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Management**

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**THE DIFFUSION NETWORK OF RESEARCH KNOWLEDGE
IN OPERATIONS MANAGEMENT**

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Abstract

Purpose: To examine how the research knowledge in OM has been obtained and distributed since the first journals in OM began publication in 1980, changes in the interests of OM over the decades and where they are heading in the future, and to explore the changing roles of individual journals in the development of OM.

Design/methodology/approach: A two-stage bibliometric study was employed, first using citation analysis to examine the changing research interests in OM through an analysis of the OM journals. Then the top journals of most importance to OM were analysed to determine the role that each one played in the knowledge distribution network and how that changed over the decades.

Findings: OM's journal base consists of 7 research knowledge sources, 12 transmitters linking different journal groups, and 11 sinks with limited input. Research attention changed from practice, engineering, and OR to general management, strategy, and production management in the 2000s, with strategy, organizational issues, and logistics surfacing in the 2010s. OM features increasingly academic research with less interest in practice. OM journals' network importance has increased substantially, with JOM now a bridge between the quantitative and management journals.

Practical implications Both researchers and managers gain in understanding the history and identifying the future direction of OM, as well as which journals will have the most relevant papers to their interests.

Originality/value: This research identifies the history of the OM field in terms of its constituents and where it is going in the future. This history is related to the role OM plays among the knowledge network of top journals and presents a novel way of classifying and labeling journals based on their contribution.

Keywords: Knowledge diffusion, journal network, citations, references, source journals

THE DIFFUSION NETWORK OF RESEARCH KNOWLEDGE IN OPERATIONS MANAGEMENT

1. Introduction

As a functional field such as Operations Management (OM) matures in importance to business, both in academia as well as in practice, it is useful to examine from where its research knowledge has been obtained and to where it has been distributed, how this has changed over the years, and if it is still relevant to both groups of users (Behara and Babbar 2014; Kulkarni et al. 2014; Linderman and Chandrasekaran 2010; Simpson et al. 2015). Knowing this history will help researchers and practitioners in multiple ways. For researchers, both inside and outside of OM, it will alert them to ongoing changes in their field such as the direction the field is moving; its influence on other fields; new research methods; what subjects are losing or gaining in importance; new, insightful, or innovative journals; and what topics and journals they could, or should, be targeting with their research. For practitioners, it will show them whether the field is moving toward subjects of more or less interest to them, and what outlets are becoming the most influential in those topics so they can monitor them and stay up to date.

Given that new knowledge typically appears in journals first and then is built upon by further articles referencing earlier ones, we chose to examine this diffusion network or “flows” of research knowledge between journals by identifying those journals most frequently referenced in the oldest, still extant journals solely dedicated to OM topics. Most other fields in business, such as management, commonly take stock of their progress in various ways as Kulkarni et al. note (2014, p. 972): “Management has also developed a tradition of taking stock of its intellectual structure with conceptual reviews, manual content analysis, and citation-cocitation analysis.”

As the field of OM, and business in general, has evolved over the last three decades, it has frequently had to reach outside of its own field to draw upon new insights, research methods, and knowledge from other fields, commonly called “reference disciplines.” This has been true of other business disciplines as well, of course. As Simpson et al. (2015, p. 97) point out: “...research networks outside of one’s primary discipline may lead to highly beneficial and novel research outcomes.” Linderman and Chandrasekaran (2010, p. 357) agree, saying: “...Operations Management scholars should actively participate in an ecosystem of exchanging ideas with other management disciplines to enhance learning and create knowledge,” but they also note that “few empirical studies examine cross-disciplinary citation exchanges in management.”

Our aim here is to identify the group of journals of most importance to the OM field over the 1980-2016 time span during the 1980s (when OM-dedicated journals first appeared), 1990s, 2000s, and 2010s decades and their importance to OM in each decade based on their citation frequencies. Note that our interest is *not* in identifying the topics per se nor the most influential authors since these kinds of analyses have already been conducted (e.g., see Behara and Babbar 2014; Pilkington and Meredith 2009). In addition, we want to understand the role that the most popular journals play in each full decade of this knowledge diffusion network, particularly in terms of whether they are sources or receivers of knowledge.

More specifically, our research questions were:

Q1: Which journals are the most cited in each decade since 1980 in OM?

Q2: Which journals and disciplines play a central role and which play a peripheral role in the knowledge diffusion network overall?

Q3: How do the roles of the top journals change over the three complete decades in terms of strengthening or weakening in importance, and why?

Q4: Do OM journals play a significant role in this network? If so, what? If not, when might they?

To help answer these questions, we employ citation analysis, as Kulkarni suggests above. Citation analysis reveals what articles (and journals) are actually cited in new research publications, allowing us to follow the emergence, growth, and shrinkage in popularity of individual journals over time. This then allows us to identify changes and trends in the interests of a field, or occasionally that of a specific journal that changes its own direction and interests. To identify the group of journals, we follow Behara and Babbar (2014), Petersen, Aase, and Heiser (2011) and Pilkington and Meredith (2009) and confine our analysis of references to just three pure OM journals, which we refer to as our “base” journals: *Journal of Operations Management* (JOM), *International Journal of Operations and Production Management* (IJOPM), and *Production and Operations Management* (POM). Although any one journal could be sufficient to identify the top journals of interest to the field, each of these three has different personalities and foci that represent the various interests of the scholars in OM, so some diversity was useful among the base journals. Since we are interested in how the set of journals most relevant to the OM field has evolved over time, we included the full publication history of these three journals starting from their initial year of publication (1980 for JOM and IJOPM, 1992 for POM) through 2016. Obviously, these three journals do not encompass the complete publication history of OM, since excellent OM papers have been published in many other journals, but these three do publish the full range of topics in the field and *only* in the OM field, and their history reaches back almost four decades. The total number of references among these three base journals was 192,772, which should well capture all journals of even marginal relevance to OM.

2. Literature review

Citation analysis of the references in selected articles, writings, or publications has been used in many fields to analyze a variety of phenomena such as innovation (Fox et al., 2013), inventions (Lee et al., 2010), and engineering technology (Pilkington, 2008). In business, we have also seen it used in marketing (Baumgartner and Pieters, 2003; Stremersch et al., 2007; Zinkhen et al., 1992), strategy (Ramos-Rodriguez and Ruiz-Navarro, 2004), and information systems (Holsapple et al., 1993, 1994; Wade et al., 2006). In the field of OM, a wide variety of studies have been done: to analyze supply networks (Kim et al., 2011), to rank the top journals in the field (Vokurka, 1996; Goh et al., 1997), to determine the major articles and subfields within OM (Pilkington and Fitzgerald, 2006; Pilkington and Meredith, 2009), and to evaluate the differences in the research agenda between European and American OM scholars (Pilkington and Liston-Hayes, 1999).

In particular, Goh et al (1997) explored the data from three OM dominated journals JOM, IJOPM and JPR (see Table 1 for abbreviations) over a five-year span (1989-1993) to classify the top 48 cited journals into two groups (elite and major). Their analysis made use of four measures: breadth, consistency, trend, and intensity of recognition, but was unable to conclude anything about changes in the rankings or the relationships between the journals. Vokurka (1996) used a similar approach to examine the citations from three journals DS, JOM, and MS from 1992-1994 to rank 25 journals in terms of the most relevant journals used in OM research based on the number of total citations they received, the number of cites per OM article, and the cites per number of OM words. Again, the resulting ranking is only a snapshot and does not examine the roles of the individual journals.

TABLE 1 HERE

As such, no one has used citation analysis to evaluate the flows of knowledge in the OM field--identifying the journals employed in creating, distributing, and receiving knowledge, confirming the primary fields represented, and showing how all that has evolved over the decades, the purpose of this paper. One paper in engineering (Tsay et al., 2003) used co-citation analysis to assess the knowledge

flows between semiconductor journals but it was a static rather than dynamic view, and of a different field.

The study here investigates those journals of major relevance to the field of OM, not to “rank” them or evaluate them, but to understand the flows of knowledge between them. Identifying these flows will help us understand which journals and fields we are relying upon in conducting our research and which we are helping with our own research. As well, by evaluating these flows over the decades, we should be able to discern the evolution and growth of OM’s interests, and the role of our own OM journals in this knowledge network. This should then allow us to answer the questions posed in the Introduction to the paper.

3. Methodology and Data

3.1 Methodology

In this study, we use the set of references in the bibliography, endnotes, and footnotes of papers for our citation analysis, but according to Price (1970) *references* are directionally outgoing from a paper in a journal whereas *citations* are directionally incoming to particular journals— here we are interested in both. It should be noted however that many authors use the two terms interchangeably. When referencing certain items, authors in a discipline inherently identify those documents and journals that are important in the evolution of their thinking to the study at hand; hence, it is generally believed that more frequently cited journals reflect greater influence in that field (Sharplin and Mabry, 1985).

Of course, citations may also be made for other reasons, many of which are detailed in the literature (e.g., see Biehl et al., 2006; Baumgartner and Pieters, 2003). Some of the more obvious include simply established referencing practices in that discipline, self-citations for personal gain, social expectations in the discipline, and even to point out erroneous examples in the literature. Although most of these may be exceptions, there are also some other difficulties with citation analysis such as lack of accessibility to the full literature, the need to treat all citations as equally important, cultural referencing biases, and perhaps most significantly, the high likelihood of citation errors simply because different journals use different referencing procedures: full names versus initials, full journal titles versus abbreviated titles, inclusion versus exclusion of issue numbers, and inaccuracies in identifying the author, date, volume, pages, and other crucial information.

Although in this study we could not correct citations for social, cultural, discipline, and other exceptional effects, we did exercise extreme care to eliminate errors due to alternate referencing procedures by journals, going back to the source whenever any inconsistencies, possible duplications, or questionable citations appeared. This was facilitated here due to our analyzing a relatively narrow field. And in terms of “correcting” for the equal treatment of all citations, we use the multiplicity of references from large numbers of actual researchers to infer the influence of each journal, rather than trying to establish some subjective “weighting” scheme based on a small group of “experts” in the field. As Baumgartner and Pieters (2003, p. 125) note, although citation-based measures have many limitations, they are less prone to systematic biases than subjective measures and are thus becoming “the preferred measures of journal influence in many disciplines.”

The data were analysed using a variety of tools, including text manipulation within MATLAB (MATLAB, 2012), and Excel for data preparation, the scientometric tool Bibexcel for the preparation of citation data (Persson et al, 2009) and UCINET/NetDraw (Borgatti, 2002; Borgatti et al, 2012) for manipulation of the data matrices and to visualize the resulting networks.

3.2 Data

As noted earlier, we used the three base OM journals JOM, IJOPM (both initiated in 1980), and POM (initiated in 1992) to identify the most OM-relevant journals through their 192,772 references made over the 36-year span of interest. The main data source for the three journals was the Institute for Scientific Information's (ISI) Social Science Citation Index (SSCI) but other sources were also used when particular issues were missing. We excluded books and other referenced items that were not specifically journals since our only interest in this study was research journals. For the references from the non-OM journals identified in the study, we relied totally on the ISI's SSCI.

We initially started our analysis of the major journals of relevance to OM with the most frequently referenced journals over the 3+ decades. Table 1 shows the top 30 journals in each decade. But in trying to plot their references and citations on our network graphs, we found the networks too dense to easily visualize with the 41 journals listed in all the top 30s across all decades and so we reduced the number of major journals to 30. In order to be sure we had not lost sensitivity with our choice of 30, we examined the impact of adding the next 15 most cited journals and found that they were much less significant than the first 30, adding less than 4 percent more citations. In addition, many of the journals were less familiar to OM scholars, being engineering journals, and didn't alter the analysis but removed the clutter, so we stayed with just 30 as our "major" journals.

After identifying the top 30 most-cited journals in each decade from the three base OM journals to address Question 1, we next turned our attention to the roles the top 30 journals played over the decades to address the last three questions. To get comparable results for each decade, we only considered the full, 10-year decades of the 1980s, 1990s, and 2000s because the data for determining the various *roles* the 30 journals played in each decade required considerably more data than just citation rates based on three journals and we felt that the partial decade of the 2010s did not have enough data for us to be confident of the results. We analyze and describe our results for each of the four questions in the next section.

4. Analysis and Results

4.1 Decade ranks based on OM journals

The 41 most-cited journals over the decades based on the three baseline OM journals are listed alphabetically in Table 1, along with their abbreviation, the year they initiated publication, and their rank within the top 30 in each decade. The absence of a ranking means that a journal fell outside of the top 30 in that decade. Of interest in the column of journal names is the wide range of interests outside of OM that the journals represent, such as marketing, engineering, practice, MS/OR, strategy, and of course, management.

TABLE 1 HERE

The trends in the decade ranks of individual journals are also quite noticeable, such as the substantial improvement (i.e., closer to #1) in disciplines such as management (AMJ, AMR, ASQ, OS, and SMJ) and marketing (JMar, JMR, MktS, and IMM). We even see a few other areas beginning to show up such as economics (IJPE), innovation (JPIM), and information systems (MISQ). At the same time, we see many areas lose favour such as engineering (IEEETEM, IIET, IE, and JManfS), practice (BH, CMR, HBR, and SMR), and some (but not other) journals in the MS/OR area (DS, EJOR, Intf, JORS, NRL, and OMEGA). In that regard, it is worth noting that journals might move into or out of the top 30 group (e.g., JIBS) not due to anything the journal has done or OM's lack of or increased interest in the journal, but simply because they were on the margin near 30 when other journals above or below them changed ranks. Finally, considering the OM journals themselves, we see marked changes in their rankings, with many

improving significantly (IJOPM, JOM, POM, and MSOM) and some staying relatively steady (JSCM) or losing some interest (IJPR).

Looking at the changes over the decades, in the first decade that OM had its own journals, the 1980s, most of the papers and references reflected our interest in solving practical problems (HBR, IE, IJPR, Intf) using mathematical methods (MS, OR, DS, IIET). General management and its practice had much less interest for us at that time. In the 1990s, our interests in engineering and MS/OR began to slip a bit (IEEEEM, IIET, IE, JManfS; and Intf, NRL, JORS, OMEGA, OR) while our interests in marketing and general management, especially strategy began to increase (JMar, JMR; and AMR, CMR, HBR, OS, SMR, and especially SMJ). These trends largely accelerated through the 2000s, while our own OM journals continued to gain favour, especially with the addition of POM in 1992. Based on the first half of the 2010s, it appears that these trends are now slowing somewhat, and our field is losing interest in the management practice journals (CMR, HBR, BH, and SMR). POM continues to gain popularity and the new MSOM journal has leaped to prominence, ranking twelfth.

4.2 Rank changes over the decades based on the network of top-30 journals

We next move to an analysis of the changing roles based on the network of the overall top 30 journals over the full three-decade span to address Questions 2, 3, and 4. The diffusion networks for the three full decades are shown in Figures 1, 2, and 3, giving us a picture of the roles and relationships between these journals. In the figures, the journals are nodes identified by their abbreviations in Table 1 and the citations are shown by linking arrows from the referencing journal to the cited (arrowhead) journal. The linking arrows between the nodes have varying thicknesses to indicate the number of citations a journal received from another journal. The positions of the nodes/roles in each network are primarily based on grouping the most strongly linked titles together, but also on minimizing an overall “stress” value for the graph (Hanneman and Riddle, 2005). There are 3 link thicknesses shown in the figures (though Figure 1 only has the lowest 2), with the lower limit set at 52 citations. The thinnest links then range from 52 to 300 citations, the next thickest links are from 301-1500 citations, and the thickest links have more than 1500 citations. The decision on the level of citations shown as each line thickness was made by iteratively adjusting the limits, inspecting the figure and re-adjusting. Those chosen balance clarity of the major links with detail in the groups which emerge in the diagram.

FIGURES 1,2,3 HERE

The size of the nodes reflects their citation popularity among the 29 other journals, with the larger nodes tending to fall near the center of the network (e.g., MS) and the smaller nodes on the periphery. However, where they fall is also determined by the range of interest any particular journal has among the other journals.

Each of the journal nodes also identifies the role of that journal in the network. Following Biehl et al. (2006) who ascribed “roles” to the journals in the Financial Times (FT40) premier journal list, we subdivided the list of journals by using their citation/reference ratios to determine if they were primarily *sources* of knowledge, *transmitters* of knowledge, or *sinks* (users) of knowledge. Analyzing our citation data, we found that the citations follow a negative exponential distribution relative to the journals, with the top 8 of the 30 comprising slightly over 50 percent of all the citations. If a journal was largely an information “source” for other journals, as can be seen by having many large arrows pointing in, we used a triangular node (e.g., MS), if a “transmitter” (a circular node), and if a “sink”, with the largest arrows pointing out, an upside-down triangle. We tested a large variety of ratios for each, including Biehl et al.’s (2006), and then examined the resulting network diagrams for what seemed most logical. In the end, we chose a simple symmetric rule that categorized “sources” as those journals that received

50% more citations than they made in references and “sinks” as those that received 50% less than they made in references; those in-between were then deemed “transmitters”. The results for the three decades were that the top 6 or 7 cited journals were sources, the middle 9 or 10 were transmitters, and the remaining 14 or 15 were sinks, following the negative exponential distribution.

Bear in mind, again, that these roles are not necessarily how OM perceives the journals, but rather how the top 30 journals of importance to OM perceive them, so even though OM may not have cited some of these journals very highly, other journals in the network may have. Also, the journals can move a bit between these categories over the decades, as we will see later. Two exceptions were made in the list: since we didn’t have references for HBR after 1991 and no information for IE’s references at all, we labeled HBR as a source based on its high number of citations by other journals and IE as a sink based on its low citations. Finally, we also calculated in-degree, out-degree, and betweenness centralities, as well as the Herfindahl index (Tellis et al., 1999; Baumgartner and Pieters, 2003; Stremersch and Verhoef, 2005) for each of the journals, but the tabular values didn’t vary sufficiently to be able to clearly discriminate between the journals and the network figures here give a better visualization of the same information.

Figures 1, 2, and 3 present the networks for each of the three decades of the 1980s, 1990s, and 2000s, respectively. As noted previously, a triangle is used to indicate a source journal, a circle a transmitter journal, and an upside-down triangle a sink journal.

4.2.1 The 1980s

As seen in Figure 1 for the 1980s, MS dominates in size the sources (triangles) for this decade among the six source journals: MS, ASQ, OR, HBR, AMR, and AMJ. The position of MS in the middle of the network shows the “bridging” function that MS plays during this period, tying the practice (IE, Intf, and IJPR, but also JOM and IJOPM which were very close to practice in the 1980s) and quantitative journals to the management journals. The network seems fairly evenly divided down the middle, with the management journals on the left and the practice/quantitative journals on the right. MS and OR dominate the group on the right as the two sources, with the other quantitative journals nearby and manufacturing (IE and IJPR) and OM (JOM and IJOPM) on the outskirts near the middle. There are four transmitters (circles) on the right: DS, IJET, NRL, and IJPR. On the left, ASQ is the main source, with the other three being HBR, AMJ, and AMR. The transmitters on the left are JMR, JMar, and PB. Half of all the journals are sinks in this decade. The two journals missing from the figure are POM and OS, which didn’t exist in the 1980s. Only two levels of link thickness are evident in this early decade.

It is interesting that ASQ is the second largest source journal while JOM and IJOPM are sinks among this group of the most important journals to the field of OM in the 1980s, showing that management has always been an integral part of OM. Also, although JOM and IJOPM may themselves not have frequently referenced ASQ and the other management journals directly (they primarily referenced HBR), the journals they draw from certainly did. It is also interesting that the marketing journals JMar and JMR are transmitters at this early date, possibly of importance due to their close relationship with logistics, an OM interest as well, or their use of survey methodologies, which OM was only beginning to employ at this time. Last, the position of IEEETEM on the management side of the diagram rather than the quantitative or practice side is also interesting, indicating that the management orientation of this journal rather than its engineering orientation was of interest to the OM field.

4.2.2 The 1990s

Moving to the 1990s in Figure 2, we again see the split with the primarily quantitative group at the right and the primarily management group at the left. Also, the network is considerably denser, with three bolded arrows now showing. POM and OS have now joined the network (upper right and lower

left, respectively) and there have also been some shifts in position, such as JOM and IJOPM moving toward the management group and IJPE moving solidly into the quantitative group on the far right. The sources are again dominated by MS, with OR again the other source on the right but EJOR and NRL switching roles, with EJOR becoming a transmitter and NRL a sink. And on the left, SMJ has moved much closer to the center and jumped all the way from a sink in the 1980s to now joining the previous group of four sources. Also, three new transmitters—SMR, CMR, and JMan—have joined the former group of transmitters but PB has dropped from a transmitter to a sink. Last, JMar appears to have moved from the periphery closer to the center of the network.

The OM journals are still sinks, but now with POM joining JOM and IJOPM. More attention seems to be paid to the European journals now, with IJOPM, EJOR, and perhaps also IJPE appearing to move closer to the center of the network. Most of the interesting changes however seem to be on the management side, with three new transmitters as well as a new source: SMJ. In addition, SMR, and especially SMJ, have moved closer to the center of the network with many new links to the other journals. Also, the highly regarded HBR appears to be moving away from the center of the management group of journals, and the overall network as well.

4.2.3 The 2000s

Finally, we reach the most recent decade in Figure 3 and see the density of the diagram increasing even further, especially in terms of bold arrows on the management side although on the quantitative side as well. The main changes on the quantitative side are JOM moving toward the management side and the center of the network. Moreover, JOM has now changed from a sink to a transmitter while DS had changed in the opposite direction. On the management side of the diagram, OS has also changed from a sink to a transmitter while CMR has changed in the opposite direction. On both the management side and the quantitative side, the group networks seem to have become more tightly bound with each other. Also, MS and HBR seem to be moving to the edge of the networks while JOM and JMar seem to be taking on the bridging role between the two groups. It is worth noting that HBR stopped referencing other journals after 1991.

4.3 Role changes across the decades

This completes our answer for Question 2 about which journals are central to the diffusion network and which are peripheral, and begins to address how the roles of the journals changed over the decades. This then leads us into Questions 3 and 4 concerning more specifically how these roles change for the 30 journals over the decades, and especially those of the OM journals. This will indicate the trends in the interests of this group of 30 journals and the changing popularity of each of them. On occasion, changing popularity may not indicate a change in the group's interests but rather a change in the journal's direction itself. Table 2 presents the 30 journals in order of citations (self-citations excluded) for each decade and their role as a source, transmitter, or sink for that decade. As can be seen, MS has maintained its top status over the full 30-year period, and although its citation rate has dropped about 2 percent over each of the decades, the runner-up's rates have dropped also. And while the top journals' citation rates have generally declined over the 3 decades, the lower cited journals' rates have risen. For example, the range in citation rates across these top 30 journals has shrunk from 18.1 percent in the 1980s to $14.1 - 0.3 = 13.8$ percent in the 2000s, resulting in a considerably tighter distribution of citations.

TABLE 2 HERE

Next, and perhaps most interesting, is the shifting citation popularity of the journals over the decades. We already noted the strength of MS in holding the top position over the three decades but equally notable is the striking increase in positions of OS and SMJ, OS rising from not yet in print in the 1980s (it began publication in 1990) to 9th place in the 2000s, 21 places in two decades, and SMJ rising from #17 in the 1980s to #6 in the 1990s to #2 in the 2000s, a total of 15 places. Four other journals also rose substantially over the three decades: #24 JOM rising to #11 (13 places), #28 IJPE to #16 (12 places), #15 EJOR rising to #7 in the 2000s (8 places), and #25 JMan to #17 (8 places). One interesting anomaly is the move of AMJ from #4 in 1990 to #3 in 2000, even though its citation rate slipped from 7.4 to 6.8. In terms of losses, PB dropped from #8 to #23 (15 places), NRL dropped from #9 to 19 (10 places), and IE dropped from #16 to #29, 13 places. The two marketing journals JMar and JMR and the management practice journals HBR, SMR, and CMR each dropped about 4 places.

It is interesting that none of the OM journals break into the top ten in this list of the relationships within the most OM-relevant journals, although JOM reached position #11 in the 2000s, substantiating the difficulty of breaking into the circle of popular journals with a long history of publication. And IJOPM did well also over this period, moving up 7 places, while POM, getting a late start in the 90s, moved up 4 places. We will reconsider all these movements in more detail in the discussion section later.

The changes between ranks in Table 2 give a “macro” view of the general popularity and roles of the 30 journals but not what’s happening in detail for each journal. For a better perspective on the decade changes for each journal, Figure 4 illustrates the change in citation rates for each journal between the decades, in order of the largest increase between the two most recent full decades (that is, the 1990s to the 2000s) followed by the increase between the two earlier decades (1980s to 1990s). Since citation rates are another measure of influence among the OM-relevant journals, these statistics show more clearly which journals are gaining stature among this group of journals of importance to the OM field and which are losing stature.

Bear in mind that the rates are actual citation percentage points so that the journals are all being compared on the same basis. That is, a 2.1 percentage point loss of cites for MS (at 18.1 percent of the total cites in Table 2 for the 1980s) would be a loss of only $2.1/.186 = 11.3$ percent *of its citations*, whereas a 2.1 percentage point loss for NRL (at 3 percent of cites) would be a 70 percent loss of NRL’s total citations. That is, Figure 4 shows the citation “percentage points,” *not* the percent gain or loss relative to where it started. As a result, the same percentage point loss for two journals might affect one journal’s position in the ranks considerably more than the other.

FIGURE 4 HERE

First, as noted earlier, SMJ had impressive increases in citation rates among these 30 OM-relevant journals over the three decades, being top in both sets of decade increases with about 3 percentage points improvement from the 90s-00s, and over 4 points from the 80s-90s. EJOR also did quite well, being in second place with a little over 2 points from the 90s-00s, and almost tied with IJPR (toward the bottom of the figure) for second place in the 80s-90s. However, IJPR lost most of that gain between the 90s-00s. OS in third place did almost as well as EJOR, with a bit over 2 points from the 90s-00s, and tied with JMan with about a 1.6-point gain between the 80s-90s. However, JMan made very little gain between the 90s-00s.

Inspecting the three base OM journals—JOM, IJOPM, and POM—for their gains or losses of stature among these OM-relevant journals, we see that they did quite well in the 90s-00s, holding the fifth to seventh gain positions. JOM gained the most, a bit less than 2 percent between the 90s-00s, IJOPM about 1 percent, and POM a bit less than 1 percent (due to its later publication in 1992). And the order was the same between the 80s-90s, although the amounts were somewhat less. The marketing journal

JMar largely stayed at the same citation rate over the three decades (as did OMEGA), but JMR had a 2+ point loss between the 80s-90s.

Looking now at the losses, the biggest losers were OR and MS, with losses of almost 3 and 2 percentage points between the 90s-00s, respectively, and about 2 points between the 80s-90s. Still, that hasn't significantly affected their role as major source journals over the three decades, as we saw earlier in Table 2. The third biggest loser between the 90s-00s was ASQ with about 2 points, but it had also been the biggest loser between the 80s-90s with over 4 points. Yet, once again, this wasn't enough to affect its role as a major source journal. Interestingly, the fifth biggest loser was HBR, with losses of over 1 point between the 90s-00s and almost 2 points between the 80s-90s. Two other major reversals besides IJPR were the Academy journals AMJ and AMR, which lost about a half point between the 90s-00s after gaining about 1 point (AMR) and half a point (AMJ) between the 80s-90s. DS also had some of the same results as AMJ gaining a bit between the 80s-90s and then losing about the same between the 90s-00s.

5. Discussion

We will divide our discussion here between the journals of most interest to the OM field based on the references from just the three OM journals and then move to a larger discussion of the popularity of the top 30 journals over the three decades based on the references from all 30 journals. Table 1 was based on just the three OM journals and indicated that OM's interests over the period 1980-2016 were moving away from engineering, practice, and quantitative methods toward general management, strategy, and marketing. That seems to have occurred because the field of OM moved from being interested in practical applications of their engineering and quantitative tools toward more interest in services, management, organizational, and strategic issues.

We also saw that, as would be expected, the OM journals moved up substantially in the citations, JOM moving into position #1, IJOPM into #3, POM #4, and the relatively new journal MSOM #12. Table 1 also had some surprising results in the most recent 2010s column, with JSCM moving from 13th place in the 2000s back to 20th place in the 2010s, and LRP improving its ranking for the previous three decades up to 21st place, and then falling out of the top 30. We don't know if this is due to a sharp change in OM's interests or perhaps simply due to only half a decade's data for this column. It is also interesting how the three managerial practice journals HBR, SMR, and CMR have fallen in OM's interests. In the case of HBR, which used to have frequent articles about OM in their issues, the journal has moved strongly toward more strategic and organizational articles. The slippage in position for both SMR and CMR is even more extreme. In all three cases, the movement in these journals' interests toward strategic issues coincides with the change in OM's interests, so why such slippage? One possibility is that the slippage is not due to the change in topics as much as a change in the orientation of OM journals to a more academic perspective and away from the previous practical perspective; but again, perhaps the data for only half a decade is misleading.

Moving on to the three-decade data from the top 30 journals, we saw that there were some prominent structures in the diffusion networks, especially the 2000s network, that tied many of the quantitative journals together, many of the management journals together, the two marketing journals, and two of the three OM journals. MS is the main bridging and source journal connecting the entire network together, with JOM and IJOPM also playing an important, but secondary, bridging and transmitter role.

In the rank changes over the three decades shown in Table 2, we found that even though the top journals tended to stay in the top, the entire range of citation rates tended to close a bit over the decades with the top journals losing some of their popularity and the lower journals gaining some. There were also some impressive jumps (and losses) in popularity over the decades, with notable increases by

OS, SMJ, JOM, and IJPE. As a group, the OM journals improved markedly in popularity among this group of the most important journals to OM, a positive trend that hopefully foreshadows the acceptance of OM as an important functional area in business.

Last, Figure 2 illustrates more starkly which journals are gaining and losing popularity among these top 30 journals. Of interest is that despite the impressive leaps in ranks exhibited by OS, SMJ far exceeded it in citation percentage point increases, illustrating the fact that changes in ranks don't translate necessarily into the same changes in citation rates; i.e., rankings aren't linear with citation rates. As noted earlier, the three OM journals did quite well in terms of citation increases over the decades. Interestingly, the biggest losers here were the three top journals in 1980 and 1990 (Table 2), showing the decreasing popularity of some of the quantitative and even management journals among this group.

6. Conclusions

To begin, it might be asked of this citation/diffusion analysis why some journals have more citations than other journals—is it the topic, the subject, the journal itself, or something else? Our answer is: all of these! Often it is the topic, which is why some marketing and psychology journals (e.g., PB) had citations for their survey methodology. But marketing journals also have subjects of interest to OM, such as logistics and channels, and service strategy. But it can also be the journal, since the best journals in a field probably will have the best papers on subjects and topics in OM's areas of interest. And again, we need to note that Table 1 was based on just the references in our three base OM journals and reflected only the OM field's interests, whereas Table 2 and the figures were based on the citations of all the top-30 journals of importance to OM.

We had four questions we wanted to explore for this study, the first being which journals were most cited by OM journals in each decade since 1980, since these journals should reflect the OM field's changing interests over the decades. We found that in the 1980s, the OM field was primarily concerned with practice, addressing the narrow, tactical problems of operations managers primarily with analytical models. Disciplines of interest in that period were quantitative methods, managerial practice, and engineering, illustrating the willingness of OM researchers to utilize and collaborate across business disciplines as well as other fields to enhance their learning and knowledge. In the 1990s, OM's interests turned to the larger organization involving broader, executive-level issues such as general management, strategy, and marketing. To address these more complex issues, OM added empirical methodologies such as surveys, case studies, action research, and ethnography to their arsenal of research techniques. To help learn these new research techniques, they turned to psychology, strategy, management, and marketing (which, of course, was also involved in developing strategy). Then in the 2000s, OM's interests expanded further into inter-organizational issues concerned with such topics as organizations, strategy (again), and supply chains. However, OM also seemed to become more interested in academic theory and reputation, consequently losing some interest in actual practice, a turn of events that has concerned many in the field.

Our second question concerned the entire network of journals of importance to OM, asking which journals and disciplines were central to our interests and which were peripheral. We found that quantitative methods and general management were the major disciplines OM relied upon, as well as marketing and practice to a lesser extent. The quantitative journal MS played a major role in the network, being both the largest source and the bridge across the network for most journals, but JOM was becoming a secondary bridge as well. The third question concerned how the roles of the network of journals changed over the three decades and why. We found that the top journals generally stayed the top journals but that there was substantial movement among the rest of the journals, with some gaining prominence and others diminishing substantially, depending on the changing interests of the network.

More specifically, strategy, organizational, and OM journals were gaining greater prominence (along with EJOR and IJPE) and some quantitative, engineering, practice, and administrative journals were losing prominence.

Our last question concerned the roles the OM journals were playing in this network and what their prognosis was. Here we saw that they were all rising in prominence substantially (including, it appears the new MSOM journal), and JOM was also playing an important bridging role in the network. However, none of the journals were yet source journals in the network, the highest being JOM as a transmitter. And when will OM journals become top journals in this group of top-30 journals? Although they are moving in that direction, the difficulty of becoming a major cited journal is quite clear—it usually takes a long time and history of excellence to break into the top set of journals. Compared to the lengthy history of many of the top-30 journals examined here, our OM journals are relative neophytes, but the trends look favorable.

For academics interested in deciding where to best search for information related to their current research, this paper gives some good insights into the most important sources, and perhaps where to send their latest research for publication. It is also of interest to not only researchers but also editors for identifying the up and coming journals, and those that are slipping. One question of importance to most OM researchers is whether we are becoming more or less relevant to real-world managers (Simpson, 2015), as noted earlier. Also, the focus of OM research has shifted from the functional OM manager to strategic, organizational, and inter-organizational issues, so the paper is important to operations and supply chain managers who are interested in more strategic issues and keeping up with what's happening in their field—the latest areas of interest, the best journals for information, and so on. Last, although this paper was written only for the OM field, the apparent gain or loss of popularity among the journals in other fields such as marketing, strategy, or general management would still be of value to academics and managers in these other disciplines and fields.

As with any study, there are some limitations of this research that should be noted. First, our results were limited to the top 30 research journals of interest to the OM field. Another field that includes some of the journals we analyzed here might find that their major journals have different citation and other statistics for some of the journals listed here. For example, the strategy field may find that the citations among their major journals to HBR were increasing instead of decreasing as we found. Also, our results were based on only the top 30 journals and the top 60 or top 100 might have given different results, although we found that the top 45 did not. In terms of future research, this work has raised many questions as to why some journals play a central role and why this changes over time—have the journals changed something or has the field turned its attention elsewhere? And why do some journals like SMJ and OS quickly gain prominence and others suddenly drop? Another natural question for future research is how the results found here may change as this decade passes on. And other metrics might have illustrated other interesting characteristics of the journals that we hadn't considered. Finally, as Kim et al. (2011) mentioned, there are procedures to weight some journals more heavily than other journals (e.g., the source journals) and it would be interesting to see how this might have altered our results here.

References

Baumgartner, H., and Pieters, R., (2003), "The structural influence of marketing journals: A citation analysis of the discipline and its subareas over time", *Journal of Marketing*, Vol. 67, pp. 123-139.

Behara R.S., and Babbar S., (2014), "Leadership in OM research: a social network analysis of European researchers," *International Journal of Operations and Production Management*, Vol. 34, No. 12, pp. 1537-1563.

Biehl, M., Kim, H., and Wade, M., (2006), "Relationships among the academic business disciplines: A multi-method citation analysis," *Omega*, Vol. 34 pp. 359-371.

Borgatti, S.P., Everett, M.G., and Freeman, L.C., (2002), *Ucinet for Windows: Software for Social Network Analysis*, Analytic Technologies, Harvard, MA.

Borgatti, S.P., (2002), *Netdraw Network Visualization*, Analytic Technologies, Harvard, MA.

Fox, L. F., Smith, J. S., Cronin, J. J., and Brusco, M., (2013), "Weaving webs of innovation," *International Journal of Operations & Production Management*, Vol. 33, pp. 5-24.

Goh, C.-H., Holsapple, C. W. , Johnson, L. E., and Tanner, J. R. , (1997), "Evaluating and classifying POM journals," *Journal of Operations Management*, Vol. 15, pp. 123-138.

Hanneman, R. A., and Riddle, M., (2005), *Introduction to social network methods*, University of California, Riverside, CA.

Holsapple, C.W., Johnson, L.E., Manakyan, H., and Tanner, J., (1993), "A Citation Analysis of Business Computing Research Journals," *Information and Management*, Vol. 25, No. 5, pp. 231-244.

Holsapple, C.W., Johnson, L.E., Manakyan, H., and Tanner, J., (1994), "A Normalized Citation Analysis," *Journal of Management Information Systems*, Vol. 11, No. 1, pp. 131-140.

Kim, Y., Choi, T. Y., Yan, T., and Dooley, K., (2011), "Structural investigation of supply networks: A social network analysis approach," *Journal of Operations Management*, Vol. 29, pp. 194-211.

Kulkarni S.S., Apte, U.M., and Evangelopoulos, N.E., (2014), "The use of latent semantic analysis in operations management research," *Decision Science*, Vol. 45, No. 5, pp. 971-994.

Lee, P-C., Su, H-N., and Wu, F-S., (2010), "Quantitative mapping of patented technology—The case of electrical conducting polymer nanocomposite," *Technological Forecasting & Social Change*, Vol. 77, pp. 466-478.

Linderman, K., and Chandrasekaran, A., (2010), "The scholarly exchange of knowledge in operations management," *Journal of Operations Management*, Vol. 28, pp. 357-366.

MATLAB, *MATLAB and Statistics Toolbox Release 2012b*, The MathWorks, Inc., Natick, MA.

Persson, O., Danell, R., Schneider, J., (2009), "How to use Bibexcel for various types of bibliometric analysis," In *Celebrating scholarly communication studies: A Festschrift for Olle Persson at his 60th Birthday*, ed. Åström, F., Danell, R., Larsen, B., and Schneider, J., Leuven, Belgium: International Society for Scientometrics and Informetrics, pp. 9–24.

Petersen, C. G., Aase, G. R., Heiser, D. R., (2011), "Journal ranking analyses of operations management research," *International Journal of Operations & Production Management*, Vol. 31, pp. 405-422.

Pilkington, A., (2008), "Engineering management or management of technology? A bibliometric study of IEEE-TEM," *International Journal of Management Science and Engineering Management*, Vol. 3, pp. 63-70.

Pilkington, A., and Fitzgerald, R., (2006), "Operations management themes, concepts and relationships: a forward retrospective of the IJOPM," *International Journal of Operations & Production Management*, Vol. 11, pp. 1255-1275.

Pilkington, A., and Liston-Heyes, C., (1999), "Is production and operations management a discipline? A citation/co-citation study," *International Journal of Operations & Production Management*, Vol. 19, pp. 7-20.

Pilkington, A., and Meredith, J., (2009) "The evolution of the intellectual structure of operations management—1980-2006: a citation/co-citation analysis," *Journal of Operations Management*, Vol. 27, pp. 185-202.

Price, D. J. D., (1970), "Citation measures of hard science, soft science, technology, and nonscience," In Nelson, C. E., and Pollack, D. K., eds. *Communication among Scientists and Engineers*, Heath Press, Lexington, MA, pp. 3-22.

Ramos-Rodriguez, A.R., and Ruiz-Navarro, J., (2004), "Changes in the intellectual structure of strategic management research: a bibliometric study of the Strategic Management Journal, 1980-2000," *Strategic Management Journal*, Vol. 25, pp. 981-1004.

Sharplin, A., and Mabry, R., (1985), "The relative importance of journals used in management research: an alternative ranking," *Human Relations*, Vol. 38, pp. 139-149.

Simpson, D., Meredith, J., Boyer, K., Dilts, D., Ellram, L.M., and Leong, G.K. (2015), "Professional, research, and publishing trends in operations and supply chain management," *Journal of Supply Chain Management*, Vol. 51, No. 3, pp. 87-100.

Stremersch, S., Verniers, I. , and Verhoef, P. C. , (2007), "The quest for citations: Drivers of article impact," *Journal of Marketing*, Vol. 71, pp. 171-193.

Stremersch, S., and Verhoef, P.C., (2005), "Globalization of authorship in the marketing discipline: Does it help or hinder the field?" *Marketing Science*, Vol. 24, No. 4, pp. 585-594.

Tellis, G. J., Chandy, R. K., and Ackerman, D. S., (1999), "In search of diversity: The record of major marketing journals," *Journal of Marketing Research*, Vol. 36, pp. 120-131.

Tsay, M., Xu, H., and Wu, C., (2003), "Journal Co-citation analysis of semiconductor literature," *Scientometrics*, Vol. 57, No. 1, pp. 7-25.

Vokurka, R. J., (1996), "The relative importance of journals used in operations management research: A citation analysis," *Journal of Operations Management*, Vol. 14, pp. 345-355.

Wade, M., Biehl, M., and Kim, H., (2006), "Information systems is not a reference discipline (and what we can do about it)," *Journal of the Association for Information Systems*, Vol. 7, pp. 247-269.

Zinkhan, G.M., Roth, M.S., and Saxton, M.J., (1992), "Knowledge Development and Scientific Status in Consumer-Behavior Research: A Social Exchange Perspective," *Journal of Consumer Research*, Vol. 19, pp. 282-291.

Table 1: Top 30 OM-Relevant Journals by Decade

Journal Name	Abbreviation	Year Published	1980s Rank	1990s Rank	2000s Rank	2010s Rank
Academy of Management Journal	AMJ	1963	17	17	9	8
Academy of Management Review	AMR	1976	15	12	8	6
Administrative Science Quarterly	ASQ	1956	23	23	16	16
Business Horizons*	BH	1958	18		30	
California Management Review	CMR	1958	22	19	19	30
Decision Sciences	DS	1970	6	6	7	19
European Journal of Operational Research	EJOR	1977	19	9	12	14
Harvard Business Review	HBR	1922	2	1	4	9
IEEE Transactions on Engr. Mgmt	IEEETEM	1963	20	27		
IIE Transactions	IJET	1969	8	13	28	28
Industrial Engineering*	IE	1969	4	14		
Industrial Marketing Management	IMM	1971				26
Intrl. Jr. of Opns. and Pdtn. Mgmt	IJOPM	1980	10	4	3	3
Intrl. Jr. of Production Economics	IJPE	1976		29	18	11
Intrl. Jr. of Production Research	IJPR	1961	3	3	15	17
Interfaces	Intf	1971	9	16	24	
Journal of Business Strategy	JBS	1980	27			
Journal of International Business Studies	JIBS	1970				29
Journal of Management	JMan	1975		30	22	24
Journal of Management Studies	JMS	1964	29		23	23
Journal of Manufacturing Systems	JManfS	1982	26			
Journal of Marketing	JMar	1936	28	20	10	10
Journal of Marketing Research	JMR	1964		26	14	15
Journal of Operations Management	JOM	1980	7	5	1	1
Journal of the Opnl. Research Society	JORS	1950	11	21		
Journal of Product Innovation Mgmt.	JPIM	1984			26	22
Journal of Supply Chain Management	JSCM	1965	21	11	13	20
Long Range Planning	LRP	1968	30	28	21	
Management Review	MR	1926	25			
Management Science	MS	1954	1	2	2	2
Manufacturing and Service Opns. Mgmt.	MSOM	1999				12
Marketing Science	MktS	1982				18
MIS Quarterly	MISQ	1977			25	21
Naval Research Logistics	NRL	1954	12	22		
OMEGA	OMEGA	1973	14	18	27	
Operations Research	OR	1952	5	7	17	7
Organisation Science	OS	1990		25	20	13
Production and Operations Management	POM	1992		15	5	4
Psychological Bulletin	PB	1904	24	24	29	25
Sloan Management Review	SMR	1959	16	10	11	27
Strategic Management Journal	SMJ	1980	13	8	6	5

* BH: Not included in ISI database from 1990 (vol.33 no.6) to 2008 (vol. 51, no. 1); IE: Industrial Engineering, 1969-1995; then became IIE solutions and is not included in ISI database.

Table 2. Changing Influence and Characteristics of the 30 Major Journals 1980-2009

Rank	1980s				1990s				2000s		
	Journal	% Cites	Role		Journal	% Cites	Role		Journal	% Cites	Role
1	MS	18.1	Source		MS	16.0	Source		MS	14.1	Source
2	ASQ	12.8	Source		OR	9.2	Source		SMJ	8.7	Source
3	OR	11.1	Source		ASQ	8.6	Source		AMJ	6.8	Source
4	HBR	7.3	Source		AMJ	7.4	Source		ASQ	6.7	Source
5	AMJ	7.1	Source		AMR	6.8	Source		OR	6.5	Source
6	AMR	6.0	Source		SMJ	5.6	Source		AMR	6.4	Source
7	JMR	5.2	Transmitter		HBR	5.5	Source		EJOR	5.9	Transmitter
8	PB	3.6	Transmitter		IJPR	4.8	Transmitter		HBR	4.3	Source
9	NRL	3.0	Transmitter		EJOR	3.7	Transmitter		OS	3.6	Transmitter
10	JMar	2.6	Transmitter		JMR	3.0	Transmitter		IJPR	3.2	Transmitter
11	IJPR	2.6	Transmitter		IIET	3.0	Transmitter		JOM	3.2	Transmitter
12	DS	2.5	Transmitter		DS	2.8	Transmitter		JMR	3.0	Transmitter
13	IIET	2.4	Transmitter		JMar	2.5	Transmitter		IIET	3.0	Transmitter
14	Intf	1.9	Sink		NRL	2.5	Sink		JMar	2.5	Transmitter
15	EJOR	1.7	Sink		JMan	2.1	Transmitter		DS	2.4	Sink
16	IE	1.4	Sink		PB	1.9	Sink		IJPE	2.3	Sink
17	SMR	1.3	Sink		Intf	1.8	Sink		JMan	2.2	Transmitter
18	SMJ	1.3	Sink		JMS	1.7	Sink		JMS	2.0	Sink
19	CMR	1.3	Sink		JOM	1.6	Sink		NRL	1.9	Sink
20	JMS	1.3	Sink		CMR	1.5	Transmitter		IJOPM	1.7	Sink
21	OMEGA	1.3	Sink		SMR	1.5	Transmitter		SMR	1.6	Transmitter
22	LRP	1.2	Sink		OS	1.4	Sink		CMR	1.5	Sink
23	BH	0.9	Sink		OMEGA	1.3	Sink		PB	1.3	Sink
24	JOM	0.7	Sink		IE	0.9	Sink		OMEGA	1.2	Sink
25	JMan	0.6	Sink		IJOPM	0.7	Sink		Intf	1.2	Sink
26	IEEEEM	0.5	Sink		IEEEEM	0.6	Sink		POM	0.9	Sink
27	IJOPM	0.1	Sink		LRP	0.6	Sink		IEEEEM	0.7	Sink
28	IJPE	0.0	Sink		BH	0.5	Sink		LRP	0.5	Sink
29					IJPE	0.4	Sink		IE	0.3	Sink
30					POM	0.2	Sink		BH	0.3	Sink

* HBR, BH and IE do not have any citing data and so their roles are estimated.

Figure 1: Citation Network of Major OM-Relevant Journals—1980s Decade

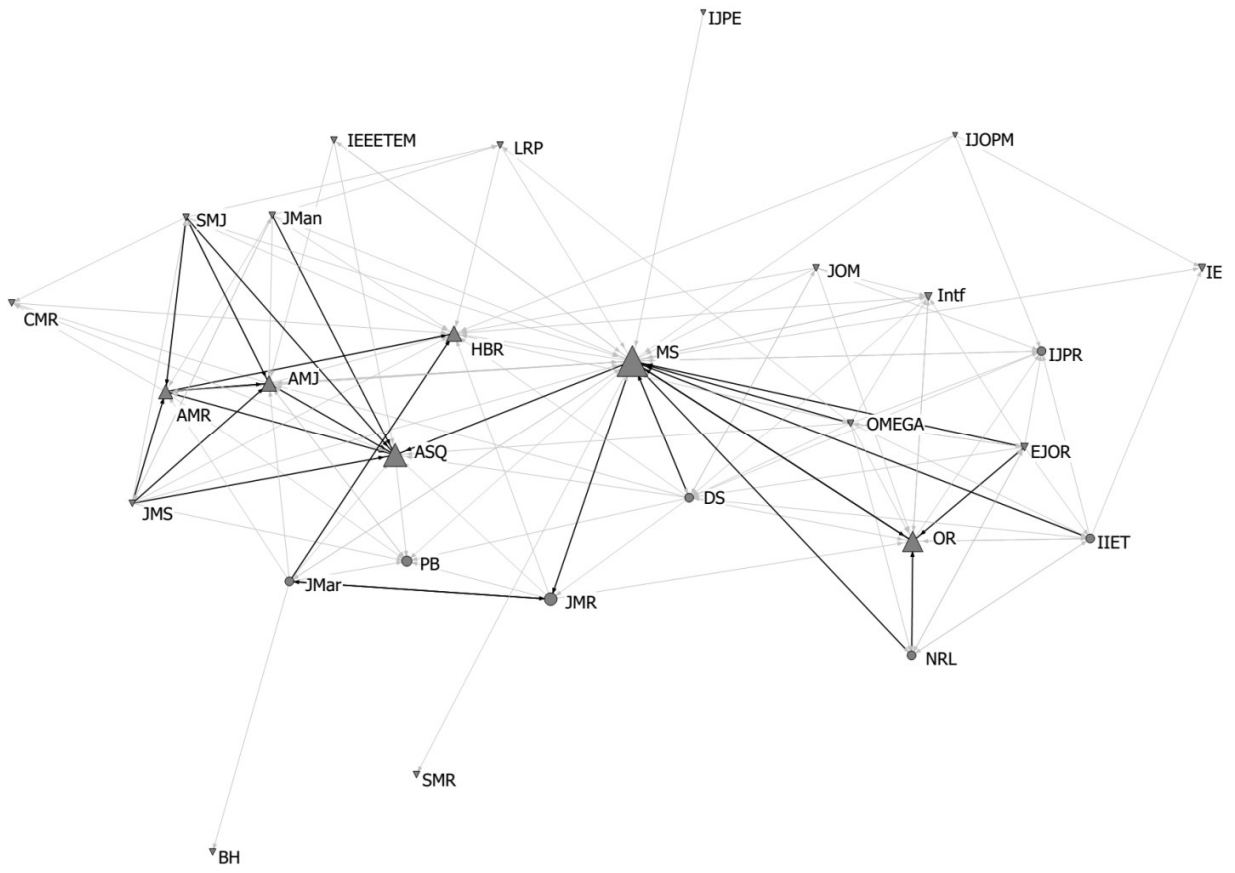


Figure 2: Citation Network of Major OM-Relevant Journals—1990s Decade

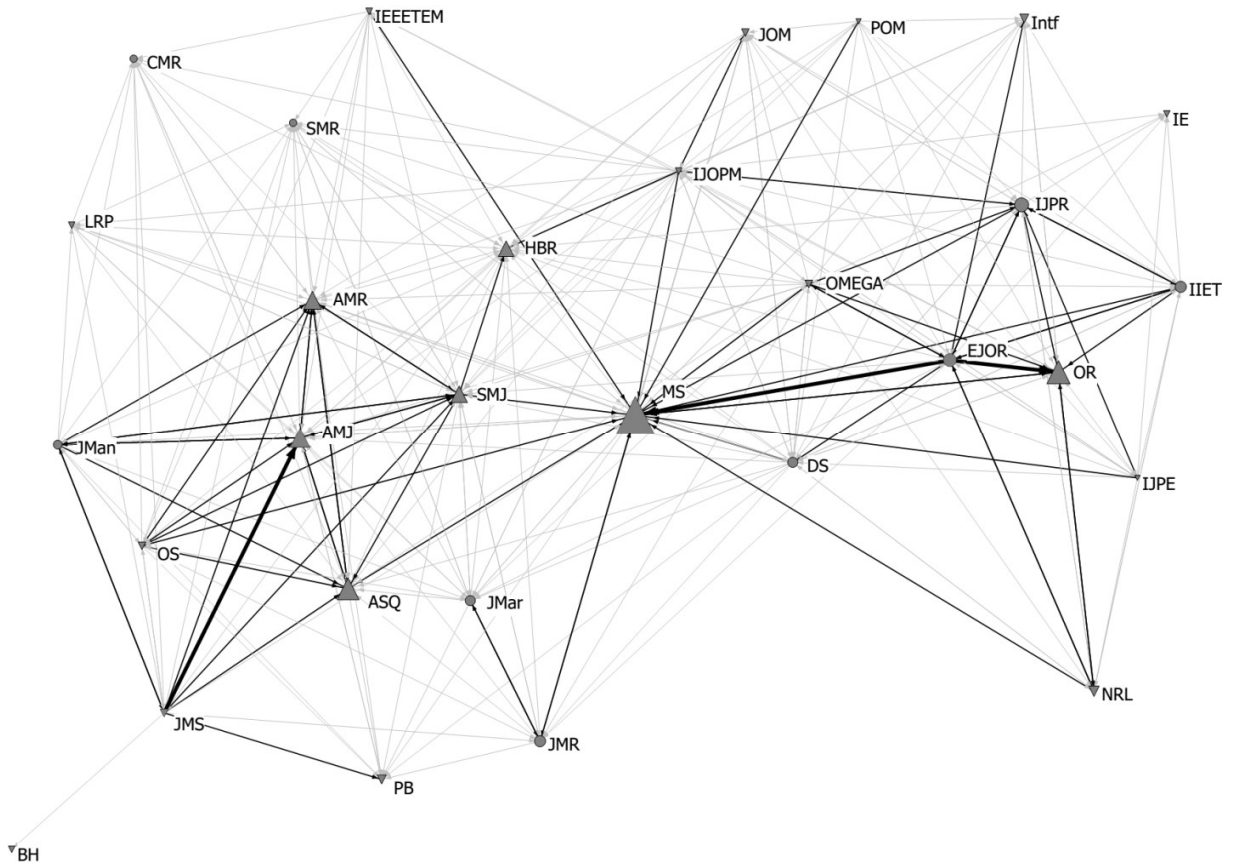


Figure 3: Citation Network of Major OM-Related Journals—2000s Decade

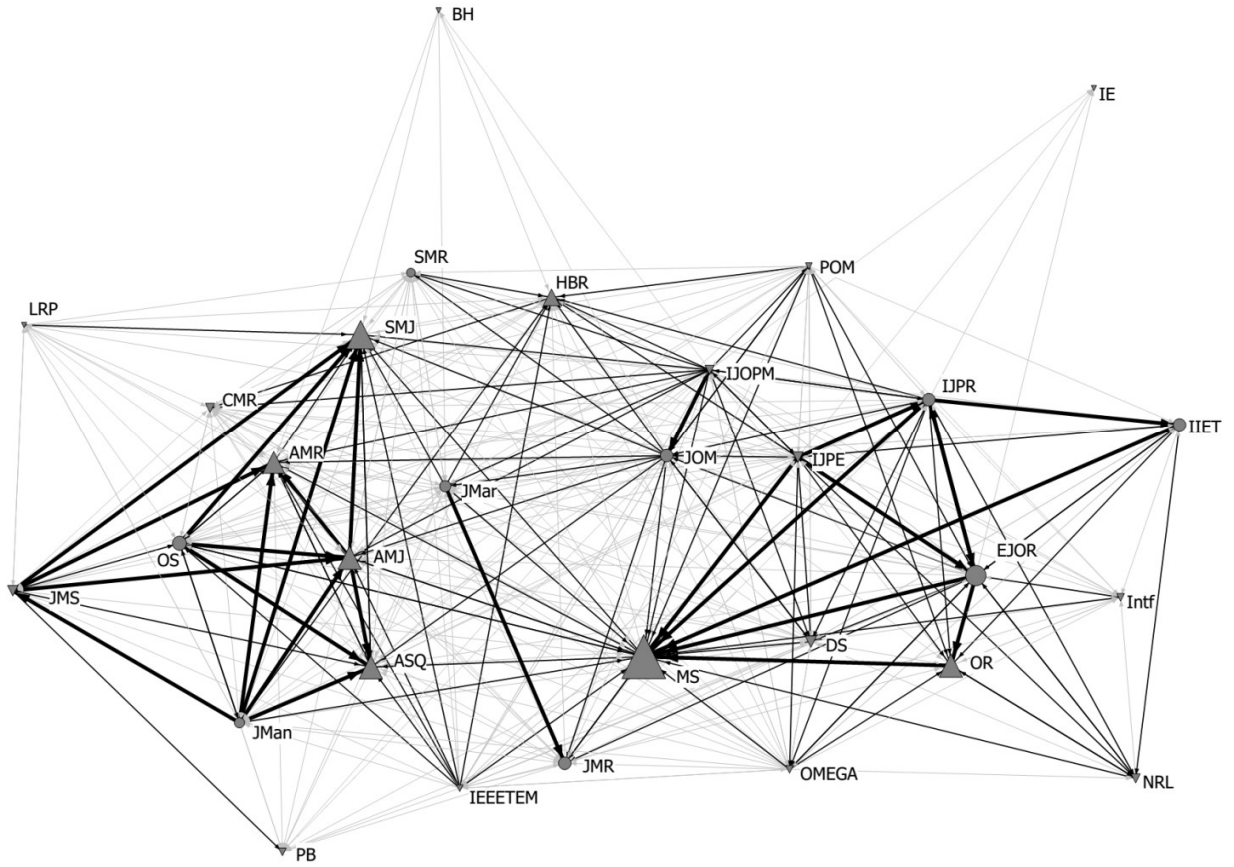


Figure 4: Change in Citation Rates over the Decades (% points)

