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# The Drivers of Citations in Management Science Journals

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# The drivers of citations in Management Science journals

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**Abstract:** The number of citations is becoming an increasingly popular index for measuring the impact of a scholar's research or the quality of an academic department. One obvious question is: what are the factors that influence the number of citations that a paper receives? This study investigates the number of citations received by papers published in six Management Science journals. It considers factors that relate to the author(s), the article itself, and the journal. The results show that the strongest factor is the journal itself but other factors are also significant including the length of the paper, the number of references, the status of the first author's institution, and the type of paper, especially if it is a review. Overall, this study provides some insights into the determinants of a paper's impact which is helpful for particular stakeholders in making important decisions.

**Keywords:** Citations, impact factors, journals, quality

# The drivers of citations in Management Science journals

## 1. Introduction

Measuring the scientific impact of researchers' work is a difficult but important issue. Evaluative bibliometric analyses are increasingly being seen as part of the answer, often in combination with some form of peer review. Particular attention has been paid to the number of citations that a publication receives. As early as 1927, Gross (1927) suggested citations to evaluate researchers' work and then it was widely used to assess the status of academic departments and the quality of books and scientific journals (Garfield 1972; Nicolaisen 2002). As well as this, there is evidence to suggest that citations are correlated with other assessments of scientific influence or impact such as awards, honours (Inhaber and Przednowek 1976), departmental reputation (Hargens 2000) and academic rank (Cole and Cole 1971). The "Leiden methodology" (van Raan 2003; van Raan et al. 2007), which evaluates research centres in terms of the mean citations per paper normalised against the field average, is being considered for the new Research Excellence Framework (REF) in the UK. Despite the growing importance of this index as a performance measurement, there is still considerable uncertainty as to what drives citation rates for a given paper.

There is a huge variance in the number of citations that papers receive, as many as 20% are never cited at all, while highly cited papers receive many hundreds (thousands in the sciences) (Mingers and Burrell 2006). There is no doubt that the primary driver is the actual content or quality of the paper; those which are particularly innovative, empirically or theoretically, or rigorous become seminal papers for their area and are constantly referenced. However, it is also clear that other, more quantifiable factors, such as the type of paper (e.g., a review article), the reputation of the (Podsakoff et al. 2005) author or the standing of the journal may also have significant effects. There have already been some research in this area. Most researchers aggregate determinants of citations to different categories such as author level (Allison and Long 1990; Long et al. 1998), institution level (Stahl et al. 1988; Trieschmann et al. 2000) or journal level (Franke et al. 1990; Podsakoff, Mackenzie et al. 2005). Generally, these researchers start with a collection of papers selected from particular journals in particular disciplines - law (Ayres and Vars 2000), marketing (Stremersch et al. 2007), management (Judge et al. 2007), ecology (Leimu and Koricheva 2005) and chemical engineering (Peters and Van Raan 1994) - and then analyse the roles of various factors on influencing number of citations. A few studies focus on particular factors and considered how they affect article citations (Baldi 1998) or examine the articles themselves to discover which ones are most likely to be cited and in which journals (Hoffman and Holbrook 1993)

Nederhof and Van Raan (Nederhof and Van Raan 1987) claimed that number of citations may be subject to a halo effect or, more generally, to the Matthew effect. This means that high citations lead to a good reputation and this good reputation then attracts even more citations. It seems like "success-breed-success". As reputation is invisible and difficult to measure, other quantitative factors were tested for their influence on the number of citations such as the number of authors, paper length, and different paper types. Besides these factors, the academic field is one of the major factors that affect number of citations significantly. For example, a study of the outputs from the 2001 UK Research Assessment Exercise (RAE) found that the mean citations per article for 48,000 bio-medical science papers was 30.1 while for 19,000 social science papers it was 5.4 and for humanities 2.3 (Mahdi et al. 2008). Also, within a discipline, papers in a relatively narrow field could attract fewer citations than more general ones. For this reason citation analysis of research groups or departments are always related to the appropriate field averages (van Raan 2003). In addition, time-dependent factors also influences number of citations. In some fields, recent works are cited much frequently than the old ones. Moreover, the influence of the physical details of an article such as the language, number of tables or figures, and presentation of the article have also been examined (Stremersch, Verniers et al. 2007).

Moving more specifically to the field of management, Judge et al (Judge, Cable et al. 2007) looked at a sample of 600 papers published in top management journals between 1990 and 1994 counting the citations until 2006. They were interested in looking at the relative contribution of the content of the article itself, characteristics of the author(s), and the perceived quality of the journal using structural equation models. Their main conclusions were: i) the best predictors of citations were characteristics of the journal: the citation rate and perceived quality. ii) The next most significant effect was the number of references and

then other article attributes such as year published (negative). iii) In terms of authors, the prestige of the authors' institution and the number of other top tier publications were both significant. iv)Finally, in terms of content the only significant attributes were if it was a meta-analysis, or if it was revolutionary in a Kuhnian sense, i.e, breaking new ground rather than being incremental. Effects that might have been expected but were not found were review papers, or a dependence on the application area.

Stremersch et al (Stremersch, Verniers et al. 2007) conducted a similar study using regression on five top marketing journals, looking at 1800 papers published from 1990 to 2002. They were interested in universal factors (broadly the content), social constructivist factors (broadly the authors) and presentational factors (how and where the paper appeared). The main results are: i) For universal factors, number of awards (a surrogate for quality) and article length both positively affected citations, as did some of the subject areas, e.g., relationship, services and e-commerce positively and advertising and sales negatively. ii) With social factors, editorial board membership, institutional ranking and self-citation intensity (self-promotion) were the main effects. iii) Presentationally, the only significant factors were number of appendices and reading clarity (negatively correlated interestingly). The number of references was not included as a variable. Finally, there was not a huge journal effect which is unusual. This may be explained by the fact that all the journals were top class and four out of the five were US so they were in principal very similar. The only non-US one, *International Journal of Research in Marketing*, did have a significant negative effect.

In this paper we will report the results of an investigation into various factors that cause papers in management science journals to be cited. We applied negative binomial model to build the relationship between citations and other factors we discovered. The paper is organized as follows: the next paragraph is mainly about methodology including sample selection, data collection and data clean, followed with the results we achieved from the experiments. And a conclusion is given at the end.

## 2. Methodology

*2.1 Sample of papers*

In order to find the factors affecting number of citations, we need to examine a representative set of papers. In this study, we selected all papers published in six management science journals in 1990 - *Management Science* (ManSci), *Journal of the Operational Research Society* (JORS), *European Journal of Operational Research* (EJORS), *Operations Research* (OpsRes), *Decision Science* (DecSci) and *Omega* (Omega). These six management science journals are selected due to their variety on the following factors: the narrowness and wideness of the topics and different levels of status of journals. In addition, the six journals nearly include papers in different types, which can provide comprehensive information. There are regular papers, technical notes, replies, letters and book reviews in six journals. On sample selection stage, given that book review is considerable different from other types of papers, we decided to excluded them of the sample. The final sample of papers includes all regular papers, technical notes, replies and letters in every issue of each journal. In total, we have selected 696 papers as a collection of papers in this study. All papers are coded from 1 to 696. More details about ensuring the validity of the dataset are contained in (Mingers and Burrell 2006). Unlike the two studies discussed above, our data does not include any time dependence as all papers are from the same year – 1990.

*2.2 Dependent variable*

Article impact is measured through the number of citations a paper received until July, 2008. It is coded as *Citations* in the data set. The information is provided by Social Science Citation Index accessed from Web of Science (WoS). The number of citations per paper varies widely both across journals and within journals. All journals have a significant proportion of papers that are never cited. Mingers and Burrell (2006) showed both theoretically and empirically that the number of citations is distributed according to the negative binomial. This is accounted for in the regression model.

*2.3 Independent variables*

In reviewing the literature we have found many potential independent variables, and ways of measuring them. We have also considered the extent to which they have been found to be significant in previous studies. These results are summarised in Table 1.

**Table 1 Summary of studies factors in previous researches**

Among these factors several are hard to measure such as the author's reputation, the accessibility (Scoper 1976) and visibility (Silverman 1985) of the journal, and, above all, the paper's intrinsic quality. We might hope that it is the quality of the paper that determines how often it is cited but how can one measure quality except through factors such as the journal it is published in or the number of citations which clearly becomes circular? It is interesting that in the UK's recent Research Assessment Exercise (RAE) over 12,000 separate publications in business and management were rated from 0* (little research quality) - 4* (world-leading research quality) by a peer review panel (Otley 2009) in order to evaluate the quality of different business schools. Although the overall results are public the actual grades given to individual papers are not. Had it been otherwise this would have been a tremendous data source.

In this study we decided to focus on quantitative factors that could be reliably measured and we explored how these factors affect the number of citations in six journals. All factors involved are grouped into three levels: journal level, author level and article level. Each level contains several dimensions.

*2.3.1 Author level*

Four dimensions related to authors characterizes are tested in this study. The previous research revealed that more authors could increase the chance of paper being cited (Beaver 2003; Lawani 1986). The first variable is called *Authors* which is the number of author of each paper. The second variable is called *Publications* which records the number of publications of the sole author or the first author through Web of Science. There are two main reasons of considering the first author: i) it avoids the errors and subjectivity generated from inappropriate weights distributed on different orders of co-authors in a paper; ii) the first author tends to have the most contribution to the articles than the other co-authors (Floyd et al. 1994). Then, it is possible to compare scientific contribution between the sole author and the first author.

The third variable is named *Rank* which reveals the status of the institutions of the first author or sole author. It seems reasonable that articles produced from institutions with a good reputation can attract higher citations. In order to test how this factor is going to influence the number of citations, we recorded the rank information for each institution or university from *The Times Higher Education Supplement* (THE) website (http://www.topuniversities.com). This website provides the latest rank information for the top 500 universities or institutions in the world. The higher number of ranks indicates lower status of this institution. For those institutions which cannot be found from the list, i.e. their ranks are over 500, we use 550 as a rank for each institution.

The last variable records the nationality of the first author or the sole author. This variable has been studied before as well (Vinkler 1987; Yue and Wilson 2003). It is coded as *Country*. As the authors of 696 papers may come from very different countries, and there is no need to identify all nationalities, we summarised them into three groups: *UK*, *US* and *Other*.

*2.3.2 Article level*

As the name suggests, this category is mainly about the factors related to the article characteristics. The first one is called *Title* which means the length of title. We counted the number of main words in the title to stand for the length of title, and some words such as a, of, in are excluded. Another variable is called *References* which counted the number of references a paper contains. With regard to the length of paper, we used the number of pages of this paper for measurement. It is coded as *Pages*. It is argued that long papers could have more citations as the more contents the more chance to be cited. We are going to verify this argument in this study.

The next variable is called *Keywords* which records the number of keywords in each paper. We expect that more keywords will bring higher citations, as it increases the chance of this paper being found by a search engine and thus the chance of it being cited. As well as this, keywords actually represent the fields of this article. Field is believed to be a major factor affecting the number of citations (Bazerman 1996; Hagstrom 1971; Hurt 1987; Klamer and Van Dalen 2002; Lewison and Dawson 1997) and it is no doubt that paper written on hot topics can get easily published and be more frequently cited. However, it is difficult to determine the appropriate fields for a paper. Each journal has its own set of preferred key words which do not correspond with each other, and often a paper is relevant to more than one subject. The most possible approach seems to manually read the papers and then divide them into the different fields categorised in

advance according to the keywords. However, it is quite difficult that how to determine the appropriate fields or even to know whether they should be categorised by technique (e.g., simulation) or application (e.g., production) or both. For this reason the field or subject was not included in the study.

The last variable, called *Methodtype*, is designed to capture the type of papers. It is known that review papers can easily get higher citations than other types of papers (Boyack and Klavans 2005; Shaw 1987). In order to have a further understanding, we tested six types of papers and examined how they would affect number of citations. All papers are divided into six groups by reading the abstract or roughly browsing the content. Here are six classifications:

- *Theoretical*: which is mainly about the description of a theory, method or algorithms. It may use some test data.
- *Empirical*: this is a paper where the primary content is the collection and analysis of empirical data. It may involve some theory or analysis technique but the focus is on the data.
- *Methodological*: this is a paper that discusses a general approach to using OR methods, or deals with philosophical or professional issues.
- *Review*: which reviews previous researches, findings or the development for a topic or theory.
- *Case study*: where the research is primarily concerned with applying known methods or techniques in a real organisation. Whilst it might have description of theory, and the analysis of data, the primary focus is on the particular organisational context.
- *Viewpoint*: which contains other types of papers such as replies, letters, notes and so on.

Methodologically, the two researchers compared their classifications of samples of papers until they were in agreement. Borderline cases were looked at by both.

*2.3.3 Journal level*

Journal impact is an obvious factor affecting citations of papers inside (Cano and Lind 1991; Meadows 1998; Tainer 1991). In this study, all papers are chosen from six pre-determined journals in order to examine the influence of the perceived quality of the journal on the number of citations of its papers. Values from 1 to 6 are assigned to the following journals: ManSci, JORS, EJOR, OpeRes, DecSci and Omega respectively for further application. Broadly speaking, based on an analysis of a variety of journal rankings (Mingers and Harzing 2007), ManSci and OpeRes are top-rated (and US) journals, and the others are good quality but lower rated ones with EJOR and JORS being primarily European.

In summary, for individual cases (each paper) in the sample we have collected the following variables: *Citations, Authors, Publications, Rank, Country, Title, Keywords, References, Pages, Methodtype* and *Journals*.

*2.4 Data cleaning*

Before running the regression we cleaned the data. By examining the standardized residuals of citations, we detected 21 cases that were not well fitted by a regression equation. After examination, we decided to keep these as it is worthwhile to think about questions like why they have such high citations. On the other hand, we also looked at the homogeneity of all papers and discovered four that had unusual independents, such as a paper that was extremely long because of many screen images, and excluded these so as not to distort the regression coefficients. This left 692 cases in the sample.

## 3. Results

*3.1 Exploration of the data*

Table 2 presents the number and types of papers that published in six journals in year 1990. Among these six journals, most papers are from EJOR (*215* of *692*, *30.07%*), while DecSci has the smallest number of papers (*61* of *692*, *8.82%*). This is due to the different publishing frequency of each journal. Of *692* articles, most articles are theoretical (*420* of *692, 60.69%*). JORS and EJOR can be seen to be different, especially from the US journals, in publishing more methodological, review and case study papers.

**Table 2 Summary of paper distribution in six journals**

Table 3 shows the descriptive statistics of the variable *Citations* for each journal. This by itself is very revealing as it explains more of the variation than any of the other variables. We can see that ManSci far outweighs any other journal with a mean of 44 citations per paper (over 15 years), the next nearest being OpeRes with 18. So, on average a paper published in ManSci will attract nearly three times more citations than one published in EJOR. Looking at the median, which is less affected by the high skewness, we still see that ManSci stands out with a value of 29 compared to the next nearest of 9. On the other hand all journals, including ManSci, have papers that have never been cited in 15 years although this varies from 23% in EJOR to 4.5% in ManSci. And, all journals have papers with a large number of citations. This will be discussed further when we analyse the regression rates. The behaviour of these citations over time has been examined in (Mingers,2008).

**Table 3 Citation statistics per paper of six journals**

Table 4 reports correlations among these variables. From this table, we find the following factors are positively related with citations: *Title* (r=*0.013*), *Keywords* (r=*0.277*), *Pages* (r=*0.048*), *References* (r=*0.326*), *Publications* (r=*0.104*), whereas number of authors (r=-*0.013*) and rank of author's institution (r=-*0.215*) are negatively correlated although the latter is simply because a lower rank is better. This kind of "halo effect" could be an advantage for generating citations of papers affiliated to such institutions. In terms of methodtype, review papers (r=*0.2*) reveal a significant positive relationship as we would have expected. With regard to nationality of authors, US researchers (r=*0.147*) appear to attract more citations than UK. Probably it is because to most papers were written by US researchers (*332* of *692*, *47.98%*) in this study. ManSci is the only journal with a significant correlation. However, the effects are much more complex than this might indicate since there are also significant correlations between the independents.

**Table 4 Correlations between each variable**

| Correlations | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Variables** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 1.Title | 1 | | | | | | | | | | | | | | | | | | | |
| 2.Authors | .135** | 1 | | | | | | | | | | | | | | | | | | |
| 3.Pages | .039 | .187** | 1 | | | | | | | | | | | | | | | | | |
| 4.Keywords | -.008 | .030 | .125** | 1 | | | | | | | | | | | | | | | | |
| 5.References | -.022 | .034 | .433** | .064 | 1 | | | | | | | | | | | | | | | |
| 6.Publications | -.043 | -.067 | .021 | -.037 | .044 | 1 | | | | | | | | | | | | | | |
| 7.Rank | -.005 | -.062 | -.089* | -.025 | -.077* | -.131** | 1 | | | | | | | | | | | | | |
| 8.Citations | .013 | -.013 | .277** | .048 | .326** | .104** | -.215** | 1 | | | | | | | | | | | | |
| 9. UK | -.120** | -.072 | -.102** | -.128** | -.065 | .032 | -.185** | -.013 | 1 | | | | | | | | | | | |
| 10. US | .116** | .061 | .198** | .122** | .134** | .068 | -.227** | .147** | -.342** | 1 | | | | | | | | | | |
| 11. Theoretical | .058 | -.036 | .120** | .082* | -.054 | -.107** | .030 | -.038 | -.165** | .078* | 1 | | | | | | | | | |
| 12. Empirical | -.004 | .092* | .179** | .057 | .232** | .072 | -.023 | .138** | -.001 | .071 | -.446** | 1 | | | | | | | | |
| 13.Methdological | -.066 | .000 | .035 | .023 | .011 | .023 | .000 | -.001 | .045 | -.028 | -.249** | -.072 | 1 | | | | | | | |
| 14. Review | -.097* | -.047 | .093* | -.030 | .293** | .127** | -.049 | .200** | .073 | -.021 | -.244** | -.071 | -.040 | 1 | | | | | | |
| 15. Case study | .058 | .169** | .012 | .054 | -.112** | -.072 | .017 | -.101** | .126** | -.140** | -.407** | -.119** | -.066 | -.065 | 1 | | | | | |
| 16. ManSci | .104** | .050 | .297** | -.034 | .183** | .049 | -.182** | .322** | -.082* | .181** | .047 | .151** | -.067 | -.065 | -.130** | - | | | | |
| 17. JORS | -.050 | -.065 | -.240** | -.160** | -.168** | .011 | .072 | -.133** | .235** | -.222** | -.073 | -.103** | .056 | .042 | .128** | - | - | | | |
| 18. EJOR | -.012 | -.014 | -.030 | -.011 | -.024 | -.065 | .092* | -.047 | -.082* | -.190** | .019 | -.124** | .059 | .049 | .105** | - | - | - | | |
| 19. OpeRes | -.024 | .004 | -.094* | .372** | -.037 | -.016 | -.038 | -.006 | -.133** | .165** | .093* | -.134** | -.048 | .016 | -.014 | - | - | - | - | |
| 20. DecSci | .091* | .037 | .218** | -.157** | .043 | .021 | .053 | -.052 | -.111** | .223** | .032 | .064 | -.010 | -.061 | -.068 | - | - | - | - | - |

**: correlation is significant at 0.01 level (2-tailed)

*: correlation is significant at 0.05 level(2-tailed)

To explore these we carried out a factor analysis using principal components as the extraction method combined with both varimax and quartimax rotations. The results across the different methods were reasonable consistent. Table 5 shows the loadings of the first 4 components. These will be described in this section and then discussed more fully in the later analysis.

**Table 5 Loadings of the first four components**

The first component combines together *Pages, References, Citations* and *ManSci.* In other words we have a picture of longer papers with many references appearing in ManSci and getting highly cited. The second component links *OpeRes* with *Keywords*. However, this is an artefact of the data. In 1990 OpeRes papers did not have keywords as such but they were classified by the journal into relevant subject areas and this led to a greater number of words. Factor three links *DecSci* and *US* authors showing that even more than the others, it predominantly publishes US papers. Finally factor four contrasts two types of papers: *Theoretical* and *Empirical*.

*3.2 Regression analysis*

The next stage was to develop a regression equation between citations and the independent variables. Given that number of citations follows negative binomial model which is both a count variable and clearly over-dispersed in comparison with a normal distribution, we applied the generalized linear model (GLM) in SPSS which has an option for the negative binomial. It linearises the variable by using the natural logarithm as a link function.

However, it was first necessary to consider the fact that we actually had six different groups of data, one from each journal. By regressing them all together we would implicitly assume that the same regression model held for each journal. Alternatively, could it in fact be the case that the relationships (i.e., the regression coefficients) were different in the various journals? We can in fact test this using the Chow test (1960). The null hypothesis is that the regression coefficients are the same across all journals. Although this cannot be done directly in SPSS it can be done using the LMATRIX command and in our case the results were not statistically significant ($F_{5, 648} = 0.449$).

Table 6 shows the results after running the regression model in terms of the main effects. Country, Methodtype and Journals are grouped variables. We found that several factors have a significant influence on the number of citations and they are included in the regression equation: Methodtype, Journals, Pages, References and Rank (of institution). Correspondingly, Country, words in Title, number of Authors, number of Keywords, and number of publications of the first author were not significant.

**Table 6 Initial regression analysis result**

Table 7 shows the results for individual components of the categorical variables including the regression coefficients. It only includes those variables which were found to be significant.

**Table 7 Final Generalised Linear Model results**

Now, we can write the equation where number of citations is explained by its independents.

$$Log\ (citations) = 0.8548 + 0.052*Pages + 0.012*References + 0.569*Theoretical + 0.6*Empirical + 1.223*Review + 1.43*ManSci + 0.931*EJOR + 0.734*OpeRes$$

If we consider these results, we can see several similarities, especially with Judge et al's study. The most significant effect, which can in any case be seen from Table 3, is that of particular

journals. ManSci, EJOR and DecSci are all very significant in comparison with the base case Omega. Judge et al did not include individual journals because they had so many, but they did include variables measuring perceived journal quality and found these significant. This finding raises a very relevant question as to the underlying explanation. One argument would be that papers in journals such as ManSci get more citations simply because they are better papers. The reviewing and acceptance procedures for these journals ensure that only good papers are submitted and that they publish only the very best. A corollary of this argument would presumably be that journals with less citations (and lower impact factors) must publish poorer papers. This argument also suggests that citations (or impact factors) are a good measure of journal quality. Call this the paper quality theory.

However, there are significant arguments against this view, primarily that journals become established in a way that means authors cite their papers simply because they are seen as the top journals over and above the quality of the papers themselves. Evidence in favour of the latter argument can be found in the results of the recent UK RAE. The Business and Management Panel operated by peer review and had to assess over 12,000 outputs. The Panel stated beforehand that they expected to find high quality work in a range of journals, not just the top ones, and that being published in a top journal was not a guarantee of top quality. After the event, the results seem to bear this out and the Main Panel stated: “Top quality work could also be found in journals occupying a lower position in conventional rankings” (Otley 2009, p. 1) although the detail of which outputs were submitted is not yet available. In other words, all journals publish high quality work but there is a journal effect on citations over and above the quality of the papers (journal effect theory).

It is also noticeable that even the top journals have a small but significant number of papers that have never been cited (see Table 3) and that all the journals do have highly cited papers. Oswald (2007) conducted a similar study on papers published 25 years ago in six economics journals. He found similar, highly skewed results with the top journal, American Economic Review, averaging 68 cites per paper and the lowest, Oxford Bulletin of Economics and Statistics, averaging only 7 although the medians were much less skewed – 23 and 1 respectively. But he concludes that citations cannot be taken as an unproblematic measure of journal quality since the best papers in the low-cited journals get more citations than some of the papers in the highly-cited journals. To us this seems a fallacious argument since it is likely that if the same article had been published in a top journal it would have received even more citations.

It would be very difficult to resolve this issue empirically for a paper is always published in a particular journal and so the two effects cannot be separated. In the end, we would argue, the reality is a complex combination of both which involves multiple feedback loops (see Figure 1).

**Figure 1 Relationship between paper quality and journal effect theories**

We would need to distinguish between the intrinsic quality of a paper in terms of originality and rigour (about which there could be disagreement), and the quality it comes to be perceived to have. One would expect that the intrinsic quality would positively influence perceived quality, number of citations (initially) and the perceived quality of the publishing journal. As the paper becomes cited there will be a positive loop (known in this context as the Matthew effect (Merton 1968)) generating more citations. Equally, the number of citations positively influences the perceived quality of the journal through the impact factor. So far this is the paper quality theory. If

the journal effect theory is correct then there are further influences: the effect of a journal perceived to be of high quality will by itself increase the perceived quality of its papers regardless of their actual quality, and thereby increase the number of citations even more. Moreover, it will increase the number of citations directly as people like to be seen to be citing the top journals. In the case of the journals in this study there may be a further effect as they are primarily American in terms of their editorial boards, authors, reviewers and citations. Since the US has the greatest number of academics this will also lead to a greater number of citations.

The other significant factors in our results are paper length and number of references, institution of the author, and type of paper. A big paper with more references (the two are correlated) will cover more material and so is likely to be cited more. This might also reflect different citation habits perhaps between discursive and mathematical papers. Looking at the correlations in Table 4, *References* are positively correlated with *Empirical* and *Review* papers, and interestingly with *ManSci* and *US* authors but negatively correlated with *JORS*. We already noted these relationships when considering the factor analysis. Could this imply that it is not *References* per se that influence *Citations*, but only indirectly in that ManSci papers tend to have a lot of references, and also gain more citations? In fact this is ruled out by the model. If the observed correlation between *References* and *Citations* were only due to the different journals, then *References* would appear significantly in a regression that did not include a journal variable but would not be significant in a regression that did include it. In our case it is significant and so this must be an effect over and above the ManSci effect confirming Judges' results.

The rank of the institution of the first author is significant but not the number of papers they have published. It seems unlikely that citers would look specifically at the institution, and more likely that the institution is a marker for the quality of the author, i.e., better researchers writing better papers will be at better institutions. They will also be more likely to publish in the top journals – there is a significant correlation between institution and ManSci, but not with the other journals. Of the types of papers, theoretical, empirical and reviews all figured as significant. Confirming previous work, reviews had the greatest effect.

## 4. Conclusion

Article impact is becoming an important index of a researcher's scientific influence and the number of citations is widely used as a measure of articles impact. We accept that the intrinsic quality of a paper is the main determinant of the number of citations it receives but that intrinsic quality is not possible to measure. Many other factors have been suggested in the literature as drivers of citations and we have explored a number of these through a sample of nearly 700 papers published in 1990 in six well-known management science/OR journals. The factors that we investigated concern either the author, the article, of the journal.

In terms of the (first) author, only the rank of their institution was significant – the number of authors, the number of papers they had published, and their country were not significant. In terms of the paper itself, the number of references and the length of the paper were strongly significant but the length of the title and the number of keywords was not. Review papers and theoretical papers were cited more highly than case studies, methodological or empirical papers. Finally, one of the biggest influences was the journal of publication with the mean citations per paper being six times higher in ManSci than JORS.

There are, of course, limitations to the study. We have used a sample of data limited to only six journals and one publication year. To what extent are these journals representative of the whole

field, and have there been changes in publication and citation practices since 1990. Indeed, is the current interest in citations of itself altering citation behaviour? Many other variables could potentially have been investigated, and is there actually a practical way of trying to measure the underlying quality of a publication? Would it be possible, for example, to have a large number of papers peer reviewed for quality and use this in an analysis? It is ironic that this has actually been done in the 2008 UK RAE where over 12,000 papers were reviewed but the individual results will never be made public? It would also be interesting to approach the problem from the other direction and explore the reasons people give for choosing which papers to cite in order to better understand the citation generation process. Finally, would it ever be possible to disentangle the paper/journal issue? Could one conduct an experiment in which there were two samples of papers, matched by peer review in terms of quality and subject, but differing in terms of journal to try and quantify the journal effect if there is one.

**Table 1 Summary of studies factors in previous researches**

| Level | Tested Factors | Reference | Results |
|---|---|---|---|
| **Journal level** | quality(prestige) | (Judge, Cable et al. 2007) | positive predicator for empirical articles not for theoretical/review article |
| | | (Seglen 1989) | positively related |
| | | (Peters and Van Raan 1994) | prestige of the publishing journal by far is the strongest predictors of citations |
| | citation rate | (Judge, Cable et al. 2007) | significant, positive predicator |
| | accessibility | (Lawrence 2001) | free accessibility increase the impact of papers |
| | circulation | (Leimu and Koricheva 2005) | small circulation are cited much less, additional positive effect on circulation frequency |
| | visibility | (Baldi 1998) | significantly increase its likelihood of being cited |
| | | (Hoffman and Holbrook 1993) | reviews got highest citation, editorials, letters and several other types are cited rather frequently |
| | | (Peters and Van Raan 1994) | a clear difference in citation scores between different types. Review papers come first |
| **author level** | number of authors | (Leimu and Koricheva 2005) | significantly affected, when the number >=4, receive more citations than fewer authors |
| | | (Ayres and Vars 2000) | coauthored articles were cited more frequently than single-author pieces |
| | | (Baldi 1998) | the greater the number, the more chances that scientists might know the authors |
| | | (Peters and Van Raan 1994) | papers with four or more authors are cited most |
| | nationality | (Leimu and Koricheva 2005) | UK authors have more citations than European authors |
| | gender | (Leimu and Koricheva 2005) | first author's gender has no effect on citation rate |
| | | (Ayres and Vars 2000) | female authors received 57 percent more citations than white menles by white men. |
| | | (Baldi 1998) | scientists are significantly less likely to cite articles written by female authors |
| | age | (Ayres and Vars 2000) | authors below 36 received significantly more citations than authors aged 41-46 |
| | Affiliated institute | (Leimu and Koricheva 2005) | first author's affiliated university affect citations |
| | rank of institutes | (Stremersch, Verniers et al. 2007) | not significant, but positive effect |
| | | (Judge, Cable et al. 2007) | highest prestige of affiliation significantly and indirectly predicted citations |
| | | (Leimu and Koricheva | researchers from top university receive more citations |

| | | | |
|---|---|---|---|
| | | 2005) | |
| | | (Bergh et al. 2006) | Scholars from higher ranked schools receive higher number of citations. |
| | | (Baldi 1998) | institutional prestige has no significant effects on whether an article is cited |
| | reputation | (Leimu and Koricheva 2005) | significantly positive effect |
| | | (Judge, Cable et al. 2007) | positive effect, like top-tier publications of authors |
| | | (Peters and Van Raan 1994) | top-author may attract more citations |
| | | (Baldi 1998) | author's rank has no significant effects on whether an article is cited |
| | self-citation rates | (Stremersch, Verniers et al. 2007) | positive effect |
| | social status | (Hoffman and Holbrook 1993) | mentioned |
| | publication record | (Stremersch, Verniers et al. 2007) | positive effect |
| | citation record | (Leimu and Koricheva 2005) | good record results frequently cited |
| | | (Bergh, Perry et al. 2006) | positively related with citation counts |
| | editorial board membership | (Stremersch, Verniers et al. 2007) | positive effect |
| **article level** | published year | (Hoffman and Holbrook 1993) | mentioned |
| | | (Bergh, Perry et al. 2006) | positive and significant related |
| | position in journal | (Stremersch, Verniers et al. 2007) | negative effect |
| | | (Judge, Cable et al. 2007) | first article positively predicted for all articles combined |
| | | (Laband and Piette 1994) | the first paper tends to generate more citations than later ones |
| | | (Leimu and Koricheva 2005) | negative effect, appearing first are more frequently cited |
| | | (Ayres and Vars 2000) | appearing first in an issue is a significant advantage |
| | which issue | (Bergh, Perry et al. 2006) | special issue is positive and significant related |
| | field | (Hoffman and Holbrook 1993) | mentioned |
| | | (Judge, Cable et al. 2007) | positive effect |
| | | (Bettencourt and Houston | mentioned |

| | | | |
|---|---|---|---|
| | | 2001) | |
| | field size | (King 1987) | Small fields normally attract fewer citations than those general fields |
| | method type | (Judge, Cable et al. 2007) | positive direct effect; with exploration research plots has higher citations in empirical and combined models |
| | title length | (Stremersch, Verniers et al. 2007) | no effect |
| | | (Ayres and Vars 2000) | articles with shorter titles received significantly more citations than articles with long titles |
| | number of keywords | (Stremersch, Verniers et al. 2007) | negative effect |
| | language | (Leimu and Koricheva 2005) | when English is national language attract significantly more citations than non-native English speaking counties |
| | | (Peters and Van Raan 1994) | papers written in English are cited three times more frequently than papers written in French or German |
| | number of pages | (Leimu and Koricheva 2005) | no affect citation frequency |
| | | (Ayres and Vars 2000) | increasing citations throughout the relevant range of pages but declining citations per page after page 53 |
| | | (Peters and Van Raan 1994) | direct significant correlation is not found, but statistically significant correlation between the number of references and the number of pages |
| | number of references | (Judge, Cable et al. 2007) | positive effect |
| | | (Peters and Van Raan 1994) | a reasonably high correlation coefficient between the number of references and number of citations |
| | article length | (Stremersch, Verniers et al. 2007) | positive effect |
| | | (Judge, Cable et al. 2007) | positive effect |
| | | (Leimu and Koricheva 2005) | positive effect |
| | | (Baldi 1998) | longer papers have a great possibility of citing other papers and also have more content that can be cited |
| | | (Bergh, Perry et al. 2006) | positive and significant related |
| | paper is awarded or not | (Stremersch, Verniers et al. 2007) | positive effect |

**Table 2 Summary of paper distribution in six journals**

| Journals | Total articles | Theoretical articles | Empirical articles | Methodological articles | Review articles | Case study | View points |
|---|---|---|---|---|---|---|---|
| **ManSci** | 111 | 73 | 25 | 1 | 1 | 1 | 10 |
| **JORS** | 129 | 69 | 5 | 8 | 7 | 23 | 17 |
| **EJOR** | 212 | 132 | 11 | 11 | 11 | 31 | 16 |
| **OpeRes** | 113 | 80 | 2 | 2 | 5 | 10 | 14 |
| **DecSci** | 61 | 40 | 11 | 2 | 0 | 2 | 6 |
| **Omega** | 66 | 26 | 24 | 2 | 2 | 1 | 11 |
| **Total** | 692 | 420 | 78 | 26 | 26 | 68 | 74 |

**Table 3 Citation statistics per paper of six journals**

| Journals | N | Minimum | Maximum | % Zero Cites | Mean | Median | Std. Deviation |
|---|---|---|---|---|---|---|---|
| **ManSci** | 111 | 0 | 264 | 4.5 | 44.5 | 29 | 51.4 |
| **JORS** | 129 | 0 | 78 | 17.8 | 7.0 | 3 | 11.0 |
| **EJOR** | 212 | 0 | 188 | 23.0 | 15.3 | 8 | 27.2 |
| **OpeRes** | 113 | 0 | 348 | 4.7 | 18.3 | 9 | 36.1 |
| **DecSci** | 61 | 0 | 85 | 9.8 | 12.9 | 6 | 17.9 |
| **Omega** | 66 | 0 | 115 | 22.7 | 8.6 | 3 | 19.1 |

**Table 5 Loadings of the first four components**

| | Components | | | |
|---|---|---|---|---|
| | **1** | **2** | **3** | **4** |
| **Title** | -0.0527 | -0.1001 | 0.2262 | -0.0684 |
| **Authors** | 0.1659 | 0.0453 | 0.1210 | -0.0009 |
| **Pages** | **0.7552** | -0.0131 | 0.2391 | -0.0531 |
| **Keywords** | 0.1243 | 0.**7506** | -0.1216 | 0.0285 |
| **References** | **0.7574** | 0.0362 | 0.0715 | 0.1351 |
| **Publications** | -0.0733 | -0.0866 | 0.1309 | 0.2076 |
| **Rank** | -0.1454 | -0.0380 | 0.0815 | 0.1026 |
| **Citations** | **0.5976** | 0.0246 | -0.1279 | 0.0586 |
| **UK** | -0.0381 | -0.2513 | -0.4456 | 0.0071 |
| **US** | 0.1524 | 0.2795 | **0.5815** | -0.0021 |
| **Theoretical** | 0.0848 | 0.0687 | 0.1112 | **-0.7961** |
| **Empirical** | 0.2285 | -0.0173 | 0.0753 | **0.8451** |
| **Methdological** | -0.0039 | -0.0112 | 0.0222 | 0.0440 |
| **Review** | 0.3406 | -0.0121 | -0.0776 | 0.0202 |
| **Case study** | -0.1834 | 0.0223 | -0.2054 | 0.1542 |
| **ManSci** | **0.4914** | -0.1076 | -0.1077 | 0.0915 |
| **JORS** | -0.2218 | -0.2120 | -0.1876 | -0.0481 |
| **EJOR** | -0.0955 | -0.2528 | -0.2894 | -0.1125 |
| **OpeRes** | -0.1285 | 0.**8520** | 0.0777 | -0.1004 |
| **DecSci** | 0.0363 | -0.2352 | **0.8190** | 0.0039 |

**Table 6 Initial regression analysis result**

| Tests of Model Effects | | | |
|---|---|---|---|
| **Source** | **Type III** | | |
| | **Wald Chi-Square** | **df** | **Sig.** |
| **(Intercept)** | 43.7409 | 1 | 0** |
| **Country** | 2.3875 | 2 | 0.303 |
| **Methodtype** | 19.8133 | 5 | 0.001** |
| **Journals** | 57.4644 | 5 | 0** |
| **Title** | 0.5749 | 1 | 0.448 |
| **Authors** | 3.1469 | 1 | 0.076 |
| **Pages** | 11.5331 | 1 | 0.001** |
| **Keywords** | 0.1717 | 1 | 0.679 |
| **References** | 7.8479 | 1 | 0.005** |
| **Publications** | 0.3691 | 1 | 0.544 |
| **Rank** | 10.4557 | 1 | 0.001** |

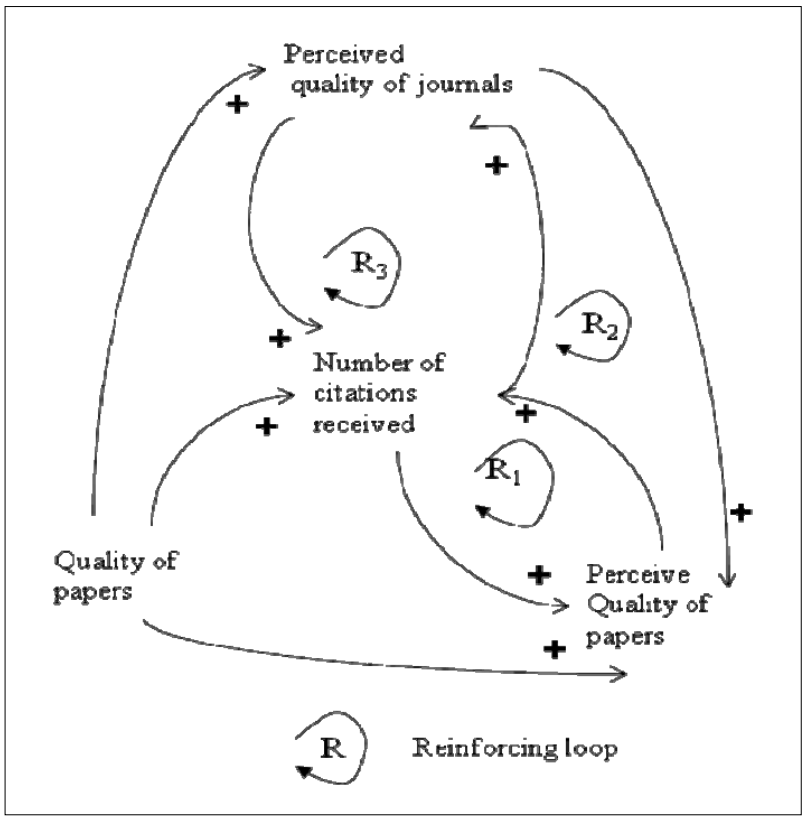
**Table 7 Final Generalised Linear Model results**

| Parameter Estimates | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Parameter** | **B** | **Std. Error** | **95% Wald Confidence Interval** | | **Hypothesis Test** | | |
| | | | **Lower** | **Upper** | **Wald Chi-Square** | **df** | **Sig.** |
| **(Intercept)** | .854 | .2702 | .324 | 1.384 | 9.990 | 1 | .002** |
| **Theoretical papers**[1] | .569 | .2132 | .151 | .987 | 7.116 | 1 | .008** |
| **Empirical papers**[1] | .600 | .2805 | .051 | 1.150 | 4.580 | 1 | .032** |
| **Methodological papers**[1] | .111 | .3544 | -.584 | .806 | .098 | 1 | .754 |
| **Review papers**[1] | 1.223 | .3798 | .479 | 1.967 | 10.368 | 1 | .001** |
| **Case study**[1] | .145 | .2800 | -.404 | .693 | .266 | 1 | .606 |
| **ManSci**[2] | 1.430 | .2378 | .964 | 1.896 | 36.185 | 1 | .000** |
| **JORS**[2] | .230 | .2407 | -.242 | .701 | .909 | 1 | .340 |
| **EJOR**[2] | .931 | .2380 | .465 | 1.398 | 15.311 | 1 | .000** |
| **OpeRes**[2] | .734 | .2238 | .295 | 1.173 | 10.754 | 1 | .001** |
| **DecSci**[2] | .374 | .2797 | -.174 | .922 | 1.787 | 1 | .181 |
| **Pages** | .052 | .0159 | .021 | .083 | 10.751 | 1 | .001** |
| **References** | .012 | .0041 | .004 | .020 | 8.248 | 1 | .004** |
| **Rank** | .000 | .0003 | -.001 | .000 | 13.820 | 1 | .000** |
| **(Scale)** | 1.750b | | | | | | |
| **(Negative binomial)** | 1 | | | | | | |

Note: this table is produced after excluding all insignificant factors.

1. This variable is compared with viewpoint paper. Take theoretical paper as an example. On average, it can produce 0.617 more log(citations) compared to viewpoint papers and this relationship is significant (p<=0.05).
2. This variable is compared with journal of Omega.

**Figure 1 Relationship between paper quality and journal effect theories**



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