), pp.279-295

Brooks, T.A. (1985). Private acts and public objects: an investigation of citer motivations. *Journal of the American Society for Information Science*, 36(4), pp.223-229

Brooks, T.A. (1986). Evidence of complex citer motivations. *Journal for the American Society for Information Science*, 37(1), pp.34-36

Brown, C. (2004). The Matthew effect of the *Annual Reviews* series and the flow of scientific communication through the World Wide Web. *Scientometrics*, 60(1), pp.25-36

Brown, C. (2007). The role of web-based information in the scholarly communication of chemists: citation and content analyses of American chemical society journals. Journal of the American Society for Information Science and Technology, 58(13), pp.2055-2065

Brown, R. (2009). Let's repair the damage. *Times Higher Education*, 29 March 2009, p.27

Brunel University, (2008). *Impact factors and the research excellence framework (REF)*. Available from http://www.brunel.ac.uk/life/study/library/researcher/impactfactor

Butler, L. (2003). Explaining Australia's increased share of ISI publications - the effect of a funding formula based on publications counts. *Research Policy,* 32(1), pp.143-155

Butler, L. (2008). Using a balanced approach to bibliometrics: quantitative performance measures in Australian Research Quality Framework. Available from http://www.int-res.com/articles/esep2008/8/e008p083.pdf

Case, D.O. and Higgins, G.M. (2000). How can we investigate citation behavior? A study of reasons for citng literature in communication. *Journal of the American Society for Information Science*, 51(7), pp.635-645

Cheung, C.K. (2008). Audience matters: a study of how authors select educational journals. The Asia-Pacific Education Researcher, 17(2), pp.191-201

Conn, V.S., Valinine, J.C., Cooper, H.M. and Rantz, M.J. (2003). Grey literature in meta-analyses. Nursing Research, 52(4), pp.256-261

Corbyn, Z., (2008a). Citation database accuracy queried. Times Higher Education. Available from http://www.timeshighereducation.co.uk/story.asp?sectioncode=26&storycode=404233&c=1

Corbyn, Z., (2008b). Keep peer review at REF core, chairs warn. *Times Higher Education*. Available from http://www.timeshighereducation.co.uk/story.asp?sectioncode=26&storycode=403336&c=1

Corbyn, Z., (2009a). Conflict of interest warning over Evidence sale. *Times Higher Education*. Available from http://www.timeshighereducation.co.uk/story.asp?storyCode=405093&sectioncode=26

Corbyn, Z. (2009b). Structural adjustments: evolution not revolution. *Times Higher Education*. Available from http://www.timeshighereducation.co.uk/story.asp?sectioncode=26&storycode=406492

Crane, D. (1972). Invisible colleges: Diffusion of knowledge in scientific communities. London: The University of Chicago Press

Cronin, B. (2003). Scholarly communication and epistemic cultures. *New Review of Academic Librarianship*, 9(1), pp.1-24

David, M.E. (2008). Research quality assessment and the metrication of the social sciences. *European Political Science*, 7, pp.52-63

Davis, P.M. (2009). Author-choice open-access publishing in the biological and medical literature: a citation analysis. *Journal of the American Society for Information Science and Technology*, 60(1), pp.3-8

De Villiers, F.P.R. (1984). Publish or perish – the growing trend toward multiple authorship. *South African Medical Journal*, 66, pp.882-883

Doyle, J.R. and Arthurs, A.J. (1995). Judging the quality of research on business schools: the UK as a case study. *Omega*, 23, pp.257-270

Drenth, J.P.H. (1998). Multiple authorship: the contributions of senior authors. *The Journal of the American Medical Association*, 280, pp.219-221

Evaluation Associates Ltd (1999). *Interdisciplinary Research and the Research Assessment Exercise*. Bristol, Higher Education Funding Councils for England.

Evans, A.E. (2008). Electronic publication and the narrowing of science and scholarship. *Science*, 321, pp.395-399

Fowler, J.H. and Aksnes, D.W. (2007). Does self-citation pay? *Scientometrics*, 72(3), pp.427-437

Frandsen, T. and Nicolaisen, J. (2008) Reactive Tendencies of Bibliometric Indicators: Trends in the alphabetization of Authorship in Economics and Information Science. *Proceedings of the 71st Annual Meeting of the American Society for Information Science and Technology*, 45.

Frandsen, T.F. (2009). The effects of open access and un-published documents: a case study of economics working papers. *Journal of Informetrics*, 3(2), pp.124-133

Frandsen, T.F. and Wouters, P. (2009). Turning working papers into journal articles: an exercise in microbibliometrics. Journal of the American Society for Information Science and Technology, 60(4), pp.728-739

Fry, J. (2006). Scholarly research and information practices: a domain analytic approach. *Information Processing and management*, 42, pp.299-316

Fry, J. and Talja, S. (2004). The cultural shaping of scholarly communication: explaining e-journal use within and across academic fields. In *Proceedings of the American society for information science and technology annual meeting on managing and enhancing information: cultures and conflicts.* Providence, Rhode Island, 13-18 November, 2004

Garvey, W.D., Lin, N., and Nelson, C.E. (1979). Communication in the physical and social sciences. *In: Communication: The essence of science*. W. Garvey, D. (Ed.) Oxford: Pergamon Press. pp. 280-299

Georghiou, L., (2009). *Responding to rankings and evaluations – university strategy*. International Symposium on University Ranking, 6th & 7th February 2009. Available from http://www.mediabank.leidenuniv.nl/ppt/ics/2009/responding-to-rankings-and-evaluations-georghiou-university-strategy.ppt

Gani, D., (2009). *Update on the research excellence framework*. Available from http://www.sfc.ac.uk/nmsruntime/saveasdialog.aspx?lID=1078&sID=373

Geuna, A. and Martin, B.R. (2003). University research evaluation and funding: an international comparison. *Minerva*, 41, 277-304

Griffith, B.C. and Miller, A.J., (1970). Networks of informal communications among scientifically productive scientists. In: C.E. Nelson and D.K. Pollock, Editors, *Communications Among Scientists and Engineers*, Health Lexington Books, Lexington, MA (1970).

Hall, P. (2007). Measuring research performance in the mathematical sciences in Australian universities. *Australian Mathematical Society Gazette*, 34(1), pp.26-30

Hare, P.G. (2002). *The UK's research assessment exercise impact on institutions, departments, individuals*. Paper prepared for OECED Conference on Higher Education on the theme of

Incentives and Accountability – instruments of Changes in Higher Education, Paris, September 2002.

Harley, S. (2002). The impact of research selectivity on academic work and identity in UK universities. *Studies in Higher Education*, 27(2), pp.187-205

Harrison, M.K., (2008). MMU library services: researchers' weekly bulletin 283: training opportunities: web of science: citation reporting and H-index (online web-based training session). Available from http://www.library.mmu.ac.uk/rwb/283.html#training

Harvey, D. (2006) Editorial: the geographies of critical geography. *Transaction of the Institute of British Geographers* NS 31, pp.409-412

Harwood, N. (2008). Publication outlets and their effect on academic writers' citations. *Scientometrics*, 77(2), pp.253-265

Harwood, N. (2009). An interview-based study of the functions of citations in academic writing across two disciplines. *Journal of Pragmatics*, 41, pp.497-518

He, Z., Geng, X. and Campbell-Hunt, C. (2009). Research collaboration and reseach output: a longitudional study of 65 biomedical scientists in a New Zealand university. *Research Policy*, 38(2), pp.306-317

HEFCE, (2008a). *Analysis of responses to HEFCE 2007/34, the research Excellence Framework consultation.* Available from http://www.hefce.ac.uk/pubs/consult/outcomes/ref.pdf

HEFCE, (2008b). *User-valued research and the research excellence framework (REF),* Available from http://www.hefce.ac.uk/research/ref/valued/REF_user_valued_summary.pdf

Henderson, M., (2009). Science funding to target money-makers, says minister John Denham. *Timesonline*. Available from http://www.timesonline.co.uk/tol/news/uk/science/article5768915.ece

Hicks, D. (2004). The difficulty of achieving full coverage of international social science literature and the bibliometric consequences. *Scientometrics*, 44(2), pp.193-215

Hicks, D. (2009). Evolving regimes of multi-university research evaluation. *Higher Education*, 57, pp.393-404

Hopewell, S., McDonald, S., Clarke, M., Egger, M. (2007). Grey literature in meta-analyses of randomized trials in health care intervention. *Cochrane Database Systematic Reviews*, 2. Available at http://www.mrw.interscience.wiley.com/cochrane/clsysrev/articles/MR000010/pdf_fs.html

Inzelt, A., Schubert, A. and Schubert, M. (2009). Incremental citatin impact due to international co-authorship in Hingarian higher education institutions. *Scientometrics*, 78(1), pp.37-43

Iribarren-Maestro, I., Lascurain-Sanchez, M.L. and Sanz-Casado, E. (2009). Are multi-authorship and visibility related? Study of ten research areas at Carlos III university of Madrid. *Scientometrics*, 79(1), pp.191-200

Jones, M.J., Brinn, T. and Pendlebury, M. (1996). Judging the quality of research in business schools: a comment from accounting. *Omega*, 24(5), pp.597-602

Kao, C. (2009). The authorship and country spread of operation research journal. *Scientometrics*, 78(3), pp.397-407

Katz, J.S. and Hicks, D. (1997). How much is collabration worth? A calibrated bibliometric model. *Scirntometrics*, 40(3), pp.541-554

Kennedy, D. (2003). Multiple authors, multiple problems. *Science*, 301(5634), p.733. Available from http://www.sciencemag.org/cgi/content/summary/301/5634/733?ck=nck&etoc

Kerr, A., (2008). *Faculty of education, social science and law: report from the pro-dean for research*. Available from http://www.essl.leeds.ac.uk/assets/files/internalmeetings/faculty-board/fb-07-08.pdf

King, C., (2007) Multiauthor papers redux: a new peek at new peaks, Sciencewatch, 18(6), pp.1-4. Available from http://archive.sciencewatch.com/sw_nov-dec2007_page1.htm

Kling, R. and McKim, G. (2000). Not just a matter of time: Field differences and the shaping of electronic media in supporting scientific communication. *Journal of the American Society for Information Science*, 51(14), pp. 1306-1320

Kwok, L.S. (2005). Research ethics: the white bull effect: abusive coauthorship and publication parasitism. *Journal of Medical Ethics*, 31, pp.554-556. Available from http://jme.bmj.com/cgi/content/full/31/9/554

Kyvik, S. (2003). Changing trends in publishing behaviour among university faculty, 1980-2000. *Scientometrics*, 58(1), pp.35-48

Lancaster, F.W., Lee, S.K., and Diluvio, C. (1990). Does place of publication influence citation behaviour? *Scientometrics*, 19(3/4), pp.239-244

Langfeldt, L. (2004). Expert panels evaluating research: decision-making and sources of bias. *Research Evaluation*, 13(1), pp.51-62

Larivière, V., Gingras, Y., Archambault, É. (2009). The decline in the concentration of citation, 1900-2007. *Journal of the American Society for Information and Technology*, 60(4), pp.858-862

Larkin, M.J. (1999). Pressure to publish stifles young talent. *Nature*, 397 Available from http://www.nature.com/nature/journal/v397/n6719/pdf/397467a0.pdf

Lee, F.S., (2006) The research assessment exercise, the state and the dominance of mainstream economics in British universities. *Cambridge Journal of Economics*, 31, pp.309-325. Available from http://www.cje.oxfordjournals.org/cgi/reprint/31/2/309

Levitt, J.M. and Thelwall, M. (2008). Is multidisciplinary research more highly cited? A macrolevel study. *Journal of the American Society for Information Science and Technology*, 59(12), pp.1973-1984

Levitt, J.M. and Thelwall, M. (2009). Citation levels and collaboration within library and information science. *Journal of the American Society for Information Science and Technology*, 60(3), pp.434-442

Lindholm-Romantschuk, Y. (1996), The role of monographs in scholarly communication: an empirical study of philosophy, sociology and economics. *Journal of Documentation*, 52(4), pp.389-404

Liverpool Hope University, (2006). *Research and scholarship development plan 2006 - 2010*. Internal document, unpublished

Loftus, A. (2006). RAE-ification and the consciousness of the academic. *Area*, 38(1), pp.110-112

Luukkonen, T. (1992). Is scientists' publishing behaviour reward-seeking? *Scientometrics*, 24(2), pp.297-319

Macdonald, S and Kam, J. (2007a). Aardvark et al.: quality journals and gamesmanship in management studies. *Journal of Information Science*, 33(6), pp.702-717

Macdonald, S and Kam, J. (2007b). Ring a ring o' roses: quality journals and gamesmanship in management studies. *Journal of Management Studies*, 44(4), pp.640-655

Madison, C.L. (2003). Review of published literature JSLHR: selected parameters. *American Speech-Language-Hearing Association Convention, Chicago, November, 2003 (session 183)*. Available from http://www.asha.org/NR/rdonlyres/EB66C46A-14D3-495B-BD09-2E8841A31974/0/183Handout.doc

Makarow, M. and Haila, K. (2006). *Research assessment exercise 2005: summary report university of Helsinki*. Available from http://www.helsinki.fi/research2005/PDFfiles/summary_report.pdf

Makino, J. (1998) Productivity of research groups - relation between citation analysis and reputation within research communities, *Scientometrics*, 43 (1)87-93

Manchester University, (2008). *Institutional repository project: steering group meeting minutes (confirmed): Friday 25th of January 2008.* Available from http://www.essl.leeds.ac.uk/assets/files/internalmeetings/faculty-board/fb-07-08.pdf

Marinova, D., Newman, P. (2008). The changing research funding regime in Australia and academic productivity. *Mathematics and Computers in Simulation*, 78, pp.283-291

Marshall, I., (2008). HEFCE's Hobson's choice. *Times Higher Education*. Available from http://www.timeshighereducation.co.uk/story.asp?storycode=400784

McAuley, L., Pham, B., Tugwell, P. and Moher, D. (2000). Does the inclusion of grey literature influence estimates of intervention effectiveness reported in meta-analyses? *The lancet*, 356, pp.1228-1231

McDowell, L. (2009). Part XI: why write books? IN: Ward et al. The future of research monographs: an international set of perspectives. *Progress in Human Geography*, 33(1), pp.101-126

Méndez, A. and Gómez, I. (1989). A comparison of citation classics in three fields of science. *Scientometrics*, 15(5/6), pp.621-631

Merton, R.K. (1968). The Matthew effect in science. *Science*, 159(3810), pp.56-63

Meyer, M.S. and Tang, P. (2007). Exploring the "value" of academic patents: IP management practices in UK universities and their implications for Third-Stream indicators. *Scientometrics*, 70(2), pp.415-440

Miettunen, J., and Nieminem, P. (2003). The effect of statistical methods and the study reporting characteristics on the number of citations: A study of four general psychiatric journals. *Scientometrics,* 57(3), pp.377-388

Mili, F., (2001). Trends in publishing academic grey literature: examples from economics. *The International Journal on Grey Literature*, 1(4), pp.157-166

MMU Library Services, (2008). *E-space: current usage survey 2: executive summary: what would influence respondents to deposit items in e-space in the future?* Available from http://www.library.mmu.ac.uk/otherinfo/specialproj/usage_survey2/#_Toc210719263

Moed, H.E. (2005). *Citation analysis in research evaluation*. Springer: Dordrecht, The Netherlands

Moed, H.E. (2008). UK research assessment exercise: informed judgments on research quality or quantity? *Scientometrics*, 74(1), pp.153-161

Moed, H.E. and Garfield, E. (2004). In basic science the percentage of "authoritative" references decreases as bibliographies become shorter. *Scientometrics*, 60(3), pp.295-303

Mroz, A. (2009). *Leader: watch the devilish details*. Available from http://www.timeshighereducation.co.uk/story.asp?sectioncode=26&storycode=406515

Nature editorial, (2007). All for one… *Nature*, 447(1031). Available from http://www.nature.com/nature/journal/v447/n7148/full/4471031a.html

Nature editorial, (2009). Experts still needed. *Nature*, 457(7225), pp.7-8. Available from http://www.nature.com/nature/journal/v457/n7225/full/457007b.html

Newman, M., (2009a). Liverpool may drop subjects ranked below 4* in RAE. *Times Higher Education*. Available from http://www.timeshighereducation.co.uk/story.asp?sectioncode=26&storycode=405763

Newman, M. (2009b). RAE panel hurt field by labelling it 'weak'. *Times Higher Education*. Available from http://www.timeshighereducation.co.uk/story.asp?sectioncode=26&storycode=405927

Newman, M., (2009c). Reviewers raise concerns about RAE gameplaying. *Times Higher Education*. Available from http://www.timeshighereducation.co.uk/story.asp?sectioncode=26&storycode=404924&c=2

Nolan, M., (2008). The research excellence framework (REF): a major impediment to free and informed debate? *International Journal of Nursing Studies*, 45, pp.487-488. Available from http://www.sciencedirect.com/science?_ob=MImg&_imagekey=B6T7T-4S0RXW0-2-1&_cdi=5067&_user=122878&_orig=search&_coverDate=04%2F30%2F2008&_sk=999549995&view=c&wchp=dGLbVzW-zSkzV&md5=a28662a6ccaa364d9113ba91dc630c1a&ie=/sdarticle.pdf

Norris, M., Oppenheim, C., and Rowland, F. (2008). The citation advantage of open-access articles. *The Journal of the American Society for Information Science and Technology*, 59(12), pp.1963-1972

OCUFA Research Paper. (2006). *Performance indicator use in Canada, the U.S. and abroad*. Available from http://www.ocufa.on.ca/research/PI_Canada_and_%20abroad.pdf

Oppenheim, C. and Summers, M.A.C. (2008). Citation counts and the Research Assessment Exercise, part VI: Unit of assessment 67 (music). *Information Research*, 13(2) paper 342. Available from http://InformationR.net/ir/13-2/paper342.html

Ormerod, R.J. (1997). An observation on publication habits based on the analysis of MS/OR journals. *Omega*, 25(5), pp.599-603

Overdue Ideas [Blog], (2008). *Entries categorized "REF": Beyond the RAE.* Available from http://www.meanboyfriend.com/overdue_ideas/ref/index.html

Palmer, C.L. (2005). Scholarly work and the shaping of digital access. *Journal of the American Society for Information Science and Technology*, 56(11), pp.1140-2005

Persson, O., Glänzel, W. and Danell, R. (2004). Inflationary bibliometric values: the role of scientific collaboration and the need for relative indicators in evaluative studies. *Scientometrics*, 60(3), pp.421-432

PhRMA. (2009). Principles and guidelines: clinical trials. *PhRMA website*. Available from http://www.phrma.org/clinical_trials/

Redden, G. (2008). Publish and flourish, or perish: RAE, ERA, RQF, and other acronyms for infinite human resourcefulness. M/C Journal, 11(4), [online]. Available from http://www.journal.media-culture.org.au/index.php/mcjournal/article/viewArticle/44/0

Research Council of Norway [website]. (2009a). *Institute evaluations*. Available from http://www.forskningsradet.no/en/Article/Institute+evaluations/1229697964668

Research Council of Norway [website]. (2009b). *Subject-specific evaluations*. Available from http://www.forskningsradet.no/en/Article/Subjectspecific+evaluations/1229697964165

Research Information Network (2009) *The UK's share of world research output: an investigation of different data sources and trends*. Available from http://www.rin.ac.uk/uk_presence_research

Researchtrends. (2008a). *UK universities climb the THES rankings*. Available from http://www.info.scopus.com/researchtrends/archive/RT3/cou_tre.htm

Researchtrends. (2008b). *Why did you cite… ?* Available from http://www.info.scopus.com/researchtrends/archive/RT3/why.htm

Richards, K. (2009). Part 1: the decline of the scholarly monograph in geography – some 'evidence' and speculations. IN: Ward *et al*. The future of research monographs: an international set of perspectives. *Progress in Human Geography*, 33(1), pp.101-126

Rowlands, I. and Nicholas, D. (2005). Scholarly communication in the digital age: the 2005 survey of journal author behaviour and attitudes. *Aslib Proceedings*, 57(6), pp.481-497

Scharnhorst, A., Hellsten, I., Lambiotte, R., and Auskoos, M. (2007). *Self-citation networks as traces of scientific careers: critical events, landscapes, networks, and mobility*. Available from http://www.virtualknowledgestudio.nl/staff/andrea-scharnhorst/documents/selfcitations-issi2007.pdf

Schmidt, E.K., Langberg, K., Aagaard, K. (2006). *Funding systems and their effects on higher education systems: country study – Denmark*. Available from http://www.oecd.org/dataoecd/20/43/38307998.pdf

School of Oriental and African Studies, University of London website. (n.d.). Research Excellence Framework (REF). Available from http://www.soas.ac.uk/research/rae/ref/

Scottish Funding Council, (2005). *Information: pooling research resources.* Available from http://www.sfc.ac.uk/information/information_research/strategic_research_grant.htm#pooling

Scottish Funding Council, (2007). *News release SFCPR/01/07: £77 million for life science research in Scotland*. Available from http://www.sfc.ac.uk/news/sfc/2007/sfcpr0107/sfcpr0107.html

Scottish Funding Council, (2008). *Circular SFC/34/2008: Research Excellence Framework: outcome of consultations and next steps*. Available from http://www.sfc.ac.uk/information/info_circulars/sfc/2008/sfc3408/sfc3408.html

Shadish, W., Tolliver, D., Gray, M., and Gupta, S. (1995). Author judgments about works they cite: three studies from psychology journals. *Social Studies of Science*, 25, 477-497.

Shapiro, D.W., Wenger, N.S. and Shapiro, M.F. (1994). The contribution of authors to multiauthored biomedical research papers. *The Journal of the American Medical Association*, 271(6), pp.438-442

Shewan, L.G. and Coats, A.J.S. (2006). The research quality framework and its implications for health and medical research: time to take stock? *Medical Journal of Australia*, 184, pp.463-466

Sloman, A. [Blog], (2008). *Research evaluation / excellence framework (REF)? or research monitoring framework (RMF)?* Available from http://www.cs.bham.ac.uk/research/projects/cogaff/misc/research-evaluation.html

Smith, C. [Open research Online blog], (2009). *Citation analysis of non-journal material*. Available from http://www.open.ac.uk/blogs/ORO/index.php

Smith, V., [Blog]. (2008). *Reference excellence framework.* Available from http://vsmith.info/REF

Sønderstrup-Andersen, E.M. and Sønderstrup-Andersen, H.H.K. (2008). An investigation into diabetes researcher's perceptions of the Journal Impact Factor – reconsidering evaluating research. *Scientometrics*, 76(2), pp.391-406

SQW Consulting and LISU. (2009). *Open access to research outputs: final report to RCUK*. Available at http://www.rcuk.ac.uk/cmsweb/downloads/rcuk/news/oareport.pdf

Steering Group for the Pilot Study Research Rating. (2008). *Research Performance of German Universities and non-university Institutions in Chemistry.* Available from http://www.wissenschaftsrat.de/texte/pilot_8892-08_chemistry.pdf

SUPA, (2009). *Scottish universities physics alliance (SUPA)*. Available from http://www.supa.ac.uk/

Surya, M., D'Este, P., and Neely, A., (2008). *Citation counts: are they good predicators of RAE scores? A bibliometric analysis of RAE 2001.* Available from http://dspace.lib.cranfield.ac.uk:8080/bitstream/1826/2248/3/Citation%20Counts%20Are%20They%20Good%20Predictors%20Of%20RAE%20Scores-2008.pdf

Swan, A. (2008). The 'big picture' and researchers' key concerns within the scholarly communication process: report to the JISC scholarly communications group. Accessed from http://eprints.ecs.soton.ac.uk/15450/2/Researchers%27_top_concerns_report_-_final_version_April_08.pdf

Tenopir, C., King, D.W., Edwards, S. and Wu, L. (2009). Electronic journals and changes in scholarly article seeking and reading patterns. *Aslib Processings: New Information Perspectives*, 61(1), pp.5-32

Tertiary Education Commission [website]. (2006). *PBRF 2006 evidence portfolio schema*. Available from http://www.tec.govt.nz/upload/downloads/pbrf2006-ep-schemadescriptions.pdf

Tertiary Education Commission [website]. (2008). *Performance based research fund*. Available from http://www.tec.govt.nz/templates/standard.aspx?id=588

Tol, R.S.J. (2007). The *Matthew effect defined and tested for the 100 most prolific economists*. Working paper FNU-143. Available from http://www3.interscience.wiley.com/cgi-bin/fulltext/121421661/PDFSTART

Traweek, S. (1988) Beamtimes and lifetimes: The world of high energy physicists. Harvard University Press, London

Universities Grants Committee [website]. (2007). *Research Assessment Exercise (RAE)* Available from http://www.ugc.edu.hk/eng/ugc/publication/prog/rae.htm

Universities Grants Committee [website]. (2008). *Research Assessment Exercise (RAE) has been in place for some 15 years. Is there a need to review it?* Available from http://www.ugc.edu.hk/eng/ugc/faq/q304.htm

Van Looy, B., Ranga, M., Callaert, J., Debackere, K., and Zimmermann, E. (2003). Combining entrepreneurial and scientific performance in academia: towards a compound and reciprocal Matthew-effect? *Research Policy,* 33(3), pp.425-441

Van Teijlingen, E. and Hundley, V. (2002). Getting your paper to the right journal: a case study of an academic paper. *Journal of Advanced Nursing*, 37(6), pp.506-511

Wager, E., Field, E.A. and Grossman, L. (2003), Good publication practice for pharmaceutical companies. *Current Medical Research and Opinions*, 19(3) pp.149-154

Ward, K., Johnston, R., Richards, K., Gandy, M., Taylor, Z., Paasi, A., Fox, R., Serje, M., Teung, H.W., Barnes, T., Blunt, A. and McDowell, L. (2009). The future of research monographs: an international set of perspectives. *Progress in Human Geography*, 33(1), pp.101-126

Weingart, P. (2005) Impact of Bibliometrics on the Science System: Inadvertant consequences? *Scientometrics*, 62(1), pp. 117-131

Weintraub, I. (2000). *The role of grey literature in the sciences*, [online]. Available from http://library.brooklyn.cuny.edu/access/greyliter.htm

White, H.D. (2001). Authors as citers over time. *Journal of the American Society for Information Science and Technology*, 52(2), pp.87-108

White, H.D. (2004). Reward, persuasion, and the Sokal Hoax: a study in citation identities. *Scientometrics*, 60(1), pp.93-120

White, M. and Wang, P. (1997). A qualitative study of citing behaviour: contributions, criteria and metalevel documentation concerns. *Library Quarterly*, 67, pp122-154

Whitley, R. (2000). *The intellectual and social organization of the sciences*. Oxford University Press: Oxford

Wilson, T. [Blog], (2008). *Research assessment and bibliometrics*. Available from http://info-research.blogspot.com/2008/09/research-assessment-and-bibliometrics.html?widgetType=BlogArchive&widgetId=BlogArchive1&action=toggle&dir=open&toggle=MONTHLY-1209596400000&toggleopen=MONTHLY-1233446400000

Wouters, P. and de Vries, R. (2004). Formally citing the web. *Journal of the American Society for Information Science and Technology*, 55(14), pp.1250-1260

Wray, K.B. (2004). An examination of the contributions of young scientists in new fields. *Scientometrics*, 61(1), pp.117-128