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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 well-known 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 that may be helpful for particular stakeholders to make important decisions.

1. Introduction

Measuring the scientific impact of researchers' work is a difficult but important issue. Evaluative bibliometric analyses are increasingly being used, 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 this measure 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 large 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, 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 author (Podsakoff et al., 2005) or the standing of the journal may also have significant effects. There has 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 et al., 2005). Generally, these researchers start with a collection of papers selected from particular journals in particular disciplines – law (Ayres and Vars, 1999), marketing (Stremersch et al., 2007), management (Judge et al., 2007b), ecology (Leimu and Koricheva, 2005), and chemical engineering (Peters and van Raan, 1994) – and then analyse the roles of various factors on influencing the number of citations. A few studies focused on particular factors and considered how they affect article citations (Baldi, 1998) or examined 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 (1987) claimed that the number of citations may be subject to a halo effect or, more generally, to the Matthew effect. This means that a large number of citations lead to a good reputation and this good reputation then attracts even more citations. It seems like "success breeds 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 affects the 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

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(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 analyses of research groups or departments are always related to the appropriate field averages (van Raan, 2003). In addition, a time-dependent factor also influences the number of citations. In some fields, recent works are cited more frequently than older 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 et al., 2007).

Moving more specifically to the field of management, Judge et al. (2007b) 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 determining 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; and (iv) in terms of content, the only significant attributes were if the paper 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 whether or not the paper was a review, and a dependence on the application area.

Stremersch 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, the 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 the number of appendices and reading clarity (negatively correlated, interestingly). The number of references was not included as a variable. Finally, there was not a large journal effect, which seems to be 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 journal, the *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 a negative binomial model (Mingers and Burrell, 2006) to build the relationship between citations and other factors we discovered. The current paper is organized as follows: the next section is mainly about methodology, including sample selection, data collection, and data cleaning, followed with the results we obtained from our experiments. A conclusion is given at the end.

2. Methodology

2.1. Sample of papers

In order to study the factors affecting the 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* (EJOR), *Operations Research* (OpsRes), *Decision Science* (DecSci) and *Omega* (Omega). These six management science journals were selected to give a range in terms of breadth/narrowness of coverage, status and quality, and region of origin. The six journals include several types of papers: regular papers, technical notes, replies, letters, and book reviews. These were all included apart from book reviews, which were considered to have significantly different citation profiles. 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 the 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 in the management area discussed above, our data do 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 the Social Science Citation Index accessed from the 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 distribution. This is accounted for in the regression model.

2.3. Independent variables

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

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 circular factors such as the journal it is published in or the number of citations? It is interesting that in the UK's recent 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. A recent paper by Mingers et al. has attempted to reconstruct the Panel's judgements at the journal level using linear programming (Mingers et al., 2009).

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 the 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' characteristics are tested in this study. Previous research revealed that more authors could increase the chance of a paper being cited (Beaver, 2003; Lawani, 1986). The first variable is called *Authors*, which is the number of authors of each paper. The second variable is called *Publications*, which records the number of publications of the sole author or

Table 1
Summary of factors found in previous studies.

Level	Tested factors	Reference	Results
Journal level	Quality (prestige)	Judge et al. (2007b)	Positive predicator for empirical articles not for theoretical/review article
		Seglen (1989)	Positively related
		Peters and van Raan (1994)	Prestige of the publishing journal is by far the strongest predictors of citations
	Citation rate	Judge et al. (2007b)	Significant, positive predicator
	Accessibility	Lawrence (2001)	Free accessibility increases the impact of papers
	Circulation	Leimu and Koricheva (2005)	Small circulations are cited much less, additional positive effect on circulation frequency
	Visibility	Baldi (1998)	Significantly increases 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 (1999)	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 (1999)	Female authors received 57% more citations than white men by white men.
		Baldi (1998)	Scientists are significantly less likely to cite articles written by female authors
	Age	Ayres and Vars (1999)	Authors below 36 received significantly more citations than authors aged 41–46
	Affiliated institute	Leimu and Koricheva (2005)	First author's affiliated university affects citations
	Rank of institutes	Stremersch et al. (2007)	Not significant, but positive effect
		Judge et al. (2007b)	Highest prestige of affiliation significantly and indirectly predicted citations
		Leimu and Koricheva (2005)	Researchers from top universities receive more citations
		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)	Significant positive effect
		Judge et al. (2007b)	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 effect on whether an article is cited
	Self-citation rates	Stremersch et al. (2007)	Positive effect
	Social status	Hoffman and Holbrook (1993)	Mentioned
	Publication record	Stremersch et al. (2007)	Positive effect
	Citation record	Leimu and Koricheva (2005)	Good record results frequently cited
		Bergh et al. (2006)	Positively related with citation counts
	Editorial board membership	Stremersch et al. (2007)	Positive effect
Article level	Published year	Hoffman and Holbrook (1993)	Mentioned
		Bergh et al. (2006)	Positive and significantly related
	Position in journal	Stremersch et al. (2007)	Negative effect
		Judge et al. (2007b)	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; papers appearing first are more frequently cited
		Ayres and Vars (1999)	Appearing first in an issue is a significant advantage
	Which issue	Bergh et al. (2006)	Special issue is positive and significantly related
	Field	Hoffman and Holbrook (1993)	Mentioned
		Judge et al. (2007b)	Positive effect
		Bettencourt and Houston (2001)	Mentioned
	Field size	King (1987)	Small fields normally attract fewer citations than those general fields
	Method type	Judge et al. (2007b)	Positive direct effect; with exploratory research plots have higher citations in empirical and combined models
	Title length	Stremersch et al. (2007)	No effect
		Ayres and Vars (1999)	Articles with shorter titles received significantly more citations than articles with long titles
	Number of keywords	Stremersch et al. (2007)	Negative effect
	Language	Leimu and Koricheva (2005)	When English is national language, papers attract significantly more citations than non-native English speaking countries
		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 on citation frequency
		Ayres and Vars (1999)	Increasing citations throughout the relevant range of pages but declining citations per page after 53p.
		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

Table 1 (*continued*)

Level	Tested factors	Reference	Results
	Number of references	Judge et al. (2007b)	Positive effect
		Peters and van Raan (1994)	A reasonably high correlation coefficient between the number of references and number of citations
	Article length	Stremersch et al. (2007)	Positive effect
		Judge et al. (2007b)	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 et al. (2006)	Positive and significantly related
	Paper is awarded or not	Stremersch et al. (2007)	Positive effect

the first author through the Web of Science. There are two main reasons for considering the first author: (i) differing publication habits make it impossible to deduce the relative contribution of authors simply from the order; and (ii) the first author tends to have at least as great a contribution as the other authors (Floyd et al., 1994).

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

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 a variety of 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

This category is mainly about factors related to the article characteristics. The first one is called *Title*, which denotes the length of title – the number of main words in the title to stand for the length of title with insignificant words excluded. Another variable is called *References*, which counted the number of references a paper contained. With regard to the length of paper, we used the number of pages of the paper for measurement; it is coded as *Pages*. We recognise that pages is only a surrogate for words, which is the real factor, but the word count is not always available.

The next variable is called *Keywords*, which records the number of key words in each paper. We expected that more key words will bring more 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, the key words actually represent the fields of the 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 there is no doubt that a paper written on a hot topic can get published more easily and may be more frequently cited. However, it was difficult to determine the appropriate set of fields to cover all the papers. Each journal has its own set of preferred key words which do not necessarily correspond with each other, and often a paper is relevant to more than one subject. The most plausible approach would be to manually read the papers and then divide them into the different fields categorised in advance according to the key words. However, it was quite difficult 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 get more citations than other types of papers (Boyack and Klavans, 2005; Shaw, 1987). In order to gain a further understanding, we tested six types of papers and examined how they would affect the number of citations. All papers were divided into six groups by reading the abstract or roughly browsing the content.

- *Theoretical:* Mainly about the description of a theory, method or algorithms. Such a paper 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 operational research (OR) methods, or deals with philosophical or professional issues.
- *Review:* A paper which reviews previous research, findings or the development of a topic or theory.
- *Case study:* Where the research is primarily concerned with applying known methods or techniques in a real organisation. While it might have a description of theory, or the analysis of data, the primary focus is on the particular organisational context.
- *Viewpoint:* Which includes other types of papers such as replies, letters, notes, and so on.

Methodologically, the two authors of the current paper compared our classifications of samples of papers until we 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 (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, OpsRes, DecSci and Omega, respectively, for further analysis. Broadly speaking, based on an analysis of a variety of journal rankings (Mingers and Harzing, 2007), ManSci and OpsRes are top-rated (and US) journals, while 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 *Journal*.

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

Table 2
Summary of paper distributions for 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
OpsRes	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

reasons for their high numbers of citations. We also looked at the homogeneity of all papers and discovered four that had unusual independent variables, 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 were published in the six journals in 1990. Among these six journals, most papers are from EJOR (212 of 692, 30.07%), while DecSci has the smallest number of papers (61, 8.82%). This is due to the different publishing frequency of each journal. Of 692 articles, most are theoretical (420, 60.69%). JORS and EJOR can be seen to be different, especially compared to the US journals, in publishing more methodological, review, and case study papers.

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 OpsRes 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% for EJOR to 4.5% for ManSci. In addition, all journals have some papers with a large number of citations. This will be discussed further when we analyse the regression results. The behaviour of these citations over time has been examined by Mingers (2008).

Table 4 reports correlations among these variables. From this table, we find the following factors are significantly positively related with citations: *Pages* ($r = 0.277$), *References* ($r = 0.326$), *Publications* ($r = 0.104$), whereas the rank of author's institution ($r = -0.215$) is negatively correlated although this 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 because most papers were written by US researchers (332 of 692, 47.98%) in this study. ManSci is the only journal with a significant positive correlation to citations. In fact, JORS has a negative correlation. However, the effects are much more complex than this might indicate since there are also significant correlations between the independents.

To explore these correlations further 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 reasonably consistent. Table 5 shows the loadings of the first four components. These will be described in this section and then discussed more fully in the later analysis.

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 *OpsRes* with *Keywords*. However, this is an artefact of the data. In 1990, *OpsRes* papers did not have keywords as such, but were classified by the journal into relevant subject areas and this led to a greater number of key 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 the number of citations follows a negative binomial model, which is both a count variable and highly skewed 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 test this using the Chow (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 ($F_{5648} = 0.449$). Thus, it is reasonable to include all the data with the journal being a category variable.

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
OpsRes	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 4
Correlations between each variable.

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

Correlations between variables 16–20 are not shown as they are mutually exclusive dummy variables.
* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Table 5
Loadings of the first four components. Bold shows the significant loadings.

	Components			
	1	2	3	4
Title	−0.05	−0.10	0.23	−0.07
Authors	0.17	0.05	0.12	0.00
Pages	**0.76**	−0.01	0.24	−0.05
Keywords	0.12	0.75	−0.12	0.03
References	**0.76**	0.04	0.07	0.14
Publications	−0.07	−0.09	0.13	0.21
Rank	−0.15	−0.04	0.08	0.10
Citations	**0.60**	0.02	−0.13	0.06
UK	−0.04	−0.25	−0.45	0.01
US	0.15	0.28	**0.58**	0.00
Theoretical	0.08	0.07	0.11	**−0.80**
Empirical	0.23	−0.02	0.08	**0.85**
Methdological	0.00	−0.01	0.02	0.04
Review	0.34	−0.01	−0.08	0.02
Case study	−0.18	0.02	−0.21	0.15
ManSci	**0.49**	−0.11	−0.11	0.09
JORS	−0.22	−0.21	−0.19	−0.05
EJOR	−0.10	−0.25	−0.29	−0.11
OpsRes	−0.13	0.85	0.08	−0.10
DecSci	0.04	−0.24	**0.82**	0.00

Table 6 shows the results after running the regression model in terms of the main effects. *Country*, *Methodtype*, and *Journal* 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*, *Title*, *Authors*, *Keywords*, and *Publications* of the first author were not significant.

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

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

$$\begin{aligned} Log(citations) = {} & 0.8548 + 0.052^{*}Pages + 0.012^{*}References \\ & + 0.569^{*}Theoretical + 0.6^{*}Empirical \\ & + 1.223^{*}Review + 1.43^{*}ManSci + 0.931^{*}EJOR \\ & + 0.734^{*}OpsRes \end{aligned}$$

If we consider these results, we can see several similarities, especially with Judge et al. (2007a)'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 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 good papers are submitted and that they publish only the very best. A corollary of this argument would presumably be that journals with fewer citations (and lower impact factors) must typically 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 the journal's 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 out-

Table 6
Initial regression analysis results.

Tests of model effects			
Source	Type III		
	Wald chi-square	df	Sig.** = <0.01
(Intercept)	43.7409	1	0**
Country	2.3875	2	0.303
Method type	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 generalized linear model results.

Parameter estimates							
Parameter	*B*	Std. error	95% Wald confidence interval		Hypothesis test		
			Lower	Upper	Wald chi-square	df	Sig.** = <0.01
(Intercept)	0.854	0.2702	0.324	1.384	9.990	1	0.002**
Theoretical papers[a]	0.569	0.2132	0.151	0.987	7.116	1	0.008**
Empirical papers[a]	0.600	0.2805	0.051	1.150	4.580	1	0.032**
Methodological papers[a]	0.111	0.3544	−0.584	0.806	0.098	1	0.754
Review papers[a]	1.223	0.3798	0.479	1.967	10.368	1	0.001**
Case study[a]	0.145	0.2800	−0.404	0.693	0.266	1	0.606
ManSci[b]	1.430	0.2378	0.964	1.896	36.185	1	0.000**
JORS[b]	0.230	0.2407	−0.242	0.701	0.909	1	0.340
EJOR[b]	0.931	0.2380	0.465	1.398	15.311	1	0.000**
OpsRes[b]	0.734	0.2238	0.295	1.173	10.754	1	0.001**
DecSci[b]	0.374	0.2797	−0.174	0.922	1.787	1	0.181
Pages	0.052	0.0159	0.021	0.083	10.751	1	0.001**
References	0.012	0.0041	0.004	0.020	8.248	1	0.004**
Rank	0.000	0.0003	−0.001	0.000	13.820	1	0.000**
(Scale)	1.750						
(Negative binomial)	1						

Note: This table excludes all insignificant factors.
[a] This variable is compared with a *Viewpoint* paper as the baseline. For example, a theoretical paper will on average produce 0.569 more log(citations) compared to a viewpoint paper.
[b] This variable is compared with the journal Omega.

puts. 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 (Mingers et al., 2009), and the Main Panel stated in their report: "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 (and correspondingly lower quality work), but there is a journal effect on citations over and above the quality of the papers ("journal effect" theory).

It is also noteworthy 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 at least some 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 lowly 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 since a paper is always published in one and only one journal and so the two effects cannot be separated. In the end, we would argue, the reality is a complex combination of both effects which involves multiple feedback loops (see Fig. 1).

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)), thereby 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 since 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, 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

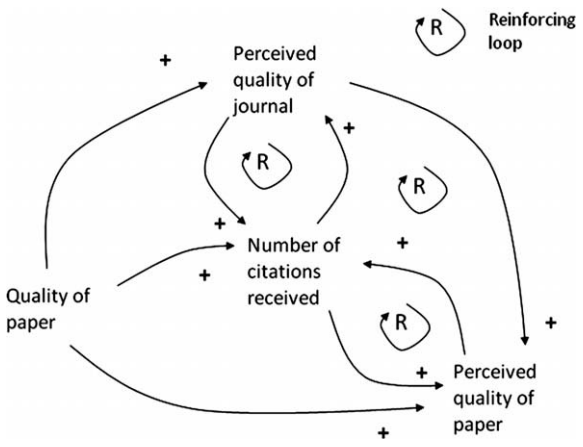

Fig. 1. Relationship between paper quality and journal effect theories.

ManSci papers tend to have many 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, thus confirming Judge et al.'s 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. Conclusions

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 an article's 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, or 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 were 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?

References

Allison, P.D., Long, J.S., 1990. Departmental effects on scientific productivity. American Sociological Review 55 (4), 469–478.

Ayres, I., Vars, F.E., 1999. Determinants of citations to articles in elite law reviews. In: Conference on Interpreting Legal Citations, Evanston, Illinois.

Baldi, S., 1998. Normative versus social constructivist processes in the allocation of citations: a network-analytic model. American Sociological Review 63 (6), 829–846.

Bazerman, C., 1996. Shaping written knowledge; the genre and activity of the experimental article in science – quarterly. Journal of Speech 82 (1), 74–91.

Beaver, D.D., 2003. Does collaborative research have greater epistemic authority? In: Proceedings of the Ninth International Conference on Scientometrics and Informatics, Beijing.

Bergh, D.D., Perry, J., Hanke, R., 2006. Some predictors of SMJ article impact. Strategic Management Journal 27 (1), 81–100.

Bettencourt, L.A., Houston, M.B., 2001. The impact of article method type and subject area on article citations and reference diversity in JM, JMR, and JCR. Marketing Letters 12 (4), 327–340.

Boyack, K.W., Klavans, R., 2005. Predicting the importance of current papers. In: Proceedings of the 10th International Conference of the International Society for Scientometrics and Informetrics, Stockholm.

Cano, V., Lind, N.C., 1991. Citation life-cycles of 10 citation classics. Scientometrics 22 (2), 297–312.

Chow, G., 1960. Tests of equality between sets of coefficients in two linear regressions. Econometrica 28 (3), 591–605.

Cole, J., Cole, S., 1971. Measuring the quality of sociological research – problems in the use of the science citation index. American Sociologist 6 (1), 23.

Floyd, S.W., Schroeder, D.M., Finn, D.M., 1994. Only if I'm first author – conflict over credit in management scholarship. Academy of Management Journal 37 (3), 734–747.

Franke, R.H., Edlund, T.W., Oster, F., 1990. The development of strategic management – journal quality and article impact. Strategic Management Journal 11 (3), 243–253.

Garfield, E., 1972. Citation analysis as a tool in journal evaluation – journals can be ranked by frequency and impact of citations for science policy studies. Science 178, 471–479.

Gross, P., 1927. College libraries and chemical education. Science 66, 385–389.

Hagstrom, W.O., 1971. Inputs, outputs, and prestige of university science departments. Sociology of Education 44 (4), 375.

Hargens, L.L., 2000. Using the literature: reference networks, reference contexts, and the social structure of scholarship. American Sociological Review 65 (6), 846–865.

Hoffman, D.L., Holbrook, M.B., 1993. The intellectual structure of consumer research – a bibliometric study of author cocitations in the 1st 15 years of the journal of consumer research. Journal of Consumer Research 19 (4), 505–517.

Hurt, C.D., 1987. Conceptual citation difference in science, technology, and social sciences literature. Information Processing and Management 23, 1–6.

Inhaber, H., Przednowek, K., 1976. Quality of research and nobel prizes. Social Studies of Science 6 (1), 33–50.

Judge, T., Cable, D., Colbert, A., Rynes, S., 2007a. What causes a management article to be cited – article, author or journal? Academy of Management Journal 50 (3), 491–506.

Judge, T.A., Cable, D.M., Colbert, A.E., Rynes, S.L., 2007b. What causes a management article to be cited – article, author, or journal? Academy of Management Journal 50 (3), 491–506.

King, J., 1987. A review of bibliometric and other science indicators and their role in research evaluation. Journal of Information Science 13 (5), 261–276.

Klamer, A., Van Dalen, H.P., 2002. Attention and the art of scientific publishing. Journal of Economic Methodology 9, 289–315.

Laband, D.N., Piette, M.J., 1994. Favoritism versus search for good papers – empirical evidence regarding the behavior of journal editors. Journal of Political Economy 102 (1), 194–203.

Lawani, S.M., 1986. Some bibliometric correlates of quality in scientific research. Scientometrics 9 (1-2), 13–25.

Lawrence, S., 2001. Free online availability substantially increases a paper's impact. Nature 411, 521.

Leimu, R., Koricheva, J., 2005. What determines the citation frequency of ecological papers? Trends in Ecology and Evolution 20 (1), 28–32.

Lewison, G., Dawson, G., 1997. The effect of funding on the outputs of biomedical research. In: Proceedings of the Sixth Conference of the International Society for Scientometrics and Informetrics, Jerusalem.

Long, R.G., Bowers, W.P., Barnett, T., White, M.C., 1998. Research productivity of graduates in management: effects of academic origin and academic affiliation. Academy of Management Journal 41 (6), 704–714.

Mahdi, S., D'Este, P., Neely, A., 2008. Citation counts: are they good predictors of RAE scores? AIM Research, London.

Meadows, A.J., 1998. Communicating Research. Academic Press, London.

Merton, R., 1968. The Matthew effect in science. Science 159, 56–63.

Mingers, J., 2008. Exploring the dynamics of journal citations: modelling with *S*-curves. Journal Operational Research Society 59 (8), 1013–1025.

Mingers, J., Burrell, Q.L., 2006. Modeling citation behavior in management science journals. Information Processing and Management 42 (6), 1451–1464.

Mingers, J., Harzing, A.-W., 2007. Ranking journals in business and management: a statistical analysis of the harzing dataset. European Journal of Information Systems 16 (4), 303–316.

Mingers, J., Scaparra, M.P., Watson, K., 2009. Estimating Business and Management Journal Quality from the 2008 Research Assessment Exercise in the UK, Kent Business school Working Paper 205, Canterbury.

Nederhof, A.J., van Raan, A.F.J., 1987. Peer-review and bibliometric indicators of scientific performance – a comparison of cum laude doctorates with ordinary doctorates in physics. Scientometrics 11 (5–6), 333–350.
Nicolaisen, J., 2002. The J-shaped distribution of citedness. Journal of Documentation 58 (4), 383–395.
Oswald, A., 2007. An examination of the reliability of prestigious scholarly journals: evidence and implications for decision-makers. Economica 74 (293), 21–31.
Otley, D., 2009. RAE2008 UOA 36 Subject Overview Report, HEFCE.
Peters, H.P.F., van Raan, A.F.J., 1994. On determinants of citation scores – a case-study in chemical-engineering. Journal of the American Society for Information Science 45 (1), 39–49.
Podsakoff, P.M., Mackenzie, S.B., Bachrach, D.G., Podsakoff, N.P., 2005. The influence of management journals in the 1980s and 1990s. Strategic Management Journal 26 (5), 473–488.
Scoper, M.E., 1976. Characteristics and use of personal allocations. Library Quarterly 46, 397–415.
Seglen, P.O., 1989. From bad to worse – evaluation by journal impact. Trends in Biochemical Sciences 14 (8), 326–327.
Shaw, J.G., 1987. Article-by-article citation analysis of medical journals. Scientometrics 12 (1–2), 101–110.
Silverman, R.J., 1985. Higher-education as a maturing field – evidence from referencing practices. Research in Higher Education 23 (2), 150–183.
Stahl, M.J., Leap, T.L., Wei, Z.Z., 1988. Publication in leading management journals as a measure of institutional research productivity. Academy of Management Journal 31 (3), 707–720.
Stremersch, S., Verniers, I., Verhoef, P.C., 2007. The quest for citations: drivers of article impact. Journal of Marketing 71 (3), 171–193.
Tainer, J.A., 1991. Science, citation, and funding. Science 251 (5000), 1408.
Trieschmann, J.S., Dennis, A.R., Northcraft, G.B., Niemi, A.W., 2000. Serving multiple constituencies in business schools: MBA program versus research performance. Academy of Management Journal 43 (6), 1130–1141.
van Raan, A., 2003. The use of bibliometric analysis in research performance assessment and monitoring of interdisciplinary scientific developments. Technology Assessment – Theory and Practice 1 (12), 20–29.
van Raan, A., Moed, H., van Leeuwen, T., 2007. Scoping Study on the Use of Bibliometric Analysis to Measure the Quality of Research in UK Higher Education Institutions, Centre for Science and Technology Studies, Leiden University, Leiden.
Vinkler, P., 1987. A quasi-quantitative citation model. Scientometrics 12 (1–2), 47–72.
Yue, W.P., Wilson, C.S., 2003. Measuring the citation impact of research journals in clinical neurology: a structural equation modelling analysis. In: Proceedings of the Ninth International Conference on Scientometrics and Informatics, Beijing, PRC.