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Importance and similarity in the evolving citation network of the *International Journal of Research in Marketing*

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Abstract

The citation network of the *International Journal of Research in Marketing* (*IJRM*) is examined from 1981 to 1995. A time-heterogenous log-multiplicative model is estimated to examine simultaneously the importance and similarity of journals in the network over time. Two distinct types of journal similarity, cohesion and structural equivalence, are considered and modeled in an integrative fashion. The findings show that the overall importance of *IJRM* in its network is growing rapidly albeit from a low base. The importance of psychology journals in the network appears to be decreasing. Clear cohesive and structurally equivalent groups of core marketing, methodology, managerial and psychology journals with distinct functions in the network are identified. Recommendations for future citation research are offered as well. © 1999 Elsevier Science B.V. All rights reserved.

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1. Introduction

In social networks, actors engage in interactions to exchange valued resources. Citation networks are specific social networks in which the actors are journals, articles, or authors, the valued resources are ideas and knowledge, and the interactions are citations from one actor to other actors. The goal of citation analysis is to describe the citation network as a whole and to understand the influence and role of specific actors and groups of actors in the network. The recent burgeoning of citation research has resulted in a growing management and marketing literature on the topic (e.g., Jobber and Simpson, 1988; Pecotich and Everett, 1990; Cote et al., 1991; Zinkhan et al., 1992; Johnson and Podsakoff, 1994). Our study tries to build on this literature in three important ways.

First, previous citation research has emphasized a single aspect of networks or has examined various aspects independently. For instance, some studies have focused on the influence of specific journals (Jobber and Simpson, 1988), while others have described the relations between journals in terms of

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mutual citations (Hamelman and Mazze, 1973; Leong, 1989). A few studies have examined the influence and roles that journals play in their networks, but different methodologies were used to investigate these issues (Rice et al., 1988; Zinkhan et al., 1992). This study examines key aspects of citation networks with a unified methodology, as will be explained below.

Second, citation research has emphasized networks at one particular point in time. This appears to be generally true in social network theory. Salancik (1995) points out that network research has underemphasized why a network looks the way it does, why it changes, and why it does not. Hoffman and Holbrook (1993) recently urged researchers to take the time dimension more explicitly into account and to investigate dynamic aspects of citation networks. This study examines a citation network across a period of 15 years.

Third, previous citation research has employed predominantly descriptive methodologies to examine networks. Usually, indicators of citation activity are calculated and interpreted, but no statistical tests of model adequacy are reported. The work of Pecotich and Everett (1990) is an exception. In reviewing social network research in marketing, Iacobucci (1996) recommends that more work be conducted in which inferential instead of descriptive methodologies are used to investigate network structure and changes in structure over time. This study applies log-linear and log-multiplicative analysis to examine a specific citation network over time.

The analysis concerns the evolving citation network of the *International Journal of Research in Marketing* (*IJRM*) between 1981 and 1995. In an earlier citation analysis, Jobber and Simpson (1988) (p. 139) indicated that two years after its birth, the number of citations that *IJRM* received from other journals ''must be encouraging to its editorial board.'' In a follow-up study, Pecotich and Everett (1990, p. 202) argued that ''new journals such as *International Journal of Research in Marketing* ... will tend to grow in importance as they build up a body of published work.'' This study was spurred by these remarks to examine *IJRM*'s citation network over time. Section 2 introduces the methodology and aspects of *IJRM*'s citation network that were selected for study.

2. Exploring IJRM's citation network

Three questions that are frequently of interest in citation analysis are: (1) how important are journals, (2) which journals are similar to each other, and (3) what is the evolution in journal importance and similarity over time? To address these questions, we estimate the time-heterogeneous log-multiplicative model shown in Eq. (1). The model builds on previous log-linear models of social networks (cf. Iacobucci and Wasserman, 1988) and on recent developments in log-multiplicative modelling (cf. Goodman, 1991; Clogg and Shihadeh, 1994). First, the components of the model are briefly introduced. Next, we describe how the model addresses the questions in our citation analysis of *IJRM*:

$$(\log F_{ijk})\mathbf{z}_{ijk} = u + u_i^S + u_j^R + u_k^P + u_{ik}^{SP} + u_{jk}^{RP} + \delta_{ijk} + \sum_{m=1}^{M} \xi_{ik}^m \psi_k^m \xi_{jk}^m + \sum_{n=1}^{N} \mu_{ik}^n \phi_k^n \upsilon_{jk}^n. \quad (1)$$

Citation data are commonly gathered in a square citation matrix in which cell entries denote the number of times that a particular row-journal cites a particular column-journal. Citations are directional because a cite from journal A to journal B differs from a cite from B to A. The diagonal of the matrix contains self-citations (i.e., citations from the journal to itself).

The model in Eq. (1) is specified for the three-way citation matrix formed by the variables *S*, *R*, *P*, with S ($i = 1, \ldots, s$) for *Sending* citations (*citing*) as the row variable, R ($j = 1, \ldots, r$) for *Receiving* citations (being *cited*) as the column variable, and P ($k = 1, \ldots, p$) for *Period* as the grouping variable.

The term F_{ijk} denotes the expected cell frequency, and z_{ijk} is a weight vector ($\mathbf{z}_{ijk} = 0$ for structural zeros, and 1 otherwise). The u terms in the model are log-linear parameters. They are identified with effect coding, expressing them as deviations from the average effect: $\sum u = 0$, $\sum u^2 = 1$. The term δ_{ijk} denotes a set of log-linear parameters that estimate the effects of self-citations in the diagonal of the citation matrices (i.e., $\delta_{ijk} = 0$ for $i \neq j$ and free otherwise).

The term $\sum \xi\psi\xi$ denotes a symmetric, and $\sum \mu\phi\nu$ denotes an asymmetric log-multiplicative term (Goodman, 1979, 1991; Clogg and Shihadeh, 1994). The asymmetric term is the product of an intrinsic level of association in the nth dimension, ϕ^n, the row score of journal i in the nth dimension, μ_i^n, and the column score of journal j in the nth dimension, ν_j^n. The symmetric term is a special case of the asymmetric term in which the row and column scores are specified to be the same ($\xi_i = \xi_j$). Essentially, the log-multiplicative terms scale the row and column scores of the citation matrix to produce the largest possible linear-by-linear interaction between S and R. Multiple dimensions of association ($N > 1$ or $M > 1$) are allowed to account for the association between S and R. The log-multiplicative terms are identified by fixing the mean of the row and column scores to 0 and their standard deviation to 1.

Next we explain how the three questions about *IJRM*'s citation network are addressed by the various terms in Eq. (1).

3. Importance in citation networks

In citation analysis a journal is important if it is cited frequently by other journals. Importance is also known as impact, influence, popularity or prestige in citation analysis (Jobber and Simpson, 1988; Scott, 1991; Wasserman and Faust, 1994). Probably the most widely used measure of importance is the impact score computed in *The Social Science Citation Index* (*SSCI*). Impact is defined as the number of citations that the typical article in a journal received over the past two years. The measure is based on the citations received from other journals and on self-citations. This can lead to seriously biased results when the incidence of self-citations is high and heterogeneous across journals in the network. For instance, journals with a high incidence of self-citations may appear more important in citation networks than journals with a low incidence of self-citations.

In Eq. (1), journal importance is assessed with the log-linear parameters for column effects. The u^R parameter captures average journal importance across time (cf. Pecotich and Everett, 1990), and the u^{RP} parameter captures period-specific deviations from the average importance. The sum of u^R and u^{RP} indicates the importance of journals in time period P. Importance is thus based on the number of citations received, but the model controls for the number of citations that a journal sends to other journals in the network, via the terms u^S, u^{SP}. These row parameters ensure that estimates of importance are independent of the volume of citations that journals send. This is similar to the descriptive measures of *net* importance used, among others, by Zinkhan et al. (1992). The δ parameters in Eq. (1) estimate the diagonal elements in the citation matrix, and they ensure that self-citations do not affect estimates of journal importance. Therefore, estimates of journal importance express the volume of citations received from *other* journals in the network, controlling for differences in the volume of citations sent.

4. Similarity in citation networks

Journals in citation networks can be similar because they cite each other frequently, and they can be similar because they have the same pattern of sending and receiving citations as other journals. In the former case we speak of cohesion, in the latter case of structural equivalence (Burt, 1983; Knoke and Burt, 1982). To our knowledge, this is the first marketing study to examine both kinds of journal similarity, and the model we propose in Eq. (1) is the first to investigate the two kinds of journal similarity simultaneously.

4.1. Cohesion of journals

Cohesion is based on the idea of mutual exchange of citations between journals. Journals that cite each other frequently form cohesive groups or cliques that cover a specific content area or domain of expertise. Previous research has explored cohesion between, e.g., communication (Rice et al., 1988) and marketing journals (Pecotich and Everett, 1990; Zinkhan et al., 1992) predominantly with descriptive methodologies such as MDS.

Instead, cohesion of journals is modeled here with the symmetric log-multiplicative term in Eq. (1). To see how cohesion of journals is captured by the

symmetric term, assume the following citation network of four journals, 1 to 4:

$$\begin{bmatrix} 3294 & 1339 & 0 & 0 \\ 1339 & 602 & 0 & 0 \\ 0 & 0 & 5 & 11 \\ 0 & 0 & 11 & 37 \end{bmatrix}. \quad (2)$$

Two cliques of cohesive journals are present. Journals 1 and 2 form a clique because they cite each other frequently (1339 times), but neither cites nor is cited by journals 3 and 4. Likewise, journals 3 and 4 form a clique. Applying a symmetric log-multiplicative model in one dimension produces the following scores for journals 1 to 4 in this matrix (ξ_i): [−0.54, −0.46, 0.50, 0.50]. As required, the scores of journals 1 and 2 on the one hand and 3 and 4 on the other hand are similar, while the scores of 1 and 2 differ from the scores of 3 and 4. Thus, cohesive journals in a citation network attain similar scores in the symmetric term of Eq. (1).

4.2. Structural equivalence of journals

Structural equivalence identifies journals that are similar in their position as senders (citing journals) or receivers (cited journals) in the network. Journals with a similar pattern of citing other journals draw from the same 'source' journals (i.e., they build on a similar knowledge base). Journals with a similar pattern of being cited by other journals are a source of knowledge for the same 'destination' journals. Previous research has examined structural equivalence in networks of communication journals (Rice et al., 1988), psychology, geography, and sociology journals (Doreian, 1985, 1988; Doreian and Fararo, 1985) with descriptive cluster analyses.

Instead, structural equivalence of journals is modeled here with the asymmetric log-multiplicative term in Eq. (1). To see how structural equivalence between journals is captured by the asymmetric term, assume the following citation network of four journals, 1 to 4:

$$\begin{bmatrix} 1677 & 0 & 221 & 0 \\ 322 & 0 & 67 & 0 \\ 0 & 20 & 0 & 11 \\ 0 & 191 & 0 & 67 \end{bmatrix}. \quad (3)$$

Two sets of structurally equivalent journals are present. In terms of sending citations, journals 1 and 2 are structurally equivalent because both cite journals 1 and 3, and journals 3 and 4 are structurally equivalent because both cite journals 2 and 4. Likewise, in term of receiving citations, journals 1 and 3 are structurally equivalent because both are cited by journals 1 and 2, and journals 2 and 4 are structurally equivalent because both are cited by journals 3 and 4. Applying an asymmetric log-multiplicative model in one dimension to this matrix produces the following row (μ_i) scores for journals 1 to 4: [−0.57, −0.42, 0.59, 0.40], and the following column (ν_j) scores for journals 1 to 4: [−0.57, 0.44, −0.42, 0.55]. As required, journals 1 and 2 on the one hand and 3 and 4 on the other hand attain similar row scores. Also, journals 1 and 3 on the one hand and 2 and 4 on the other hand attain similar column scores. Thus, structurally equivalent journals attain similar scores in the asymmetric term of Eq. (1).

Because the symmetric and asymmetric terms in Eq. (1) are estimated simultaneously, the results for cohesion of journals are independent of the results for structural equivalence of journals. This means that cohesion is not confounded with structural equivalence.

5. Evolution in citation networks

Evolution in the importance and similarity of journals in citation networks has received limited attention to date. The few available studies have only looked at changes in the importance of journals (Rice et al., 1988; Laband and Piette, 1994).

In Eq. (1), evolution in importance is modeled through the log-linear interaction parameters between receiving citations and time period (u^{RP}). Evolution in journal cohesion and structural equivalence is modeled by specifying the two log-multiplicative terms in Eq. (1) as conditional or multigroup terms (cf. Clogg and Shihadeh, 1994), as indicated by the subscript k in the row and column scores, and in the intrinsic levels of association. The subscript k specifies the number of time periods under study. Eq. (1) is the most general formulation, in which separate intrinsic levels of association and separate row and column scores are estimated for each time period. To examine specific hypotheses about evolution of the citation network over time, restricted versions of Eq. (1) will be estimated.

Obviously, a journal cannot send or receive citations before it exists. Therefore, the row and column marginals of a journal that enters an existing citation network later are *structurally zero* in the earlier periods. Journals that are present only part of the time are usually dropped from citation analyses altogether (cf. Laband and Piette, 1994). In contrast, the model in Eq. (1) allows journals to be present in the network only part of the time. It accommodates structural zeros for journals in the citation network by applying a weight vector ($\mathbf{z}_{ijk}$) to the log-frequency term (Clogg and Eliason, 1987). The weight vector ensures that estimated frequencies of structural zeros are actually zero.

The use of log-multiplicative terms in our model has important advantages over log-linear formulations. First, log-multiplicative formulations require significantly fewer parameters, which leaves more degrees of freedom in model testing. For example, degrees of freedom for the symmetric log-multiplicative term to examine cohesion are $(S-M)(R-M-1)$, with M for the number of dimensions required. For the 4×4 citation matrices that we used previously, assuming a single dimension, this would leave 6 *df*. A log-linear formulation of cohesion would require parameters for each of the $s(s-1)/2$ dyadic relations between journals in the matrices in addition to the row and column parameters, which would leave 0 *df* for a 4×4 matrix. A second advantage over log-linear terms is that log-multiplicative terms have attractive geometric properties that allow graphical presentations of their results (row and column scores) (Goodman, 1991; Clogg and Shihadeh, 1994). This is particularly useful when large matrices are examined, as is usually the case in citation analysis. An advantage of log-multiplicative formulations over descriptive methodologies such as MDS and cluster analysis, is that the former allow simple tests of model adequacy. In Section 6, the sample of journals in *IJRM*'s citation network from 1981 to 1995 is described and estimation results are offered.

6. Research method

Most citation data were collected from the Journal Citation Reports of the *Social Science Citation Index* (*SSCI*). Citation data were collected from 1981 to 1995. The *International Journal of Research in Marketing* (*IJRM*) was not included in the *SSCI* Journal Citation Reports until 1997. Hence, all citations from *IJRM* to the other journals and vice versa were counted by examining the reference lists of all articles published in the sampled journals for the 15 years under study.

Journals were sampled as follows. First, journals were selected that were consistently included in previous citation studies in marketing (e.g., Jobber and Simpson, 1988; Leong, 1989; Zinkhan et al., 1992). Second, four volumes of *IJRM* (1984, 1987, 1990 and 1993) were consulted and the number of citations that *IJRM* made to other journals were counted. Journals which were cited frequently by *IJRM*, but which had not been included in the first selection step, were added to the sample. This led to the selection of a final set of twenty journals that comprise *IJRM*'s core citation network.

The sample contains, in addition to *IJRM*, the following 19 journals (in alphabetic order): *Econometrica* (*Eco*), *European Journal of Marketing* (*EJM*), *Harvard Business Review* (*HBR*), *Industrial Marketing Management* (*IMM*), *Journal of Advertising* (*JA*), *Journal of Advertising Research* (*JAR*), *Journal of Business Research* (*JBR*), *Journal of Consumer Research* (*JCR*), *Journal of Experimental Social Psychology* (*JESP*), *Journal of Marketing* (*JM*), *Journal of Marketing Research* (*JMR*), *Journal of the Market Research Society* (*JMRS*), *Journal of Personality and Social Psychology* (*JPSP*), *Journal of Retailing* (*JR*), *Management Science* (*ManS*), *Marketing Science* (*MarS*), *Psychological Bulletin* (*PB*), *Psychological Review* (*PR*), and *Psychometrika* (*Psy*).

To control for annual fluctuations in citation incidence, five three-year time periods were examined by pooling the yearly data: 1981–1983, 1984–1986, 1987–1989, 1990–1992, and 1993–1995. Since the first complete volume of *IJRM* appeared in 1984, the journal is absent from the first time period, and the row and column entries for the journal in the first time period are structurally zero.

6.1. Estimation and model selection

To examine evolution in journal importance, cohesion, and structural equivalence, nested versions of

the model in Eq. (1) are estimated with *ML*, using the program LEM (Vermunt, 1997). Degrees of freedom for the models are obtained by *df* = number of non-zero fitted cells—number of estimable parameters (Clogg and Eliason, 1987). Model selection is based on the value of the Bayesian Information Criterion (BIC) (Long, 1997; Vermunt, 1997). In the context of log-linear and log-multiplicative models, $\text{BIC} = L^2 - \log Ndf$, where N is the number of observations and *df* is the degrees of freedom. The lower the value of BIC, the more information a particular model contains, relative to the number of parameters it requires. If BIC is smaller than 0, the estimated model is more likely than the saturated model.

7. Results

7.1. Citations in IJRM's network

In Table 1, the total number of citations that each journal sends to (*S*) and receives from (*R*) the *other* journals in the network in each time period is indicated, as well as the number of self-citations for each journal (*D*). The network contains 123,643 citations across the five time periods.

Across the four time periods that it was present, *IJRM* sent 41% of all its citations inside the network of 20 journals. The remaining citations went to a wide range of journals. Adding extra journals would

Table 1
Citations sent and received in *IJRM*'s network, 1981–1995

Journal		1981–1983			1984–1986			1987–1989			1990–1992			1993–1995		
		S	D	R	S	D	R	S	D	R	S	D	R	S	D	R
IJRM	International Journal of Marketing	0	0	0	632	11	1	535	23	6	749	38	61	966	69	109
Eco	Econometrica	35	571	179	33	760	245	21	675	264	27	833	319	8	726	399
EJM	European Journal of Marketing	219	29	26	410	75	77	680	53	58	806	126	45	1104	191	84
HBR	Harvard Business Review	2	491	342	3	303	492	0	266	527	2	171	430	0	87	769
IMM	Industrial Marketing Management	286	97	28	414	174	163	409	219	161	499	193	93	876	262	241
JA	Journal of Advertising	488	47	38	588	167	58	493	119	149	825	232	219	679	241	286
JAR	Journal of Advertising Research	263	197	359	255	190	482	408	197	457	588	334	374	520	361	474
JBR	Journal of Business Research	472	14	53	659	41	71	1128	55	117	1112	47	126	1975	102	162
JCR	Journal of Consumer Research	999	408	515	1081	480	668	1097	688	1033	1182	922	1355	1237	1123	1811
JESP	Journal of Experimental Social Psychology	867	248	779	828	274	904	830	204	797	631	185	805	690	205	856
JM	Journal of Marketing	811	414	811	907	419	1296	1171	482	1334	1049	523	1299	1357	678	2281
JMR	Journal of Marketing Research	956	827	1634	969	704	2146	995	599	2351	1136	573	2196	1463	674	2806
JMRS	Journal of the Market Research Society	99	45	32	119	42	39	325	63	47	250	139	45	213	82	61
JR	Journal of Retailing	281	157	138	379	150	232	368	192	188	398	101	215	477	103	330
JPSP	Journal of Personality and Social Psychology	1667	3352	1761	1938	4358	1935	2035	4419	2258	2113	4624	2467	2390	5394	2358
ManS	Management Science	418	848	313	439	949	419	478	881	397	525	940	470	739	983	578
MarS	Marketing Science	405	10	0	715	214	104	610	226	228	652	241	473	840	313	740
PB	Psychological Bulletin	1163	612	991	841	472	1160	1399	615	1168	1844	744	1308	1280	665	1555
PR	Psychological Review	265	348	1035	604	407	1051	544	472	1335	379	420	1327	519	630	1312
Psy	Psychometrika	55	260	371	100	927	371	63	363	411	112	605	323	97	487	218

S = citations sent to other journals (citing), D = self-citations, R = citations received from other journals (cited); Total $n = 123{,}643$.

increase the number of citations captured by the network only minimally, as the 19 journals were sampled with the highest citation rates from *IJRM*. For example, if *IJRM* cited each additional journal the same number of times as it currently cites *EJM* (cited 5 times between 1993 and 1995), adding 20 additional journals to the network would result in an additional capture of less than 5%. The four journals that jointly receive the most citations from *IJRM* between 1993 and 1995 are *JMR* (230), *JM* (180), *JCR* (144) and *MarS* (102). Combined with *IJRM*'s self-citations (69), they account for 70.0% of the citations that *IJRM* sent in the network, and for 28.8% of the total number of citations that *IJRM* sent.

Other marketing journals sent comparable percentages of their citations inside the network: *Journal of Marketing* (*JM*) 35%, *Journal of Marketing Research* (*JMR*) 38%, *Journal of Consumer Research* (*JCR*) 34%. The psychology, management and economics journals sent the lowest percentages to other journals in the network. For example, in 1995 *Psychological Review* (*PR*) and *Psychological Bulletin* (*PB*) sent 10% and 14%, respectively, to other journals in the network, mostly to other psychology journals.

The absolute number of citations that *IJRM* receives from the other journals in the network is low, but the figures have risen sharply over time, from a single citation in the second period to 109 citations in the fifth period. The incidence of self-citing varies widely across journals. For instance, in the last time period *JMR* had 674 self-citations and it received 2806 citations from other journals in the network of 20 journals specified in Table 1: a self-citation rate (D/R) of 24%. In comparison, in the same period *JCR* had 1123 self-citations and it received 1811 citations from other journals in this network: a self-citation rate of 62%. This illustrates the importance of accounting for self-citations in the network, as our model does.

7.2. Accounting for citation patterns in IJRM's network

Nested versions of the model in Eq. (1) were estimated to examine importance, cohesion, and structural equivalence in the network over time. First, importance, cohesion and structural equivalence were modeled with *time-homogeneous* log-multiplicative terms, ignoring evolution effects for the moment. Models were compared to the baseline model which excluded log-multiplicative terms and which instead modeled the interaction between sending and receiving with standard log-linear parameters (u^{SR}). This procedure established how many dimensions in the two log-multiplicative terms were required to describe journal similarity across the five time-periods. The best model comprised two dimensions for the symmetric and two dimensions for the asymmetric log-multiplicative term. The BIC value of this model was -10774 ($L^2 = 8420$, $df = 1637$), which is lower than the BIC of the baseline model (-10659; $L^2 = 5815$; $df = 1405$).

Next, evolution in importance, cohesion and structural equivalence was examined with *time-heterogeneous* log-multiplicative terms. Three models were tested. The first model was the model from Eq. (1) containing completely time-heterogenous log-multiplicative terms in two dimensions ($M = 2$, $N = 2$). The model allowed both the level of intrinsic association and the row and column scores of the journals to vary freely over time. If this were the best model, it would imply that *IJRM*'s citation network is different in each time period, and that it is fundamentally incomparable across time. In practical terms, it would be difficult to interpret this model because of the large number of parameters required. This model was not selected because it fitted the data worse than the previous time-homogenous model, attaining a BIC value of -9398 ($L^2 = 3605$, $df = 1109$).

The second model contained partially time-heterogeneous log-multiplicative terms. It restricted the scores of the journals to be homogeneous over time, but it allowed the levels of intrinsic association to vary freely across the five time periods. This model achieved a better BIC value than the time-homogeneous model (-10914, $L^2 = 7154$, $df = 1541$). The result is of substantive interest because it implies that the relative distances between the scores of the journals in *IJRM*'s network are essentially similar across the five time periods. This means that the network is comparable over time and stable in its basic structure, and that the cohesion and structural equivalence

of specific journals do not change radically across the 15 years under observation.

The third model builds on the partially heterogeneous model by examining linear trends in intrinsic levels of association over time (Wong, 1995). Specifically, it estimates $\varphi_k = \varphi_0 + \varphi_1 k$. This model was selected because it fitted the data best (BIC = -10927, $L^2 = 7282$, $df = 1553$), accounting for 97% of the association in the citation network. The substantive implications of this model are examined next. [1]

7.3. Importance of journals in IJRM's network

Table 2 presents the estimated importance scores of journals in the five time periods. Journal importance in each time period is the sum of the mean importance and the deviation per time period ($u^R + u^{RP}$) based on the selected model. Parameters are scaled such that the sum of the importance scores across journals is zero for each time period. Thus, a value of zero indicates that the importance of a journal is at the average value in the network of 20 journals for that period. Negative values indicate lower than average importance, positive values indicate higher than average importance.

Across the entire 15-year period *Journal of Marketing Research*, *Journal of Personality and Social Psychology*, *Journal of Consumer Research*, and *Journal of Marketing* are most important in terms of the number of citations they receive from the journals in the network. Generally, journals only reach their steady-state impact gradually, because it takes time to build up an article base that other journals can cite. As a consequence, younger journals like *IJRM* (established in 1984) and *Marketing Science* (1982) will tend to have lower mean importance scores than older journals like *Psychological Review* (1894) and *Journal of Retailing* (1925). This is supported by the negative correlation between the mean importance of journals across the five time periods under study and the year that journals were established ($r = -0.419$, $n = 20$, $p = 0.033$, one-tailed). Hence, we emphasize the growth-path and importance in the final time period of younger journals like *International Journal of Research in Marketing* and *Marketing Science*.

Table 2
Journal importance in *IJRM*'s network: 1981–1995: loglinear parameters

Journals	Importance per time period ($u^R + u^{RP}$)				
	81–83	84–86	87–89	90–92	93–95
IJRM	****	−5.09	−3.58	−1.39	−1.06
Eco	0.15	0.43	−0.57	−0.58	−0.82
EJM	−1.94	−1.91	−2.47	−2.87	−2.57
HBR	0.84	0.26	0.05	−0.08	−0.15
IMM	−2.02	−1.19	−1.58	−1.88	−1.84
JA	−1.39	−1.81	−1.30	−1.26	−1.19
JAR	0.71	0.01	−0.22	−0.65	−0.65
JBR	−0.56	−1.14	−0.84	−0.82	−0.94
JCR	2.28	1.66	1.87	1.99	2.05
JESP	1.10	0.63	0.28	0.19	0.21
JM	2.33	1.87	1.67	1.59	1.73
JMR	3.39	2.73	2.59	2.41	2.39
JMRS	−1.20	−1.87	−1.88	−2.05	−2.10
JPSP	2.59	2.22	2.07	2.06	2.01
JR	0.49	0.13	−0.33	−0.43	−0.26
ManS	1.46	0.77	0.57	0.60	0.54
MarS	−14.04	−0.66	0.33	0.57	0.74
PB	2.24	1.63	1.42	1.43	1.42
PR	1.89	1.32	1.26	1.07	1.01
Psy	1.57	0.90	0.65	0.08	−0.55

Table 2 identifies several journals with steep growth paths over time. The importance of the *International Journal of Research in Marketing* (*IJRM*) has grown substantially from −5.09 in the period 1984–1986 to −1.06 in the period 1993–1995. Although the importance of *IJRM* in the final time period is still below the average importance in the network, it is already higher than that of *EJM*, *JA*, *JMRS*, and *IMM*. *Marketing Science* (*MarS*) experienced the most dramatic growth from −14.04 in 1981–1983 to 0.74 in 1993–1995. The very low importance of *Marketing Science* in the period 1981–1983 is partially due to the fact that the journal was established in 1982, in the middle of the period, and hence was cited zero times until 1983 (see Table 1). Generally, younger journals are likely to grow faster than older journals. This is supported by the positive correlation between the growth in importance (difference between importance in period

[1] More detailed results on model selection can be obtained by writing to the first author.

5 and period 2, to allow for the inclusion of *IJRM* in the analyses) and the year that journals were established: $r = 0.441$ ($n = 20$, $p = 0.026$, one-tailed).

Table 2 also shows that the importance of several journals that are not core marketing has decreased over the years, notably the importance of *Econometrica* (*Eco*), *Journal of Personality and Social Psychology* (*JPSP*), *Management Science* (*ManS*), *Psychological Bulletin* (*PB*), *Psychometrika* (*Psy*), *Psychological Review* (*PR*). Still, even in the final time period the importance of non-marketing journals, particularly psychology journals, in this citation network remains high.

7.4. Cohesion of journals in IJRM's network

Table 3 presents the results for cohesion and structural equivalence of journals in *IJRM*'s network, and Figs. 1–3 display the results graphically.

Cohesion of journals in the network is displayed in Fig. 1. Inspection of the figure shows clear cliques of journals that cite each other frequently. A clique of marketing journals is located slightly to the left of the middle, including *JMR*, *JCR*, *IJRM*, *JMRS*. In the lower left portion, the management-oriented journals cluster together (*JBR*, *HBR* and *EJM*). In the upper part of the plot, the method-oriented *Management Science* and *Econometrica* form a clique, and the two form a looser clique with *Marketing Science* and *Psychometrika*. On the right side of the plot, the psychology journals form a loose cluster (*PR*, *PB*, *JESP*, and *JPSP*).

Interpretation of the two dimensions is straightforward. The horizontal dimension distinguishes cohesion in *psychology* journals, located on the right of the plot, from *business* journals, located towards the left of the plot. The vertical dimension differentiates cohesive *methodological / formal* journals, located at the top of the plot, from *substantive / empirical* journals, located towards the bottom of the plot. It is apparent that, despite its relatively low importance, *IJRM* entertains mutual citation relationships with the core marketing journals in the network.

Table 3
Cohesion and structural equivalence in *IJRM*'s citation network

Journals	Cohesion		Structural equivalence			
	Dimension 1	Dimension 2	Dimension 1		Dimension 2	
			Sending	Receiving	Sending	Receiving
IJRM	−0.08	0.03	−0.03	0.03	0.04	0.11
Eco	−0.00	0.29	−0.62	−0.46	0.22	0.21
EJM	−0.19	−0.43	−0.06	−0.19	0.16	−0.16
HBR	−0.12	−0.29	−0.18	−0.34	−0.13	−0.20
IMM	−0.29	−0.06	0.02	−0.12	−0.59	0.17
JA	−0.19	0.01	0.16	0.44	−0.26	0.05
JAR	−0.28	0.14	0.12	0.31	−0.39	0.14
JBR	−0.10	−0.24	−0.02	−0.05	0.07	−0.11
JCR	−0.03	0.05	0.06	0.26	−0.05	0.09
JESP	0.41	−0.15	0.58	0.16	0.23	−0.30
JM	−0.12	−0.14	−0.02	0.00	−0.02	−0.06
JMR	−0.05	0.07	0.00	0.04	0.03	−0.02
JMRS	−0.13	0.00	−0.03	−0.06	−0.05	−0.07
JPSP	0.44	−0.31	0.38	0.17	0.26	−0.43
JR	−0.11	−0.10	0.00	0.05	−0.02	0.11
ManS	−0.01	0.19	−0.16	−0.39	−0.05	−0.16
MarS	−0.10	0.50	−0.04	−0.12	−0.04	0.09
PB	0.35	−0.03	−0.10	0.10	0.11	−0.01
PR	0.39	0.14	−0.12	0.14	0.05	−0.13
Psy	0.21	0.32	0.00	0.00	0.43	0.68
Intercept	$\psi_0 = 41.75$	$\psi_0 = 11.57$	$\phi_0 = 30.91$		$\phi_0 = 15.77$	
Linear trend	$\psi_1 = 0.72$	$\psi_1 = -0.49$	$\phi_1 = 3.42$		$\phi_1 = 2.38$	

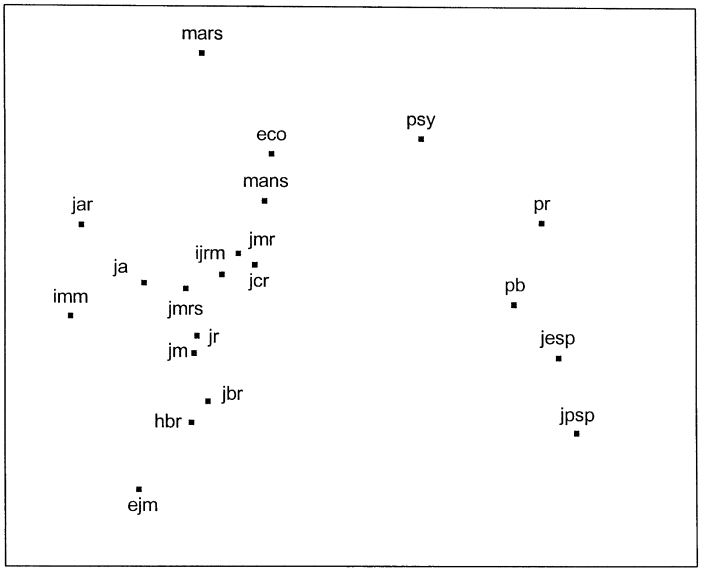

Fig. 1. Cohesion in *IJRM*'s citation network (acronyms are explained in Table 1).

7.5. Structural equivalence of journals in IJRM's network

Structural equivalence in sending citations to other journals is displayed in Fig. 2. A tight cluster of journals is located in the middle of the plot. In the periphery, seven journals are located that have a deviating pattern of sending relationships in the network. They either draw less from the journals in the network, or they draw from different journals in the network than the average journal does.

The horizontal dimension distinguishes the only *economics* journal in the network, *Econometrica* (*Eco*), located on the left, from two *psychology*

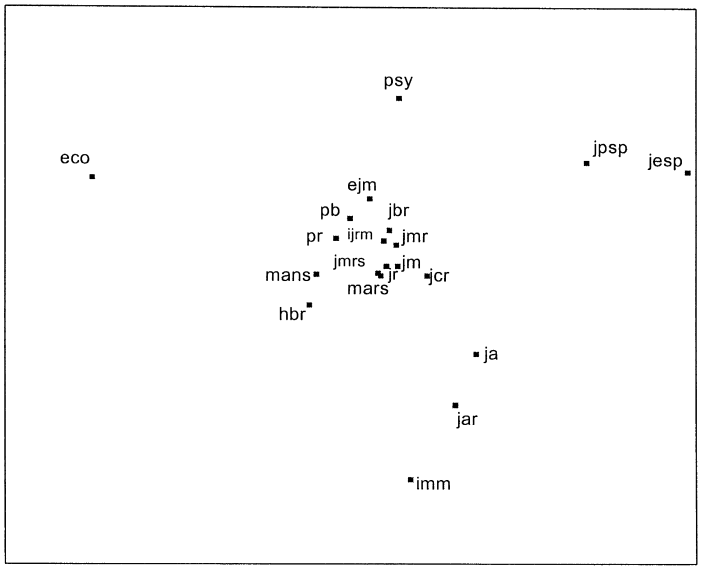

Fig. 2. Structural equivalence in *IJRM*'s citation network: sending patterns (acronyms are explained in Table 1).

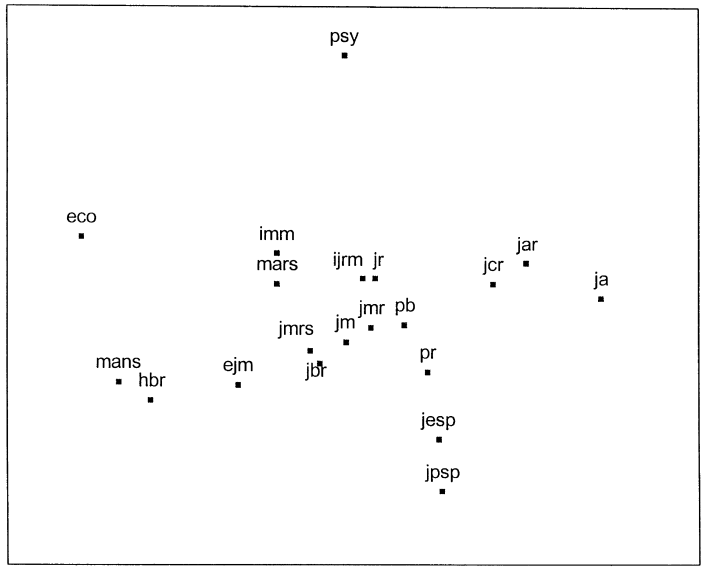

Fig. 3. Structural equivalence in *IJRM*'s network: receiving patterns (acronyms are explained in Table 1).

journals (*JESP*, *JPSP*), located on the right. *Econometrica* sends almost no citations to other journals in the network (only 8 between 1993 and 1995, see Table 1). *JPSP* and *JESP* send many citations to each other, some to other psychology journals, and almost none to the marketing journals. *Psychological Bulletin* (*PB*) and *Psychological Review* (*PR*) are located in the core cluster of the plot because, similar to the marketing journals, they send many citations to *JPSP* and to *JESP*.

The second dimension distinguishes three marketing and management journals (*IMM*, *JAR*, *JA*) that are oriented towards *knowledge-transfer*, at the bottom of the plot, from journals (*Psy*, *Eco*, *JPSP*, *JESP*) that are oriented towards *knowledge-development*, at the top of the plot. The journals in the top of Fig. 2, *Psychometrika*, *Econometrica*, *JPSP* and *JESP*, send virtually no citations to the marketing journals in the network. The plot illustrates that *IJRM* draws from the same knowledge base as the most important marketing journals do. In Section 7.5.1, structural equivalence in sending of the marketing journals is returned to.

Structural equivalence in receiving citations is displayed in Fig. 3. The horizontal dimension distinguishes the business journals, separating journals with a *macro / strategy focus* (*Eco*, *ManS*, *HBR*, *EJM*, *IMM*, *MarS*), located to the left, from journals with a *micro / tactics* focus (*JA*, *JAR*, *JCR*). The vertical dimension distinguishes psychology journals, separating *methodology*, at the top (*Psy*), from *theory*, at the bottom (*JPSP*, *JESP*). Journals that are close together are a source of knowledge for the same journals. Inspection of Figs. 2 and 3 illustrates the relevance of distinguishing between structural equivalence in sending and structural equivalence in receiving citations. For instance, *IMM*, *JA* an *JAR* have a similar pattern of sending citations in the network (Fig. 2), but a different pattern of receiving citations from the network (Fig. 3).

7.5.1. Structural equivalence of marketing journals

While the previous analysis provides important insights into the structural equivalence of journals, the psychology journals and *Econometrica* have a substantial effect on the plots. As a consequence the marketing journals form a tight cluster, in particular with respect to structural equivalence in sending. This is a substantive result, because it means that the marketing journals have a very similar pattern of sending citations in this network, i.e., that they draw from the same knowledge base. However, because their relative closeness is partly due to the outspoken sending pattern of some psychology journals and

Econometrica, relevant differences between marketing journals are difficult to discern.

To enable a more fine-grained analysis of structural equivalence in the marketing field, two k-means cluster analyses were performed on the scores of the fourteen marketing journals, including *HBR* and *Management Science*, in the network (cf. Iacobucci and Hopkins, 1992). The marketing journals were clustered separately on the two dimensions of structural equivalence in sending, and on the two dimensions of structural equivalence in receiving (in both cases after standardizing the scores to make their mean 0 and standard deviation 1). Journals within a cluster occupy the same role in sending or receiving citations in this network.

Three distinct clusters of journals emerged for structural equivalence in sending (both dimensions differentiated significantly between the three clusters, $p < 0.001$). One cluster comprised three specialized marketing journals: *JA*, *JAR* and *IMM*. Another cluster comprised two management journals: *HBR* and *Management Science*. A final cluster comprised the other journals, *EJM*, *IJRM*, *JBR*, *JCR*, *JM*, *JMR*, *JMRS*, *JR* and *Marketing Science*.

The journals in the first cluster, *JA*, *JAR* and *IMM*, appear at the bottom of Fig. 2. They sent a large part of their citations in the network to a few marketing journals only. For instance, between 1993 and 1995, *JAR* sent 87% of its citations in the network to *JM*, *JMR*, *JCR* and *JA*. *JA* even sent 90% of its citations to *JM*, *JMR*, *JCR* and *JAR*. *IMM* has a similar pattern, but in addition it sent 38 citations to *EJM*, which is 45% of the total number of citations *EJM* received in that period. The two journals in the second cluster, *HBR* and *Management Science*, draw only little on the network for their citations. *HBR* because it hardly sends citations, *Management Science* because it does not rely on this network for its knowledge. The other marketing journals, including *IJRM*, fall in one cluster. They draw from the same knowledge base, including the basic journals from psychology and economics.

Four distinct clusters of journals emerged for structural equivalence in receiving (both dimensions differentiated significantly between the four clusters, $p < 0.001$). A first cluster comprised the micro-oriented *JA*, *JAR* and *JCR*. It is located at the right middle in Fig. 3. A second cluster comprised *JM*, *JMR*, *JMRS*, and *JBR*. A third cluster comprised the management-oriented *Management Science*, *HBR* and *EJM*, and a fourth cluster comprised *IJRM*, *IMM*, *JR*, and *Marketing Science*. The roles of the clusters in receiving citations from the network are illustrated with data from the last period: 1993–1995.

In that period, journals in the first three clusters received citations from on average 11 journals in the network (excluding self-citations), while journals in the fourth cluster received on average citations from only 8 journals in the network. Clusters also differed in the citations that journals in it received from other journals in the same cluster. For example, journals in cluster 2 received 37%, the highest percentage, of their citations from other journals in cluster 2 (excluding self-citations), while journals in cluster 4 received only 16%, the lowest percentage, of their citations from other journals in cluster 4. Journals in cluster 4 appear to have a narrower base of journals that draw from them, and the other journals in the same cluster draw less from their knowledge.

So where do the citations to journals in cluster 4, in particular to *IJRM*, come from? Between 1993 and 1995 some 50% of citations to journals in cluster 4 came from *JM*, *JMR*, *JCR*, *Marketing Science*, and *IJRM* (excluding self-citations). In comparison, a lower 44% of the citations to journals in cluster 2 came from *JM*, *JMR*, *JCR*, *Marketing Science*, and *IJRM*. More specifically, 58% of the citations that *IJRM* received came from *JMR* (24), *JCR* (14), *Marketing Science* (17) and *JM* (8). *Marketing Science*, also from cluster 4, received 59% of its citations from those journals in the same period. In contrast, *JA*, a member of cluster 1 only received 33% of its citations from *JM*, *JMR*, *JCR*, *Marketing Science*, but a high 43% from *JAR*. Also, *EJM*, from cluster 3, only received 13% of its citations from *JM*, *JMR*, *JCR*, *Marketing Science*, and *IJRM*, but a high 80% from *JBR* and *IMM*. So overall, journals in cluster 4 appear to attract citations from less journals than others, but the citations they receive come to a large extent from the top marketing journals.

Finally, inspection of Table 3 shows that both for cohesion and for structural equivalence the first dimension dominates the solution, as indicated by the magnitude of the intrinsic levels of association of the first dimension relative to the second dimension. It is

apparent that the psychology journals and the other journals form relatively close cliques of journals that cite each other frequently. The intrinsic association of the first dimension for cohesion has increased over time (0.72), and the intrinsic association of the second dimension has decreased (−0.49). This indicates that over time the cliques of psychology journals on the one hand and of business and economics journals on the other hand have become tighter and more separated from each other, while the distinction between methodological/formal journals and substantive/empirical journals has become less pronounced. Table 3 also shows that over time the patterns of sending citations (3.42) and receiving citations (2.38) have become more clearly distinguishable. In other words, economics and psychology have become even more separated from the core marketing and management journals in their pattern of citing, and being cited by other journals.

8. Discussion

We proposed and estimated a time-heterogenous log-multiplicative model to simultaneously examine the importance, cohesion and structural equivalence of journals in the citation network of the *International Journal of Research in Marketing* between 1981 and 1995. While the individual components of the model are not new (cf. Goodman, 1991; Clogg and Shihadeh, 1994), Eq. (1) integrates them in a novel way, particularly in the context of citation analysis. To our knowledge, this is the first citation study in marketing to examine the structural equivalence of journals, and it is the first social network analysis to examine cohesion and structural equivalence simultaneously using a unified methodology. While previous research on social networks has emphasized log-linear components, our model employs a log-multiplicative formulation, the benefits of which have been indicated. Moreover, the model controls for the influence of self-citations, which have usually been ignored in previous citation research. Finally, this study examined a citation network of 20 journals across a period of 15 years, allowing journals to enter the network at any point in time.

The results show clear differences in the importance of journals in *IJRM*'s citation network, a distinct structure in the cohesion and structural equivalence of journals, and interesting changes over time. Tight cliques of journals that mutually cite each other were found, in particular cliques of psychology journals, methodological/formal journals, managerial journals, and core marketing journals. Within cliques the incidence of reciprocating each other's citations is high, and between cliques it is lower.

Also, our analysis identified journals with distinct roles or positions in the citation network. For example, some journals played the role of feeder journals (e.g., *Econometrica*, *Psychometrika*, and the psychology journals), while other journals were more oriented towards knowledge-transfer than knowledge-development (e.g., *Industrial Marketing Management*, *Journal of Advertising Research*, and *Journal of Advertising*). While structural equivalence in sending citations was quite homogenous in the marketing field, indicating that most journals drew from the same journals for their knowledge, structural equivalence in receiving citations was quite heterogenous. While *IJRM* entertained a central position in both cases, the structural equivalence of, for instance, *JCR*, *JA*, *JAR* and the psychology journals in receiving citations from the other journals became apparent. These patterns of cohesion and structural equivalence would have been difficult to discern by inspecting 5 matrices of 20-by-20 journals, or by applying various methodologies in sequence (e.g., Pecotich and Everett, 1990; Zinkhan et al., 1992).

Although *IJRM*'s importance is still somewhat less that some scholars predicted soon after it was launched (Jobber and Simpson, 1988; Pecotich and Everett, 1990), its growth rate up to 1995 has been impressive. An additional positive sign is the increasing numbers of self-citations which reflect that *IJRM* is building a knowledge base of its own that inspires other work. The number of self-citations of *IJRM* grew from 11 (1984–1986) via 23 (1987–1989), 38 (1990–1992), and 69 (1993–1995), to 104 (1996–1998). *IJRM* entertains cohesive citation relationships with the key marketing journals, drawing on the same core knowledge base and serving as a source for the same key journals. *IJRM* is becoming more acknowledged by the top marketing journals,

as indicated by the number of citations it receives from them. For instance, between 1990 and 1992 *IJRM* was cited 38 times by *JM*, *JMR*, *JCR* and *Marketing Science*. This grew to 63 citations between 1993 and 1995. Although not all issues of 1998 are available at the time of this writing, we counted 84 citations from the top four marketing journals to *IJRM* between 1996 and 1998. Assuming the proportion of *IJRM* citations received from *JM*, *JMR*, *JCR* and *Marketing Science* is 60% as in the period 1993–1995, this translates to a total number of around 150 citations between 1996–1998 from this network. This would bring *IJRM*'s importance close to the average of the network. Even more encouraging for *IJRM* is that the trend is still upward. Taken as a whole, these results indicate that the *International Journal of Research in Marketing* is moving toward a position among the preferred journals in marketing.

The analyses also indicate that the marketing field as a whole is maturing, and that it is becoming an independent field of inquiry. Marketing journals have become more important in the network and non-marketing journals have become less important. While psychology and economics remain important feeder disciplines, the cohesion of marketing journals in terms of the frequency of mutual citations is increasing.

It should be mentioned that the citation network under study is journal-centric because *IJRM* is the focus, and only journals which entertain intense citation relationships with *IJRM* are examined. Hence, results are conditional upon the specific journals selected. Although the citation network is very stable, as the results of our model tests show, the importance and similarity of some journals in the citation network might change somewhat if other journals were sampled. The classic network literature assumes that the network under study is closed (i.e., that it includes all actors). Examining closed networks in consumer and industrial markets is already very challenging from a data collection and analysis viewpoint (see Iacobucci, 1996; Iacobucci et al., 1996). Examining complete citation networks is virtually impossible for most domains of academic inquiry, due to the large number of journals that entertain at least some citation relationship with each other. Despite such considerations, the results of this study should be interpreted within the context of the present network.

In our model, log-linear column parameters indicate journal importance. Because the column parameters are estimated simultaneously with the row parameters, they estimate journal importance while 'controlling' for the number of citations that journals send in the network. Journals with many issues per volume or journals containing many review articles are likely to be cited frequently, but they will also tend to send many citations in the network, which is captured by the row parameters in the model. Therefore our measures of importance are similar in spirit to descriptive indicators of *net* importance as used, for example, by Zinkhan et al. (1992). In addition, our importance measures are significantly correlated with *SSCI* impact scores, although the latter do not control for self-citations and are calculated in a different way. The correlation between the *SSCI* impact score across the entire time period and our mean importance scores of journals is 0.541 ($n = 20$; significant at $p < 0.02$). This supports the validity of our measures of journals importance. Still, alternative measures of importance in social networks exist (Scott, 1991; Wasserman and Faust, 1994), and applying them may lead to somewhat different results than those obtained here.

Future research could extend the present study in several ways. Follow-up studies could track *IJRM*'s citation network further, by adding additional time periods when they become available. In view of our results, it is unlikely that dramatic changes in the cohesion and structural equivalence between journals in the network will occur in the near future, but it would be interesting to follow *IJRM*'s growth in importance over time. It may also be interesting to examine if the traditional 'feeder' journals from economics and psychology continue to lose importance in the longer run, and whether the core marketing journals in the network become more closely knit. We observed that importance and importance growth are systematically related to the first year of publication of journals. Future research might include other explanatory variables for the importance and similarity of journals. For instance, the importance of journals could be related to the broadness or narrowness of their domain of investigation, or to the extent that they are theory or method oriented.

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