Manufacturing & Service Operations Management

Publication details, including instructions for authors and subscription information:
http://pubsonline.informs.org

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M&SOM MANUFACTURING & SERVICE OPERATIONS MANAGEMENT
Vol. 7, No. 1, Winter 2005, pp. 3–19
ISSN 1523-4614 | EISSN 1526-5498 | 05 | 0701 | 0003
informs®
DOI 10.1287/msom.1040.0062

OM Forum
Evaluating Operations Management–Related Journals via the Author Affiliation Index

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We evaluate operations management–related journals based on a novel indicator of journal quality—the Author Affiliation Index (AAI). We explain the basic rationale behind the AAI, as well as its advantages and disadvantages with respect to other such indicators of journal quality. We provide a specific recipe for its calculation and apply it to 27 journals in which researchers in the field of operations management might wish to publish. We compare the resulting journal rankings to those from published survey reports and citation analyses and test AAI for sensitivity to its inputs. We find the rankings from AAI to be consistent with other studies and to be robust with respect to changes in inputs.

Key words: measures; journal quality; operations management journals
History: Received: February 21, 2004; accepted: November 23, 2004. This paper was with the authors 1 month for 1 revision.

1. Introduction

Within operations management (OM) and any academic discipline, we judge the quality of an individual's research program (i.e., it is a critical ingredient in making hiring, promotion, and tenure decisions). Unfortunately, the quality of an individual's research program can be difficult to measure, is somewhat subjective, and is often revealed only after several years. So, for reasons of expediency, practicality, and a desire for objectivity, the quality of an individual's research program is judged to a great degree by the reputation of the journals in which the research is reported. Thus, there is a continuing need to make judgments about journal quality. Indicators such as acceptance rates are not consistently reported and are insufficient to provide significant insight into journal quality. Traditionally, opinion surveys and citation analyses have been occasionally conducted and published. Whereas surveys collect subjective opinions, citation analyses count how often articles of a journal are cited in some population of journals.

This report is directed toward U.S. university professors in the discipline of OM. We review below existing survey reports and citation analyses that have been conducted for OM-related journals. We argue that surveys and citation reports both have their drawbacks. We introduce an alternative approach for judging journal quality, the Author Affiliation Index (AAI), based on the percentage of a journal's U.S. academic authors that comes from top U.S. business research universities. We argue that the AAI does not suffer from many of the disadvantages of other methods. We rank a set of 27 OM-related journals via AAI, test the sensitivity of the resulting AAI rankings to various assumptions, and compare the rankings provided by AAI to published surveys and citation analyses.

2. Indicators of Journal Quality—Existing Approaches

2.1. Surveys of OM-Related Journals

Occasionally, surveys of OM-related journal quality are conducted and reported in the literature. With surveys, some population of academicians in the field of OM (e.g., members of the Production and Operations Management Society (POMS)) are asked to rank or evaluate journals. The most recently published surveys are Barman et al. (2001), Donahue and Fox (2000), and Soteriou et al. (1999). The study of

Barman et al. (2001; a follow-up study to Barman et al. 1991) surveys 223 responding members of the POMS. The rating uses a Likert scale (1: highest quality, 9: lowest quality). Soteriou et al. (1999) use the same basic methodology of 106 European members of the Manufacturing and Service Operations Management Society of INFORMS (EurOMA). Soteriou et al. (1999) uses the scale 1: lowest quality; 9: highest quality. Donahue and Fox (2000) poll 242 members of the Decision Sciences Institute (DSI). The respondents were asked to rate journal quality on a 100-point scale where *Decision Sciences* was arbitrarily assigned the score 100.

Surveys are by their nature subjective and are often incomplete. We study six journals not found in any of the aforementioned surveys. Furthermore, the sample sizes are often small. Specialized journals have a disadvantage because many respondents lack familiarity. It is difficult to compare results between surveys that have different methodologies and different journal coverage. Moreover, surveys are relatively time consuming, which explains in part why they are not often repeated.

2.2. Published Citation Analyses

In recent years, several published citation analyses of OM-related journals have appeared (Vokurka 1996, Goh et al. 1997, and Cheng et al. 1999).

Vokurka (1996) examines 146 OM-oriented articles from *Decision Sciences*, *Journal of Operations Management*, and *Management Science* for the period 1992–1994. He then identifies the citations these journals made to a target list of OM-related journals.

Goh et al. (1997) analyzes the citations in *Journal of Operations Management*, *International Journal of Production Research*, and *International Journal of Operations and Production Management* over the years 1989–1993, providing rankings based on an age-adjusted, normalized citation index for citations in a single journal—*Journal of Operations Management*.

Cheng et al. (1999) analyzes the citations in five journals over the period 1990–1994: *IEEE Transactions on Engineering Management*, *Journal of Engineering and Technology Management*, *Journal of Product Innovation Management*, *Journal of High Technology Management*, and *Research Policy*. Their report provides the rankings of journals based on the total number of citations in *IEEE Transactions* during the base years.

Citation analyses provide good information but require a great deal of effort and, unfortunately, are incomplete. We evaluate eight journals that were not covered by the citation analyses above. Varying methodologies and journal coverage make it difficult to combine (or compare) results of one study to another. Moreover, the citations collected cover only one or a few journals.

2.3. The Impact Factor of the Institute for Scientific Information

The Institute for Scientific Information (ISI®) provides a standard methodology for performing citation analyses through its three data bases: Science Citation Index Expanded (SCI-EXPANDED)—1980–present; Social Science Citation Index (SSCI)—1980–present; and Arts & Humanities Citation Index (A&HCI)—1980–present. Each year it is possible (through paid subscription) to receive a Journal Citation Report (JCR®) of the impact factor (IF) for any journal listed in the data base (data bases). The IF is a point-in-time measurement of the number of citations a given listed journal is cited by the set of listed journals. Specifically, the IF for a given journal x in year t is computed by

$$\begin{aligned}\mathrm{IF}(x,t) = {}&[\text{total number of citations in year } t \text{ to}\\ &\quad \text{articles in } x \text{ in years } t-1,\, t-2]\\ &\cdot [\text{total number of articles}\\ &\quad \text{in } x \text{ in years } t-1 \text{ and } t-2]^{-1}.\end{aligned}$$

Thus, the IF is the ratio of the number of current citations to articles published in the two preceding years that a journal receives to the number of articles published in those same years. It is claimed that the largest portion of an article's citations occur within two to three years after its publication (e.g., see Gupta 1997) and that the size of this look-back window provides a fair impression of the general impact a given journal has on its research constituency. The size of the look-back window can change the relative ranking of journals, however. As an example, in a report by Amin and Mabe (2000), the authors point out that for the case of 30 chemistry journals, changing the window to five years causes 24 changes in journal rankings by as many as 11 positions.

In spite of its objectivity, using the IF as an indicator of journal quality should be done carefully with consideration of a number of additional caveats

(Amin and Mabe 2000). First, using the IF to make comparisons across academic disciplines is not recommended. Different disciplines have different customs and expectations regarding how many citations a given scholarly article is expected to have. For example, journals in mathematics and computer science exhibit an average IF of about 0.5, whereas journals in the fundamental life sciences exhibit average IFs of over 3.0. (For journals in the category social science, the average IF is about 0.6.) Consequently, Amin and Mabe (2000) recommend that IF only be used to make comparisons of journals in the same subject area. Because they do not report the variation within different subdisciplines within business, it might similarly be dangerous to apply IF to make comparisons across various business subdisciplines to the extent their citation customs vary. Both the number of journals typically cited by an article and the breadth of coverage of the articles affect IF. Thus, comparing journals using IF could be confounded by the level of broad appeal of a journal or its relevance to a specific discipline or subdiscipline. It might be tenuous to compare more general journals such as *Management Science* and *Decision Sciences* to more OM-discipline-relevant journals such as *Journal of Scheduling* or even *Journal of Operations Management*. Using IF to establish the quality of a journal requires both the number of journals in the reference set and the journals' relevant disciplines to be defined a priori.

The IF for any journal also exhibits a relatively high year-to-year variance. As Amin and Mabe (2000) point out, for a journal that publishes 140 articles per year the IF would have to change from one year to the next by more than ±22% to be significant. Moreover, the variance is conditioned on number of articles a journal publishes—the smaller the journal, the greater the variance. For example, for journals with fewer than 35 articles per year, the IF may vary more than ±40%, whereas for journals with 70–150 articles per year, the year-to-year variation is about ±25%.

Finally, although the JCR data base is quite extensive, there are still a number of journals not included. JCR data bases do not include nine of the journals evaluated here. However, if more OM-related journals were to be catalogued, the IF represents a standard for citation analysis that will diminish the value of specialized ad hoc citation studies.

2.4. An Author-Based Study

Agrawal (2002) reports an author-based alternative approach for analyzing OM-related journals. His study focuses on the three journals: *Journal of Operations Management*, *Production and Operations Management*, and *Manufacturing and Service Operations Management* (*M&SOM*). His analysis focuses on analyzing the affiliations of authors in these three journals and classifying them into different sets, e.g., authors from top U.S. and non-U.S. business schools as reported by *Business Week* and *U.S. News and World Report*, and authors from business and government. His focus was to describe the breakdown of author affiliation for the three journals rather than to develop a journal ranking methodology. Nevertheless, the underlying idea behind Agrawal's approach is to analyze the three journals by observing the affiliation of their authors.

3. The AAI

In a sense, the AAI formalizes the author-based approach demonstrated by Agrawal (2002) into a standardized methodology. AAI can be thought of as an alternative indicator augmenting opinion surveys and citation analyses for surmising journal quality.

3.1. AAI Introduction

David Harless and Robert Reilly of Virginia Commonwealth University conceived the AAI. Simply stated, a journal's AAI is the percent of its U.S. university authors that hail from the top U.S. business research universities. Their goal was to create an objective indicator of journal quality that allows comparison across disciplines within business administration. The basic idea is that the quality of a journal is highly correlated with who publishes in it, and that U.S. academic authors logically aspire to publish in those journals where scholars from leading U.S. schools publish.

3.2. The Basis for AAI

We adopt the view that a research journal's quality is completely embodied in the research articles it contains, and furthermore, that a research article's quality is the extent to which it advances the state of knowledge that has a positive impact on society. Thus, the quality of a research article is tied to its outputs as those outputs relate to the advancement of knowledge beneficial to society. Unfortunately, an article's quality may well take years, perhaps decades, to ascertain.[1] Thus, we often resort to quality inputs to a journal article, i.e., inputs that might logically cause quality. Such causal indicators might be the peer review procedures and policies, acceptance rate, circulation of the associated journal, citations to the article, and the like.

Aside from the aforementioned causal indicators, we might use associative indicators to surmise article quality. Consider the following arguments. Let A be the set of all research journal articles written by business school researchers. For each article, an element of A, there is a journal, a set of authors and authors' schools, and the article's quality value (Q) (a value measuring the degree to which the article advances knowledge for the betterment of society).[2] Given Q, it follows directly that it is possible to rank order the articles in A according to Q.

Ranking Conjecture. A rank ordering of A according to Q will simultaneously reveal a rank ordering of journals and a rank ordering of schools. In other words, a pattern will be revealed. Some journals will have more high-quality articles than other journals; some schools will have more high-quality articles than other schools.[3] Said differently, article quality will not be uniformly distributed over the set of journals or schools.

Supporting the conjecture that there is a rank ordering of schools is the observation that there is a difference in the research quality of different researchers. Only if researchers were uniformly distributed over all schools or if they constantly changed their affiliations could there be no difference in schools' research article quality.

Similarly, in support of a rank ordering of journals, we argue that researchers have preconceived notions about the relative quality of journals and try to publish in journals they believe to be of high quality, i.e., they do not send their work arbitrarily to a random journal. An author of a better-quality research paper has more choice for where to have his research published. The resulting journal rank ordering reflects the collective "votes" of researchers. If we accept this ranking conjecture, then the following tautology follows directly:

Association Tautology. There is positive correlation between the ranking of schools and journals. Schools having more high-quality articles will be associated with journals having more high-quality articles. Schools having fewer high-quality articles will be associated with journals having fewer high-quality articles.

The truth of the association tautology requires only that we accept the ranking conjecture. There is no claim here of any cause and effect between school or journal and quality—only an association. (An article's author affiliation or the journal in which it appears does not cause its quality.) Schools and journals are associative indicators of article quality.

One can see immediately the applications for this association. We can use it as an indicator of quality (for either schools or journals). For example, suppose we have a ranking of journals (provided a priori via causal indicators, as described earlier). Then to determine a ranking of school research quality, we look to who publishes in the higher-echelon journals.[4] In a similar manner from the opposite perspective, suppose we have a priori a ranking of school research quality (provided possibly by various causal indicators such as level of research grants and contracts, editorial board memberships, doctoral student output, etc.), as well as opinion surveys. Then, to determine a measure of journal quality, we look to where the top schools publish. This application is the basis for the AAI.

3.3. The Top U.S. Business Research Universities

A critical starting point for measuring a journal's AAI is to have of a set of top research institutions. Harless and Reilly (1998) provide a list of the top 60 U.S. business research universities across multiple business

[1] As an example, consider the publication of the *Simplex Algorithm* by G. Dantzig in 1947. Who then would have predicted the far-reaching impact of this research on society?

[2] For our purposes here, we need not provide any more specifics on how this quality value is to be measured. We simply assert that such a measurement can exist.

[3] We use the phrase "more high-quality" articles rather loosely here. Clearly, we would have to adjust or correct for size of school, periodicity of journal, etc., if we were ever actually to make such a ranking.

[4] This is exactly what is commonly done in studies of school quality. See, for example, Treischmann et al. (2000).

Table 1 **Example AAI Calculations**

Article	Author affiliations	Contribution to numerator	Contribution to denominator
1	**UC-Berkeley**	1.00	1.00
2	**Indiana**, Univ. of Utah	0.50	1.00
3	**Texas at Austin**, Univ. of Waterloo	0.50	0.50
4	London Business School, INSEAD	0.00	0.00
5	**Dartmouth**, Bucknell, IBM	0.33	0.67
	Total:	2.33	3.17
	AAI:	0.74	

Note. Affiliations in **bold** represent affiliations from the top university set.

disciplines (accounting, economics, finance, management, marketing, and management information systems (MIS) as well as OM) based on published articles on leading research universities. The approaches for measuring research performance is quantity of articles (or pages) in the disciplines' leading research journals, citation counts by department, and peer rankings. By including school ranking of non-OM business disciplines, we gain some independent (non-OM publication related) insight into top research university lists.

As a foil, we also use Malhotra and Kher's (1996) list of the top 50 research institutions in the field of OM (42 of which were U.S. universities), based on publication counts in five OM journals (*Management Science, Decision Sciences, Journal of Operations Management, IIE Transactions,* and *International Journal of Production Research*).[5] The list of Harless and Reilly (1998) is found in Appendix A. The list of Malhotra and Kher (1996) is found in Appendix B.

3.4. Calculating the AAI

We follow the detailed definition for AAI and illustration in Table 1 adapted from Harless and Reilly (1998). Consider an article i from journal x. Let $n(i)$ be the total number of authors for article i. Let $A(i)$ be the number of authors for article i from the top university set. Let $B(i)$ be the number of U.S. academic authors for article i not from the top university set. For any sample set M of journal articles we compute the AAI for journal x as

$$\text{AAI}(x) = \frac{\sum_{i\in M} A(i)/n(i)}{\sum_{i\in M}[A(i)+B(i)]/n(i)},$$

where the set M is the most recent set of articles such that $\sum_{i\in M}[A(i)+B(i)]/n(i) \geq 50$. AAI is a bounded measure lying in the closed interval $[0, 1]$.

One can think of the numerator of AAI as the number of equivalent articles by faculty from the top university set. The denominator is the number of equivalent articles by all U.S. academic authors. Authors not from U.S. universities are excluded from both $A(i)$ and $B(i)$. We define the observational unit as an author-equivalent article that measures the proportion of each U.S. university author's contribution to a given article. For example, Article 5 as shown in the Table 1 has three authors: one from the top university set, one from the set of non-top U.S. universities, and one from a non-U.S. institution. The two U.S. university authors each contribute 33%. Together their contribution is 67%—yielding an AAI of 0.5 for 0.67 equivalent articles. The five articles (and the six U.S. university authors) account for 3.17 author-equivalent articles.

4. Applying the AAI

We apply the aforementioned definition to calculate the AAI for a group of 27 OM-related journals using the top 60-university set established by Harless and Reilly (1998). We only consider journals that have a formal peer review procedure according to the journals' editorial mission statements. The list of 27 journals comprises all those journals included in at least one of the aforementioned studies of OM-related journal quality, as well as a number of others that we presume might be logical targets for publication by OM researchers.

We make no assertion regarding the relevance of a given journal to the field of OM; a fortiori, we maintain that we do not need to. We take the point of view that journal quality and its overall relevance to OM are orthogonal issues, nor is there any need to claim this list is in any way complete. Because it is easy to calculate and stable, anyone can determine the AAI for any journal at any time. We do not wish to start

[5] We use this list primarily to address concerns that "top research universities" are not the same as "top OM research universities." Although using the list of Malhotra and Kher (1996) does not strictly comply with the discussion that such a list be constructed from independent or causal surveys, we felt testing a secondary, OM-centric list to show robustness of results was warranted.

or enter any debate as to what constitutes the field of OM (and thus what are the OM journals), nor do we need to. If we adhere to the earlier definition of quality, then whether an OM-related article appears, for example, in say, an accounting journal or an OM journal makes no statement about its quality. Consequently, our study might be more accurately labeled "a study of journals in which OM researchers (as we know the field) might wish to publish," rather than "a study of OM-related journals."

In any case, the constitution of the journal list—the inclusion or exclusion of journals—is not central to the findings of the paper. Journals can be added or deleted from the list without impacting the scores of other journals; a journal's score is independent of the inclusion of other journals.

We present these results with accompanying descriptive statistics for the 27 journals. We then evaluate the AAI in three ways. First, we evaluate the significance of the differences between AAI scores by creating groupings of those sets of journals that are not significantly different (Duncan 1955). Second, we test AAI's internal consistency by judging its sensitivity to variability in the key input data. Third, to ascertain the AAI's external consistency, we compare our basecase scenario to recent studies from the literature: Vokurka (1996), Goh et al. (1997), Soteriou et al. (1999), Barman et al. (2001), Donahue and Fox (2000), and the most current IF values attainable through the JCR.

4.1. AAI Results and Descriptive Statistics

We find that the AAI is relatively quick and easy to calculate, allowing us to look at a broad cross section of journals. An undergraduate research assistant collects and tabulates the AAI scores with about one hour of training. Because this measure is straightforward and free of detailed information on references, we consider over 4,000 articles for this study.

Our initial results, henceforth referred to as the base case, use the recommendations of Harless and Reilly (1998): a sample of 50 author-article equivalent articles and a top university set of 60 universities. We use the most recent journals available as of July 2003, and add articles to the calculation backward in time until the required sample of U.S. author-article equivalents is reached. This range depends on the number of issues per year, the number of articles per issue, and the level of nonacademic and international participation in the journal. The date range included for the journals ranges from two to four years. We define *articles* to include all refereed articles and notes regardless of topic, but do not include short comments, editorials, book reviews, introductions, and obituaries. Where more than one author affiliation is given, the first one is used.

The resulting AAI values for each journal are presented in Table 2. We also provide current IF scores and the ratings from all the aforementioned published studies for comparison. The corresponding journal rankings for each approach are presented in Table 3.

We present a journal ranking of 27 journals, four of which had not been evaluated in previous studies, and nine journals whose IFs were not available. This is particularly important, given that two journals among the highest AAI scores were not covered by the vast majority of other journal-ranking sources. Due to this completeness, care must be taken in comparing the absolute ranks between the different sources. For example, *MS*'s fifth place ranking by AAI is comparable to a second or third place ranking in most other studies, because many other studies did not include *MOR*, *M&SOM*, and *TS*. Finally, we introduce the notion of ranking—not to enable any absolute claim such as "Journal x is the Number 3 journal in OM," but rather, to facilitate the statistical analysis that is to follow.

4.2. Convergence Behavior of AAI Scores

Figure 1 shows six sample paths of convergence of the mean AAI score for a subset of journals, demonstrating the general patterns we observe as sample size grows. Articles are sorted in reverse chronological order for the graphs. Because the first articles selected (essentially a random experiment) heavily impact the direction of convergence to the final AAI score, no informational value should be ascribed to the upward or downward demonstrated trends.

However, these graphs give a sense of the behavior of the variability of AAI scores as the sample size grows. Broadly speaking, after 40 to 50 author-equivalent articles, the average absolute change in AAI is 0.018, with fewer than 15% of AAI scores changing by more than 0.03, suggesting that the sample size of 50 is sufficient to get a reasonably reliable

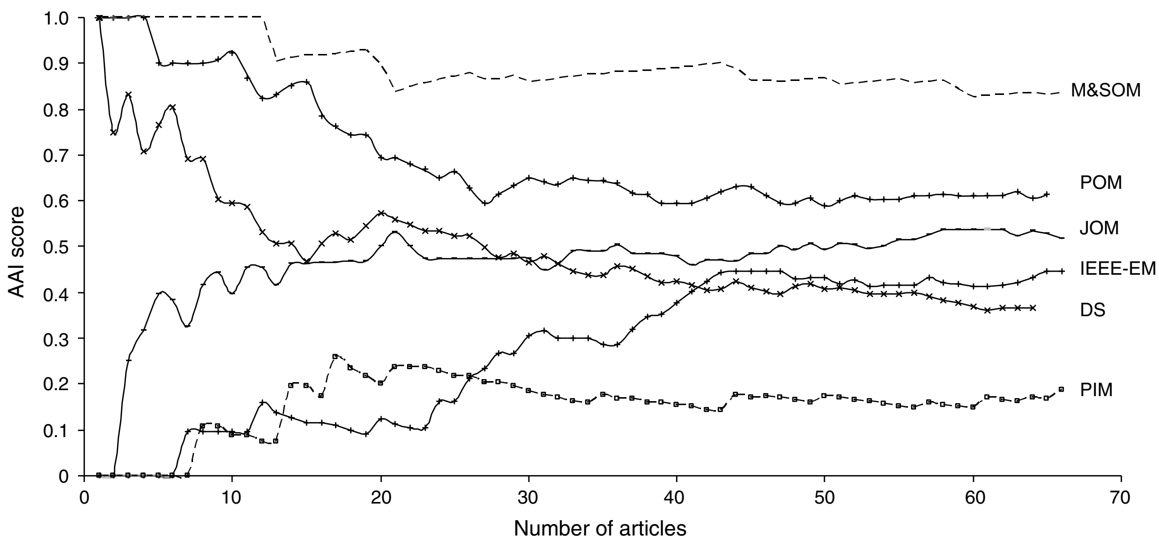
Table 2 OM-Related Journal Quality Ratings

Journal	Author Affiliation Index	2002 impact factor	Published studies: Opinion surveys: Donahue and Fox (2000): Quality rating	Opinion surveys: Barman et al. (2001) Quality rating (1:high–9:low)	Opinion surveys: Soteriou et al. (2000) Quality rating (1:high–9:low) (rescaled) (106 Europeans)	Author based: Agrawal (2002): No. of 5 highest contributing schools from top 10	Citation based: Goh et al. (1997): Rank (1989–1993 cites in *JOM*)	Citation based: Vokurka (1996): 1998–1993 Total cites of OM articles in *DS, JOM, MS*	Citation based: Cheng et al. (1999): Rank (1990–1994 citations in *IEEE-EM*
Transportation Science (TS)	0.867	0.814	111.1						
Mathematics of Operations Research (MOR)	0.847	0.778	123.8					27	
Operations Research (OR)	0.836	0.892	128.5	1.85	2.44		11	225	
Mfg. and Service Operations Management (M&SOM)	0.835					3			
Management Science (MS)	0.778	1.349	136.2	1.32	2.33		1	554	2
IIE Transactions (IIE)	0.671	0.523	106	2.83	3.87		13	125	
Production and Operations Management (POM)	0.619	0.224	91.3	2.57	3.38	5			
Journal of Scheduling (JOS)	0.599								
Interfaces (INT)	0.574	0.530	85.5	3.06	4.25		9	45	13
Journal of Operations Management (JOM)	0.523		95.9	2.34	3.14	0	3	152	
Logistics and Transportation Review (LTR)	0.522		80.2						
Annals of Operations Research (AOR)	0.515	0.258					51		
European Journal of Operational Research (EJOR)	0.501	0.553	99.5	3.03	3.39		24	64	
Journal of Supply Chain Management (JSCM)	0.500		63.3	5.3	5.23		15	28	
Naval Research Logistics (NRL)	0.488	0.451	109.1	2.84	3.81		24	66	
International Journal of Production Research (IJPR)	0.451	0.600	88.1	3.25	3.21		4	229	
IEEE Trans. on Engineering Management (IEEE-EM)	0.429	0.493					30		1
Journal of Business Logistics (JBL)	0.370		77.9						
Decision Sciences (DS)	0.361	0.578	100.0	2.57	3.65		5	201	
Production Planning & Control (PPC)	0.354	0.380							
Journal of the Operational Research Society (JORS)	0.339	0.493	99.6	3.78	3.73		28	32	
Computers and OR (COR)	0.325	0.446	80.5	5.2	4.46		50	21	
International Journal of Production Economics (IJPE)	0.232			4.53	3.83				
Omega	0.209	0.510	88.0	4.19	4.06		14	35	21
Int. Journal of Operations and Prod. Mgt. (IJOPM)	0.190	0.465	75.1	4.33	3.21		8	36	
Production and Inventory Management (PIM)	0.186			4.84	4.81		7	80	
Engineering Management Journal (EMJ)	0.147								

Table 3 OM-Related Journal Quality Rankings

Journal	Author Affiliation Index	2002 impact factor	Published studies: Opinion surveys: Donahue and Fox (2000): Quality rating	Opinion surveys: Barman et al. (2001) Quality rating (1:high–9:low)	Opinion surveys: Soteriou et al. (2000) Quality rating (1:high–9:low) (rescaled) (106 Europeans)	Author based: Agrawal (2002): No. of 5 highest contributing schools from top 10	Citation based: Goh et al. (1997): Rank (1989–1993 cites in *JOM*)	Citation based: Vokurka (1996): 1998–1993 Total cites of OM articles in *DS, JOM, MS*	Citation based: Cheng et al. (1999): Rank (1990–1994 citations in *IEEE-EM*
Transportation Science (TS)	1	3	4						
Mathematics of Operations Research (MOR)	2	4	3					15	
Operations Research (OR)	3	2	2	2	2		8	3	
Mfg. and Service Operations Management (M&SOM)	4					2			
Management Science (MS)	5	1	1	1	1		1	1	2
IIE Transactions (IIE)	6	9	6	6	12		9	6	
Production and Operations Management (POM)	7	18	11	4	6	1			
Journal of Scheduling (JOS)	8								
Interfaces (INT)	9	8	14	9	14		7	10	3
Journal of Operations Management (JOM)	10		10	3	3	3	2	5	
Logistics and Transportation Review (LTR)	11		16						
Annals of Operations Research (AOR)	12	17					17		
European Journal of Operational Research (EJOR)	13	7	9	8	7		12	9	
Journal of Supply Chain Management (JSCM)	14		19	17	17		11	14	
Naval Research Logistics (NRL)	15	14	5	7	10		13	8	
International Journal of Production Research (IJPR)	16	5	12	10	4		3	2	
IEEE Trans. on Engineering Management (IEEE-EM)	17	12					15		1
Journal of Business Logistics (JBL)	18		17						
Decision Sciences (DS)	19	6	7	5	8		4	4	
Production Planning & Control (PPC)	20	16							
Journal of the Operational Research Society (JORS)	21	11	8	11	9		14	13	
Computers and OR (COR)	22	15	15	16	15		16	16	
International Journal of Production Economics (IJPE)	23			14	11				
Omega	24	10	13	12	13		10	12	4
Int. Journal of Operations and Prod. Mgt. (IJOPM)	25	13	18	13	5		6	11	
Production and Inventory Management (PIM)	26			15	16		5	7	
Engineering Management Journal (EMJ)	27								

Figure 1 Illustration of AAI Convergence Behavior as Sample Size Grows



estimate of AAI score. We statistically compare rankings with samples of 40 and 50 articles and find little difference in journal rankings. As can be seen in Figure 1, from the volatility of AAI for small samples reductions in sample size below 30 author-equivalent articles can create considerably higher variability in the AAI estimates for some journals and should be avoided.

4.3. Significance Testing of Journal AAI Differences

Table 4 presents a Duncan grouping test to evaluate which of these AAI scores are statistically different. For some journals (*IJOPM, IJPR, JOS*, and *MOR*), the recommended sample size of 50 author-equivalent articles was not reached, due to low U.S. academic authorship participation, short journal publication life, or online sources that did not provide enough journal history. They are excluded from the subsequent statistical analysis. The Duncan tests reveal there are 10 different groupings for the 23 journals for which we performed statistical tests.

From Table 4, we see that every journal shares at least one Duncan group with its predecessor or successor, or both, thus cannot be shown to be statistically different. (No journal constitutes a Duncan group of its own.) On average, the difference in AAI scores between consecutively ranked journals is 0.032; we observe it takes an average difference of 0.172 (an average difference of six positions in rank) in most cases to identify two journals that do not share a Duncan grouping. For example, *TS* and *IIE* do not share a Duncan grouping, and the difference between their AAI scores is 0.192. Similarly, the highest journal that *IIE* does not share a Duncan group with is *EJOR*, which has 0.17 lower AAI.

Like other journal-quality indicators, AAI does not discern precise differences in relative quality for journals of similar scores. However, we find Duncan groupings based on AAI to be useful for establishing peer groups of journals of equivalent quality and for differentiating between these groups.

In viewing Table 4, note that the various Duncan groups overlap; i.e., there is no distinct set of mutually exclusive groups. For example, we can safely say that the top three journals (*TS*, *OR*, and *M&SOM*) are in the A group, but to include *MS* would imply that it is of a different quality than *IIE*, which is not the case, because *MS* and *IIE* both share a Duncan B grouping.

One approach to bring about a greater level of distinction between journal groupings would be to simply relax the required level of significance from the original $\alpha = 0.05$ level. The Table 4 column, Relaxed Duncan Grouping, provides the groupings when $\alpha = 0.50$. In this case, we observe nearly the same number of Duncan groups, but with less overlap of the groups. Even at this low level of confidence, we see 4 of 23 journals falling into multiple Duncan groups.

Table 4 Duncan Groupings of Journals by AAI Scores

Duncan grouping ($\alpha = 0.05$)					Journal	AAI	Standard deviation	Relaxed Duncan grouping ($\alpha = 0.50$)		Highest Duncan group assigned	Lowest Duncan group assigned	Heuristic groupings with common breakpoints
				A	*TS*	0.867	0.29		A	A	A	1
				A	*OR*	0.836	0.31		A	A	A	1
				A	*M&SOM*	0.835	0.33		A	A	A	1
			B	A	*MS*	0.778	0.35		B	A	B	1
		C	B		*IIE*	0.671	0.43		C	B	C	2
		C		D	*POM*	0.619	0.40		D	C	D	3
		C	E	D	*INT*	0.574	0.46	E	D	C	E	3
	F	C	E	D	*JOM*	0.523	0.41	F	E	C	F	3
	F	C	E	D	*LTR*	0.522	0.47	F	E	C	F	3
	F	C	E	D	*AOR*	0.515	0.45		F	C	F	3
G	F		E	D	*EJOR*	0.501	0.46		F	D	G	3
G	F		E	D	*JSCM*	0.500	0.45		F	D	G	3
G	F		E	D	*NRL*	0.488	0.47		F	D	G	3
G	F	H	E		*IEEE-EM*	0.429	0.43		G	E	H	4
G	F	H		I	*JBL*	0.370	0.40		H	F	I	5
G	F	H		I	*DS*	0.361	0.40		H	F	I	5
G	F	H	J	I	*PPC*	0.354	0.45		H	F	J	5
G		H	J	I	*JORS*	0.339	0.44		H	G	J	5
		H	J	I	*COR*	0.315	0.43		H	H	J	5
	K		J	I	*IJPE*	0.232	0.39		I	I	K	6
	K		J	I	*OMEGA*	0.209	0.36		I	I	K	6
	K		J		*PIMJ*	0.186	0.37	J	I	J	K	6
	K				*EMJ*	0.147	0.31		J	K	K	6

In a final tactic to coerce distinct journal groupings, we might employ heuristic schemes, although in so doing we relinquish the ability to make any statements concerning statistical confidence. Table 4 illustrates two heuristic schemes: highest Duncan group assigned and lowest Duncan group assigned. We identify the common break points in the groupings that occur in all of three of our alternative grouping methods, resulting in the six numbered groups presented in the right-hand column of Table 4.

5. Sensitivity of AAI to Input Value Selection

To evaluate the AAI's internal stability and consistency, we test its sensitivity to the following factors.

(1) AAI weighting factor. The weighting factor for articles (by author-article equivalent as recommended in the base case methodology, as well as by author and by article).

(2) Size and composition of the top university set. The number of the top universities, (60, 38, and 42 universities), and the selection process for top university designation (e.g., top OM universities or top universities).

(3) Opportunistic selection of top university set. The potential risk of manipulating outcomes through opportunistic university selection.

(4) Journal date range. The date range of the journals (generally 2001–2003, versus the previous AAI-based rankings of Harless and Reilly 1998).

We recalculate the AAI and generate alternative rankings based on these variations on our base case AAI calculation methodology. We find the changes in individual AAI scores and ranks of journals in the scenarios below are rarely significantly different in a statistical sense; the change in score is small relative to the standard deviation of the score, and the impact on Duncan groupings is minimal. However, we present the effects of these sensitivities in rank and score to provide some descriptive information to the reader.

To statistically estimate the overall impact on the rankings under each of these scenarios, we test the significance of Spearman's Rho correlation estimates of the different rankings. (Kendall's Tau-*b* test produces

Table 5 Comparison of Basecase AAI and Rank with Change of Weighting Scheme

Journal	Base case AAI	Base case rank	Author-weighted AAI	Author-weighted AAI rank	Author-weighted Delta rank	Article-weighted AAI	Article-weighted AAI rank	Article-weighted Delta rank
TS	0.87	1	0.87	1	0	0.88	1	0
OR	0.84	2	0.81	2	0	0.79	4	−2
M&SOM	0.84	3	0.81	3	0	0.84	2	1
MS	0.78	4	0.77	4	0	0.79	3	1
IIE	0.67	5	0.65	5	0	0.67	5	0
POM	0.62	6	0.62	6	0	0.61	6	0
INT	0.57	7	0.57	7	0	0.56	7	0
JOM	0.52	8	0.54	9	−1	0.53	8	0
LTR	0.52	9	0.45	13	−4	0.47	13	−4
AOR	0.52	10	0.55	8	2	0.52	9	1
EJOR	0.50	11	0.49	12	−1	0.51	10	1
JSCM	0.50	12	0.51	11	1	0.48	12	0
NRL	0.49	13	0.53	10	3	0.50	11	2
IEEE-EM	0.43	14	0.42	14	0	0.42	15	−1
JBL	0.37	15	0.39	15	0	0.44	14	1
DS	0.36	16	0.35	18	−2	0.35	17	−1
PPC	0.35	17	0.36	17	0	0.39	16	1
JORS	0.34	18	0.34	19	−1	0.33	18	0
COR	0.32	19	0.37	16	3	0.32	19	0
IJPE	0.23	20	0.24	21	−1	0.24	20	0
Omega	0.21	21	0.23	22	−1	0.23	21	0
PIM	0.19	22	0.25	20	2	0.21	22	0
EMJ	0.15	23	0.18	23	0	0.14	23	0

similar correlations; we present only Spearman's Rho correlations.) We hypothesize that the rank correlations rankings using different input factors should be positive and significantly different from zero if the AAI methodology is not sensitive to variations in its calculation.

5.1. AAI Weighting Factor

Each article constitutes an observation of journal quality as measured by the affiliations of its authors. However, one could argue that the article is the unit of observation, or alternatively that each author represents an individual affiliation resulting in different weightings to each observation—by author, by article, or by author-article equivalent (as in our base case). Different outcomes can result from these different weighting schemes. For example, in our AAI illustration from Table 1, we have five articles, 10 authors, and 3.17 author-article equivalents. The proposed author-article weighting yields an AAI of 0.74 (2.33/3.17), as shown. Using an author weighting, we would have a score of 0.667 (four top authors out of six U.S. authors). An article weighting yields an AAI of 0.625 (2.5 articles by top schools out of four U.S. articles).

We test whether changing the weighting scheme affects AAI rankings of OM-related journals in Table 5. We observe that the method of weighting each observation does affect journal rankings slightly. The largest change in any journal ranking is four positions down and three positions up. However, we note that over half of the journals' rankings are unaffected by the method of weighting.

5.2. Size and Composition of the Top University Set

In Table 6 we examine the impact of the selected set of top universities on the AAI scores and rankings. First, we examine the impact of a smaller set of top universities. To select the smaller set, we take the intersection of the list given by Harless and Reilly (1998) in Appendix A (*HR*60), and the list of the top 42 U.S. academic OM institutions identified by Malhotra and Kher (1996) in Appendix B (*MK*), referred to as $HR \cap MK$. For the most part, the top universities and top OM research universities match well. Only

Table 6 Comparison of Base Case and AAI Rank with Smaller and Different Constitution of High-Quality School Set

Journal	Base case AAI (HR60)	Base case rank (HR60)	Best 38 schools AAI (HR ∩ MK)	Best 38 schools rank (HR ∩ MK)	Best 38 schools delta rank (HR ∩ MK)	Top 42 OM school AAI (MK)	Top 42 OM school rank (MK)	Top 42 OM school delta rank (MK)	Top 42 business schools AAI (HR42)	Top 42 business schools rank (HR42)	HR42 vs. MK delta rank
TS	0.867	1	0.687	1	0	0.687	1	0	0.857	1	0
OR	0.836	2	0.648	3	−1	0.648	4	−2	0.754	3	−1
M&SOM	0.835	3	0.674	2	1	0.674	3	0	0.794	2	−1
MS	0.778	4	0.541	5	−1	0.551	5	−1	0.718	4	−1
IIE	0.671	5	0.628	4	1	0.686	2	3	0.661	5	3
POM	0.619	6	0.453	7	−1	0.458	11	−5	0.572	6	−5
INT	0.574	7	0.466	6	1	0.486	6	1	0.522	8	2
JOM	0.523	8	0.450	8	0	0.460	8	0	0.473	11	3
LTR	0.522	9	0.423	10	−1	0.459	10	−1	0.522	7	−3
AOR	0.515	10	0.415	11	−1	0.485	7	3	0.490	10	3
EJOR	0.501	11	0.435	9	2	0.460	9	2	0.491	9	0
JSCM	0.500	12	0.402	12	0	0.402	12	0	0.451	12	0
NRL	0.488	13	0.367	13	0	0.398	13	0	0.436	13	0
IEEE-EM	0.429	14	0.353	14	0	0.376	15	−1	0.382	14	−1
JBL	0.370	15	0.351	15	0	0.379	14	1	0.350	15	1
DS	0.361	16	0.259	17	−1	0.302	18	−2	0.299	18	0
PPC	0.354	17	0.328	16	1	0.364	16	1	0.315	16	0
JORS	0.339	18	0.252	18	0	0.281	19	−1	0.279	19	0
COR	0.325	19	0.248	19	0	0.331	17	2	0.308	17	0
IJPE	0.232	20	0.186	20	0	0.255	21	−1	0.232	20	−1
Omega	0.209	21	0.160	22	−1	0.183	22	−1	0.183	22	0
PIM	0.186	22	0.176	21	1	0.269	20	2	0.186	21	1
EMJ	0.147	23	0.073	23	0	0.103	23	0	0.147	23	0

four of the top OM schools (Auburn, Clemson, Missouri, and North Carolina State) are not found in the top 60 business school list from Appendix A, leaving 38 schools in the intersection of the two lists.

As would be expected, mean AAI scores fall as the size of the top university list shrinks. However, we are less interested in the absolute AAI scores than in the resulting changes in relative rankings. We see in Table 6 that ranks resulting from a smaller set of schools do not change substantially from the base case ranking; the largest change is a two-rank increase and a one-rank decrease.

We then test the sensitivity of the AAI measure to differences of opinion on what constitutes *top* universities. To have the same number of top OM research universities as Malhotra and Kher (1996), we select the 42 schools that contribute the most authors to the set of selected journals (HR42 in Appendix C) to contrast with the 42 schools of Malhotra and Kher (1996) (Appendix B). In this case, the two lists of 42 do not fully agree; 10 of the top 42 universities of Harless and Reilly (1998) are different from the top OM schools of Malhotra and Kher (1996).

We see in Table 6 that over 50% of the journal rankings are affected when these different lists are used. The change in rank is usually one or two positions, but *POM*'s ranking, for one extreme example, varies five positions between the top OM and top university lists. However, even in this most extreme case, the 0.12 change in AAI score does not constitute a statistically significant difference.

5.3. Opportunistic Selection of the Top University Set

Because Table 6 demonstrates that the selection of top institutions can be important to journal quality ranking using AAI, we evaluate the impact of gaming the method, i.e., carefully choosing schools that boost or hamper a particular journal's ranking. For each journal, we choose the largest contributing top school (the one that most helps its AAI), and remove it from the top school list to evaluate the school's contribution to the journal's ranking. These results are in Table 7.

Table 7 Impact on AAI of Removing the Biggest Contributing School to a Journal

Journal	Base case score	Base case rank	Removal of biggest contributor school AAI	Absolute change in score	Removal of biggest contributor school rank	Removal of biggest contributor school rank change	Removed (biggest contributing) school
TS	0.867	1	0.742	−0.125	5	4	Princeton/MIT
OR	0.836	2	0.767	−0.069	4	2	MIT
M&SOM	0.835	3	0.746	−0.089	5	2	NWU
MS	0.778	4	0.701	−0.076	5	1	CMU
IIE	0.671	5	0.585	−0.086	7	2	Penn State
POM	0.619	6	0.552	−0.067	8	2	U MD
INT	0.574	7	0.535	−0.039	8	1	U VA
JOM	0.523	8	0.405	−0.118	15	7	MI State
LTR	0.522	9	0.423	−0.100	15	6	U MD
AOR	0.515	10	0.465	−0.050	14	4	CMU
EJOR	0.501	11	0.455	−0.046	13	2	GA Tech
JSCM	0.500	12	0.340	−0.160	18	6	AZ State
NRL	0.488	13	0.416	−0.072	15	2	Purdue
IEEE-EM	0.429	14	0.380	−0.049	15	1	AZ State
JBL	0.370	15	0.191	−0.180	22	7	MI State
DS	0.361	16	0.328	−0.033	19	3	VA Tech
PPC	0.354	17	0.302	−0.052	19	2	LA State
JORS	0.339	18	0.291	−0.048	20	2	U VA
COR	0.325	19	0.289	−0.036	20	1	LA State
IJPE	0.232	20	0.193	−0.039	22	2	OH State
Omega	0.209	21	0.160	−0.049	23	2	VA Tech
PIM	0.186	22	0.157	−0.030	23	1	TX A&M
EMJ	0.147	23	0.093	−0.054	23	0	U Pitt

Although the average drop in AAI score is only 0.073, in some cases a journal's ranking is affected substantially (i.e., by four, six, and seven positions) by omitting its biggest contributing school from the top institution list. Not surprisingly, every top-contributing school to a journal is found in the top 35 institutions on both the top OM and top university list, so the likelihood of omitting any of these institutions based on objective criteria is slim.

We recommend a larger, more inclusive top school list in order to reduce both the ability and incentive to manipulate the AAI scores. The larger the top university set, the smaller the marginal impact of the omission of a major contributing school. Also, with a large list it becomes more difficult to omit a major contributing school; when the list is more inclusive, an errant omission is more glaring.

5.4. Journal Date Range

As a final test of the internal consistency and stability of the AAI measure, we provide some insight into the stability of the AAI over time and across different scorers. Harless and Reilly (1998) provide AAI scores for some of the journals in our list using the same school list and methodology. Table 8 compares their reported AAI scores from 1998 to ours from 2003.

We see that some journals' AAI scores change by as much as 0.091 and −0.076. However, the rela-

Table 8 Comparison of 2003 AAI Scores to 1998 AAI Scores for Selected Journals

Journal	Base case score	Base case rank (2003)	Harless et al. score (1998)	Harless et al. rank (1998)	Change in score (2003–1998)	Change in rank (2003–1998)
OR	0.836	1	0.760	1	0.076	0
MS	0.778	2	0.740	2	0.038	0
IIE	0.671	3	0.669	3	0.002	0
Interfaces	0.574	4	0.500	5	0.074	1
EJOR	0.501	5	0.430	6	0.071	1
NRL	0.488	6	0.510	4	−0.022	−2
DS	0.361	7	0.350	8	0.011	1
JORS	0.339	8	0.430	7	−0.091	−1
Omega	0.209	9	0.250	9	−0.041	0

Table 9 **Spearman Rho Correlation for Variations in AAI Calculation Methods**

Base case AAI rank correlations with other calculation methods	Author weighted	Article weighted	Best 38 schools AAI (HR ∩ MK)	Top 42 OM school AAI (MK)	Top 42 business schools AAI (HR)	Removal of biggest contributor school AAI	AAI (2003) vs. AAI (1998)
Correlation coefficient	0.9743	0.9850	0.9921	0.9644	0.9842	0.9654	0.9333
Sig. (2-tailed)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002
N	23	23	23	23	23	23	9

tive ranks for these journals are largely unaffected, indicating that AAI scores maintain stability over time.

5.5. Summary of Sensitivity Analysis

In summary, we note that in all of our sensitivity tests, no change in AAI exceeds 0.17, which is the average difference between journals that do not share a Duncan group. Thus, the change in AAI score and rank due to changing any of these inputs does not substantially change its Duncan grouping or its estimated quality.

5.6. Statistical Test of AAI Consistency

Table 9 provides Spearman's Rho correlation of rank for the numerous AAI calculation methods provided in this paper. Although different methodologies lead to changes in some journal ranks, no matter what the change in method of AAI, all rank correlations for AAI scores are over 0.95 and significant at the 1% level. This indicates that the AAI is a robust measure; it is relatively insensitive to changes in article-weighting mechanism, size, and composition of the top university set and time horizon.

Table 10 shows there is a somewhat weaker correlation between the AAI rankings of journal quality and previously published studies. The correlation of the AAI ranking is significant at the 5% level in four out of the six comparisons with other sources of journal rankings. The average correlation between AAI and other sources is 0.53.

It is interesting to note that when we look at the rank correlations between other rating methods, we see that they are only slightly more strongly correlated than the AAI rankings with those studies. Of 15 correlations of previously published studies, 11 are

Table 10 **Spearman's Rho Rank Correlations of Different Estimates of Journal Quality**

		Impact factor	Donahue and Fox	Barman	Soteriou	Goh	Vokurka
AAI	Correlation coefficient	0.4679	0.5120	0.7607	0.5676	0.3250	0.5714
	sig. (2-tailed)	0.0786	0.0430	0.0010	0.0218	0.2372	0.0413
	N	15	16	15	16	15	13
Impact factor	Correlation coefficient		0.6640	0.5273	0.5105	0.9091	0.8182
	sig. (2-tailed)		0.0180	0.0956	0.0899	0.0000	0.0038
	N		12	11	12	12	10
Donahue and Fox	Correlation coefficient			0.7470	0.7090	0.3430	0.8180
	sig. (2-tailed)			0.0030	0.0070	0.2760	0.0040
	N			13	13	12	12
Barman	Correlation coefficient				0.9000	0.6044	0.9011
	sig. (2-tailed)				0.0000	0.0287	0.0000
	N				15	13	13
Soteriou	Correlation coefficient					0.5033	0.7308
	sig. (2-tailed)					0.0666	0.0045
	N					14	13
Goh	Correlation coefficient						0.7857
	sig. (2-tailed)						0.0015
	N						13

significantly different from 0 at the 5% level, with an average correlation of 0.70.

Overall, the AAI is robust with respect to variations in its method of calculation and correlates reasonably well with the aforementioned approaches on journal quality.

6. Summary and Conclusions

For academicians in the field of OM, research performance is measured through quantity and quality of publications in refereed journals, so judging journal quality is important. Journal quality has historically been assessed through opinion surveys and citation analyses. We introduce here a third major approach—author affiliation—and apply it to a set of journals that are likely targets for reporting research by academics in OM. The AAI measures the percent of a journal's U.S. academic authors that are affiliated with top U.S. research universities.

Survey reports are often incomplete, dated, and inconsistent with respect to methodology. Published citation reports suffer the same drawbacks. A recent standardized methodology of citation reporting, IF, only includes journals listed in the JCR database and is also incomplete. More importantly, IF values are highly sensitive to differences in journal subject matter, thus comparisons across disciplines cannot be recommended.

The AAI does not suffer from the disadvantages noted above. It is simple to calculate and can be done for any journal at any time. Because its reference group is the authors from top business research universities, it can validly be used to judge the relative research quality of individual researchers in different business disciplines. This is clearly not a possibility provided by survey reports and citation analyses, which concentrate on a single discipline.

Our sensitivity analyses indicate that as few as 40 author-equivalent articles provide stable results; that the AAI is robust with respect to method of weighting articles, and the size and constitution of the top university set; and that the AAI is stable over time. Our tests show that AAI rankings correlate well with the rankings of other studies; because it is easy to calculate, AAI allows for complete analysis of any list of journals. It is relatively objective, transparent, and stable.

We do not suggest that AAI should replace surveys or IF analyses as the sole method for judging journal quality. AAI measures journal quality from a different perspective. It would be particularly useful in making interdisciplinary (within business administration) comparisons of the relative quality of journals. If it gains popularity, this will likely be the major reason.

In a perfect world, we would all like to judge research (and journal) quality solely on the intellectual depth and significance of the work itself. The practical reality is that business school ranking organizations, deans, colleagues in other fields, journal editors, etc., often insist on more-immediate and objective measures of research quality. Any objective measure of journal quality, which is inherently subjective, will have its defects, but measures such as the AAI do provide value. They give secondary evidence and indirect signals that have the advantage of being objective, if not perfect, measures of quality.

Acknowledgments
The authors would like to acknowledge Heather Mercker for her diligence and painstaking attention to detail in carrying out the AAI calculations.

Appendix A. The Top 60 U.S. Universities of Harless and Reilly (1998) (HR60)

Arizona State University	Houston, University of
Arizona, University of	Illinois at Urbana-Champaign, University of
Baruch College—City University of New York	Indiana University
Berkeley, University of California at	Iowa State University
Boston University	Iowa, University of
Brown University	Los Angeles, University of California at
California Institute of Technology	Louisiana State University
Carnegie Mellon University	Maryland, University of
Case Western Reserve University	Massachusetts Institute of Technology
Chicago, University of	Michigan State University
Cincinnati, University of	Michigan, University of
Columbia University	Minnesota, University of
Cornell University	New York University
Dartmouth College	North Carolina at Chapel Hill, University of
Duke University	Northwestern University
Florida, University of	Ohio State University
Georgia Institute of Technology	Pennsylvania State University
Georgia, University of	
Harvard University	

(cont'd.)

Pennsylvania, University of	Stanford University
Pittsburgh, University of	State University of New York at Buffalo
Princeton University	Syracuse University
Purdue University	Texas A&M University
Rice University	Texas at Austin, University of
Rochester, University of	Vanderbilt University
Rutgers-New Brunswick, University of	Virginia Polytechnic Institute and State University
Rutgers-Newark, University of	Virginia, University of
San Diego, University of California at	Washington University (St. Louis)
South Carolina, University of	Washington, University of
Southern California, University of	Wisconsin at Madison, University of
Southern Methodist University	Yale University

Appendix B. Top 42 U.S. Academic OM Institutions Malhotra and Kher (1996) (MK)

Arizona State University
Arizona, University of
Auburn University
Berkeley, University of California at
Carnegie Mellon University
Case Western Reserve University
Cincinnati, University of
Clemson University
Columbia University
Cornell University
Dartmouth College
Georgia, University of
Georgia Institute of Technology
Illinois at Urbana-Champaign, University of
Indiana University
Iowa State University
Iowa, University of
Los Angeles, University of California at
Louisiana State University
Massachusetts Institute of Technology
Michigan State University
Michigan, University of
Minnesota, University of
Missouri, University of
North Carolina at Chapel Hill, University of
North Carolina State University
Northwestern University
Ohio State University
Pennsylvania State University
Pennsylvania, University of
Purdue University
Rochester, University of
Rutgers University
South Carolina, University of
Stanford University
State University of New York at Buffalo
Syracuse University
Texas A&M University
Texas at Austin, University of
Virginia Polytechnic Institute and State University
Washington, University of
Wisconsin at Madison, University of

Appendix C. Top 42 Contributing Schools to AAI Based on Harless and Reilly (1998) (HR42)

Arizona State University
Arizona, University of
Berkeley, University of California at
Boston University
Carnegie Mellon University
Case Western Reserve University
Cincinnati, University of
Columbia University
Cornell University
Florida, University of
Georgia Institute of Technology
Harvard University
Illinois at Urbana-Champaign, University of
Indiana University
Iowa State University
Los Angeles, University of California at
Louisiana State University
Maryland, University of
Massachusetts Institute of Technology
Michigan State University
Michigan, University of
Minnesota, University of
New York University
North Carolina at Chapel Hill, University of
Northwestern University
Ohio State University
Pennsylvania State University
Pennsylvania, University of
Pittsburgh, University of
Princeton University
Purdue University
Rutgers
Southern California, University of
Stanford University
State University of New York at Buffalo
Texas A&M University
Texas at Austin, University of
Virginia Polytechnic Institute and State University
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