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The Sphere of Influence of Information Systems Journals: A Longitudinal Study

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Abstract:

The paper examines the issue of the information systems (IS) discipline's influence as represented by its key journals. We examine the well-studied topics of cumulative tradition and reference disciplines from two unique perspectives: cohesion and stability. We demarcate journals into "IS journals" and "non-IS journals that are receptive to IS work" and examine the sphere of influence of these journals based on citations over time. Specifically, we compute a log-multiplicative model to identify subareas in the IS discipline and assess journal influence using the index of structural influence based on citations from a basket of 42 IS and IS-related journals over four periods: 1999-2000, 2004-2005, 2009-2010, and 2013-2014. Results indicate that the IS discipline has established a stable and cohesive knowledge underpinning, which converges with emerging (newer) journals and diverges with non-IS journals during the late period. These results suggest that the discipline has developed boundary conditions and a strong cumulative tradition. Furthermore, based on our analysis, pure IS journals gradually gained dominance in their own network and even started to exert influence in the broader network of journals. These findings provide a unique complement to other recent studies that signify the IS discipline's influence.

Keywords: Citation Analysis, Log-multiplicative Model, Index of Structural Influence, Longitudinal Study, IS Research, Reference Disciplines, Cumulative Tradition, Journal Ranking.

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1 Introduction

Many examinations into the IS discipline have focused on whether it has built a cumulative tradition and whether it should draw from reference disciplines. In 1980, during the first ICIS conference, Peter Keen argued that IS was an “applied” discipline and that IS research should draw on existing knowledge that stems from other reference disciplines. He also claimed that, due to the rapidly changing nature of information technology, IS researchers easily become diverted by emerging ideas and choose to work on the emerging technology, which prevents them from building on prior studies. Subsequently, other scholars have echoed this view and lamented the lack of a cohesive, accepted conceptual paradigm for IS research (Benbasat & Weber, 1996). In contrast, some scholars believe that IS already has a sufficient set of core knowledge elements (i.e., topics, concepts, and phenomena) (Baskerville & Myers, 2002; Benbasat & Zmud, 2003). Others have gone further and argued that IS may even contribute knowledge to disciplines from which it seeks knowledge (Grover, Gokhale, Lim, Coffey, & Ayyagari, 2006; Polites & Watson, 2009).

Despite the number of studies in this vein, we still do not have a good sense of whether IS has indeed formed a clear disciplinary identity. Thus, in this paper, we address those issues from two unique perspectives: cohesion and stability. We examine the networks of IS journals and how they build knowledge. In these networks, we distinguish between pure IS journals and IS-receptive journals. Specifically, the pure IS network comprises journals that publish primarily IS papers, while the IS-receptive network comprises a list of pure IS journals and journals that originated in outside disciplines but are receptive to IS papers and that the IS community considers legitimate IS outlets.

Researchers have previously used the cohesion and stability concepts to better understand the internal consolidation of various academic disciplines based on citation data. Abbott (2014) contends that the key aspect of consolidation is to pass down knowledge so that later researchers can build inferences from it. In examining this knowledge transfer, we would hope that IS journals draw and build on their own research in stable research areas rather than continuously rearranging their networks of knowledge transfer with journals more affiliated with outside disciplines. In addition, if IS truly has core content, we might expect that outside journals that are IS receptive would gradually be repelled from pure IS networks and that newer, emerging IS journals would gravitate toward them. Such patterns would confirm both the cohesion and stability of IS.

Furthermore, if the IS discipline has a certain level of cohesion and stability, we need to address another important question about whether IS journals progressively gain more influence. Prior studies have tried to answer this question through journal ranking. Many prior studies have tried to assess journal quality. Some of these studies have used subjective assessments (e.g., surveys of the IS discipline’s members), while others have used objective assessments based on citation data (e.g., journal impact factors). However, extant analysis does not examine influence’s boundary conditions. By demarcating local (IS) and global (all IS-receptive) journals, we can examine journals’ sphere of influence. Specifically, we can address whether 1) they influence research in the IS discipline (namely, in the pure IS network) by creating a cumulative tradition, 2) whether their influence extends to journals outside their typical domain, 3) how this influence has changed over time, and 4) whether reference disciplines have had more or less impact on the IS discipline over the years.

To answer these questions, we conduct a subarea (topics with tight knowledge exchange) and journal influence analysis on a network of 42 journals from both IS and closely related disciplines based on citation data from four periods: 1999-2000, 2004-2005, 2009-2010 and 2013-2014. In doing so, we use a log-multiplicative model to conduct subarea analysis by clustering the influence network to ascertain journal membership. Membership changes in the IS discipline’s subarea(s) will help to create insight into the discipline’s cohesion and stability.

We define the journal membership in IS discipline and two other reference disciplines (management and operations research) based on clustering. We then compute an index of structural influence to evaluate the influence of journals in the IS-receptive network and in the pure IS network and the IS-receptive network in order to compare the changes of influence across different periods.

Our paper proceeds as follows. In Section 2, we review prior work and distinguish the structural influence approach we followed in this study. In Section 3, we describe the journal-selection, data-collection, and data-analysis processes in the network of 42 journals based on the citation report of SCI and SSCI. In

Section 4, we analyze the subareas and journal influence in the two distinct networks over time. In Section 5, we discuss the implications of our results and, in Section 6, conclude the paper.

2 Background

2.1 Cohesion and Stability

Although the IS discipline is several decades old, researchers still have disparate views on whether IS has strong boundary conditions (i.e., intellectual core) as a maturing discipline and whether it should continue to borrow from reference disciplines. Some scholars recommend that the IS discipline seek a core set of properties (i.e., concepts and phenomena) that define it. For instance, Benbasat and Weber (1996) regard diversity as a threat to legitimacy. Benbasat and Zmud (2003) advocate the signaling of boundary conditions primarily through discipline-specific research activities because they deem that, in the absence of intellectual core, IS will have suspect legitimacy. In contrast, if the discipline establishes core IS knowledge, it will heighten its ability to contribute to other areas (Baskerville & Myers, 2002; Benbasat & Zmud, 2003). Others contend that the key to development of IS is to freely borrow and extend concepts from other disciplines and apply them to the IS context (Bryant, 2008; Vessey, Ramesh, & Glass, 2002). Robey (1996) argues that diversity of research benefits the discipline and advocates creatively adopting interdisciplinary approaches due to IS scholars' varied backgrounds. Mingers (2001) also upholds diversity by suggesting a multi-paradigm approach rather than a dominant design.

Regardless of the debate, many IS researchers agree that IS work should build on previous IS work and establish IS-specific knowledge and a cumulative tradition (Grover et al., 2006). Therefore, some have suggested the tradition of strong theorizing as opposed to quickly and constantly shifting theory needs (Grover, Lyytinen, Srinivasan, & Tan, 2008). Abbott (2014) argues that consolidating a discipline renders easy access to and understanding of knowledge. He points out that, if the IS discipline establishes a cumulative tradition, more current papers will cite preceding IS papers (rather than papers from other areas such as management or operations research), which will boost the relative influence of IS-specific journals. If is the IS discipline has less of a cumulative tradition, IS journals will draw from disparate sources in and outside the discipline and will tend to have lower consistency in topics or focus. This inconsistency of what the discipline constitutes could thwart the sense of pride IS researchers have in being members and stakeholders of the discipline (Grover, 2012) and lead to less stability and ownership of research areas (Abbott, 2014)

Researchers have conducted many studies to verify the existence of the IS discipline's stability. Broadly speaking, they have conducted them in two ways. The first set of studies has focused on the content of the discipline and often used thematic analysis to determine popular topics of research (Alavi & Carlson, 1992) or to identify whether IS contains a unique core research body (Davis, 1999). Some of these studies have examined IS as a composition of different disciplines (Bariff & Ginzberg, 1982; Kendall & Kriebel, 1982). The second set of studies has used sociometrics (typically citation analysis) to examine how IS has drawn from or contributed to other research over time (Cheon, Lee, & Grover, 1992; Culnan & Swanson, 1986; Grover et al., 2006).

In this study, we address the issue differently: we employ subarea analysis to examine the IS discipline's cohesion and stability using journals (not papers) as the unit of analysis. We do based on a simple rationale: if an area has consistent topics in a certain domain, it tends to reflect cohesion, and the relationship between the journal and its subareas tends to be stable. Cohesion and stability indicate core knowledge and a cumulative tradition in the discipline. Therefore, for our research, we need to 1) identify subareas and 2) determine journal quality (influence), which we discuss below.

2.2 Methods for Subarea Analysis

Researchers that have conducted subarea analysis studies on IS journals have usually adopted either subjective or objective approaches. Subjective approaches rely on IS researchers or practitioners' personal opinions and judgments. They make judgments based on a journal's title, mission, and publications. Those subjective judges can determine which subarea one journal should belong to (Peffers & Ya, 2003; Rainer & Miller, 2005; Walstrom & Hardgrave, 2001). The subject approach has an obvious limitation: one could have restricted knowledge of the respondents—especially when confronted with emerging and unfamiliar journals.

Objective approaches use objective citation data. They normally apply the log-linear and log-multiplicative models (Stigler, Stigler, & Friedland, 1995) to identify subareas through association (e.g., citations) between sending and receiving journals in a network (Baumgartner & Pieters, 2003; Taneja, Singh, & Raja, 2009). Objective methods suffer less subjective bias because they classify journals based on mutual citation relationship rather than subjective judgment. The principle is that journals in the same subarea tend to have similar focus and share similar topics and, hence, that they should cite each other more frequently than journals from other subareas. Therefore, one can identify subareas by examining journals' citation patterns. For example, Nerur, Sikora, Mangalaraj, and Balijepally (2005) examined a relatively small network that comprised 27 journals in IS and other areas and simply identified several rough geographic categories such as North American journals and European journals. Taneja et al. (2009) extended Nerur et al.'s (2005) study by including 50 journals to enhance the reliability of the results. They identified the role of journals as synthesizers and sources of knowledge in the network and generated richer categories than Nerur et al. (2005).

Culnan and Swanson (1986) examined the progress of IS as a discipline by examining citation data. They looked into the relationship between IS and its reference disciplines by defining "work point" and "reference point". The work point for a paper refers to the discipline of the journal in which it appears. The reference point for a paper refers to the distribution of the paper's bibliographical references to journals at the same and other work points. Cheon et al. (1992) expanded this study by extending the periods covered and the number of journals. Their results indicate that, though less mature than its reference disciplines, IS has exerted more influence over time and that other disciplines have begun to recognize IS as a distinct work point. Later, Grover et al. (2006) expanded Cheon et al. (1992) further and found that IS showed a distinct trend toward a cumulative tradition. They also found positive indications regarding the IS discipline's contribution to other disciplines.

2.3 Methods for Journal Quality

To study journal quality, researchers have typically used two approaches: expert opinion and scientometric approaches (Ferratt, Gorman, Kanet, & Salisbury, 2007; Katerattanakul & Han, 2003). Expert opinion, a subjective approach, employs surveys of key informants to attain the opinions of IS researchers or practitioners about a journal's quality. The criteria usually include value, quality, prestige, relevance, innovativeness, or impact on research and practice (Holsapple & Luo, 2003; Peffers & Ya, 2003). However, this approach has received much criticism (Peffers & Ya, 2003) because it depends overly on the survey's quality. Therefore, this approach suffers from informants' restricted knowledge and information about the journals, self-serving biases, and incompetency to process excessively large basket of journals.

Objective approaches for ranking journal quality usually use citations, including impact factor, h-index, and its derivatives (Egghe, 2008; Sidiropoulos, Katsaros, & Manolopoulos, 2007), which one can calculate via resources such as Google Scholar (Cheon et al., 1992; Culnan & Swanson, 1986; Grover et al., 2006; Polites & Watson, 2009). Nevertheless, objective approaches also have drawbacks. For example, the prominently used journal impact factor (JIF) only measures a journal's influence based on papers that have been published in the last two years, and it typically measures the influence of the average paper in a journal rather than a journal's overall influence. Further, impact factor uses only the raw number of citations that one journal has sent to another without considering the total number of citations of the citing journal. Consequently, the same number of citations sent from two journals to a third journal does not necessarily mean that they rely equally on that journal. Lastly, self-citations can bias impact factors as well.

2.4 Integrating Subarea Analysis and Journal Quality

In this study, we integrate journal quality and subarea analysis. In order to determine journal quality, we need to assess its influence in a subarea. Here, we use a different objective method: the index of structural influence (Salancik, 1986). This method calculates the magnitude of journal influence in a bounded network more precisely than other approaches and, therefore, provides a richer portrait of the evolution of the IS discipline's influence. A measure of influence in social networks should possess three general requirements (Salancik, 1986).

1. One should judge influence in a network based on dependency based on the rationale that journal A's citing journal B represents journal A's depending on journal B's information. Thus, the extent to which other journals depend on a focal journal for its information should

determine the focal journal’s influence in a network. Therefore, journal A is more influential than journal B if journal B cites journal A more than journal A cites journal B.

2. One should allocate dependencies with different weights. More specifically, journal A's influence in a network relies on the influence of the members that depend on it. The more influential those members are, the more influential journal A is. In other words, a citation from a journal of higher influence should have larger weight than a citation from a less influential journal.
3. Besides direct dependency mentioned above, one should consider indirect dependencies when calculating influence. To be specific, if journal B completely mediates journal C’s influence on journal A (i.e., C does not influence A directly), one should account for journal C’s indirect influence.

Table 1 describes the superiority of the index of structural influence (ISI) over impact factor and surveys.

Table 1. Comparisons between ISI, Impact Factor, and Surveys

	ISI	**Impact factor**	**Surveys**
Nature	Objective	Objective	Subjective
Method	Citation	Citation	Surveys
Time range of citations	All previous years	Previous two years	N/A
Range of influence	Overall influence of a journal	Influence of average article in a journal	Overall influence of a journal
Type of data	Percentage of citations sent to one journal over citations sent to all other journals	Raw number of citations	NA
Give weights to the citations according to the influence of the citing journals	Yes	No	No
Consider indirect effects of citations	Yes	No	No
Range of journals	Small network of journals in the area	All journals	Small network of journals in the area
Use self-citations	No	Yes	N/A

We should note the similarity between the index of structural influence that we describe above and social network analysis (SNA). SNA techniques focus on discovering patterns of interaction relationships between social actors in social networks (Xu & Chen, 2005). They do so by showing the overall network structure and that of subgroups in the network. Subsequently, they examine the patterns of interaction among these various groups. SNA also allows the researcher to identify central, prestigious, or otherwise influential networks and subgroup members (Polites & Watson, 2009). Among the measures of SNA, the Bonacich power index is most similar to the index of structural influence (Bonacich, 1987). The Bonacich power index measures a node’s power in a network based on the other nodes’ power that are connected to the node (Bonacich, 1987). Despite their similar basic principle, the two methods actually serve different research purposes. SNA mainly provides diagrams that show the relationships among journals and discover subareas, while the index of structural influence provides more precise figures about a journal’s overall influence and influence in subareas. Hence, the index of structural influence can better address our research questions.

3 Methodology

3.1 Journal Sample

Given our research questions, we need to distinguish between “pure” IS journals and those that belong to reference disciplines but are “receptive” to IS work. We included a total of 42 IS and IS-related journals in the citation analysis. We selected our journals mainly based on a summary of prior studies on journal ranking accessible from the AIS website, which includes nine studies from 1995 to 2005, and the average score of each journal’s ranking. We selected the top 60 journals based on the average ranking score. We eliminated the journals included in less than two studies and those journals not in the journal citation reports from SSCI and SCI. Since the AIS website listed ranking studies published only before 2005, we turned to several more recent studies (Holsapple, 2009; Takeda & Cuellar, 2008) to obtain the 42 journals.

We collected citation exchanges between the 42 journals for the 1999- 2014 period. To avoid unstable citation patterns due to short-term fluctuations, we collected data and summed it across two years longitudinally over four periods (1999-2000, 2004-2005, 2009-2010, 2013-2014). We obtained our data from the journal citation reports of SSCI and SCI. In all, we obtained citation counts of 35 journals for 1999-2000, 40 journals for 2004-2005, 42 journals for 2009-2010, and 42 journals for 2013-1014[1].

3.2 Definition of Journal Membership

We adopted the “work point” and “reference point” concepts (Culnan & Swanson, 1986) to define journal membership. However, in their paper and succeeding papers (Grover et al., 2006), these papers selected only two or three journals to represent each work point so they do not cover all the journals’ affiliation with each work point. In contrast, in our research, we included a larger basket of journals. In order to justify how we classified journal membership, we referred to four previous studies (Peffers & Ya, 2003; Polites & Watson, 2009; Rainer & Miller, 2005; Walstrom & Hardgrave, 2001), and our journal clustering is based on mutual citation patterns. We posit that journals tend to cite the journals from the same discipline than those from other disciplines, so the journals from the same discipline should cluster more tightly. After conducting journal clustering, we consolidated our results with prior journal classifications to obtain a more accurate representation of journal membership (see Table A1 for the complete journal list and Table A2 for the classification of journal membership).

3.3 Verifying Stability by Subarea Analysis

Using the journal-clustering technique, we analyzed subareas via several indicators (i.e., independence of IS subarea, temporal sustainability, and how emerging newer IS journals tend to cluster) to investigate the evolution and stability of IS as a discipline.

We examined the first indicator (i.e., independence of IS subarea) by analyzing whether IS forms a separated subarea from other areas such as management, operations research, and computer science, which have historically significantly impacted IS). In other words, our first indicator concerns whether IS journals tend to converge together and separate themselves from journals in other areas. Researchers have questioned the IS discipline for relying too much on reference disciplines and its resultant blurring boundaries with those disciplines (Grover et al., 2008). Therefore, the first indicator assesses whether our discipline has made sufficient progress in establishing a stable intellectual core distinct from other academic areas (Albert & Whetten, 1985); (Sidorova, Evangelopoulos, Valacich, & Ramakrishnan, 2008

We examined the second indicator (i.e., temporal sustainability) by examining the trends over a decade from an early period (1999-2000) to a late period (2013-2014) [2] to verify whether core IS journals were still active in their own sphere without migrating to journals clusters in other disciplines.

We examined the third indicator (i.e., how emerging, newer IS journals tend to cluster) by examining whether clustered with more established (core) IS journals, which would indicated that they built on this established knowledge repository instead of non-IS journals.

In order to verify the three indicators, we conducted subarea analysis over a long time span based on citation flows between 33 journals for the 1999-2000 period and 41 journals for the 2013-2014 period. We used multidimensional scaling (Eagly & Chaiken, 1975) and log-linear analysis (Stigler et al., 1995) to deal with the journal cohesion problem. However, multidimensional scaling suffers the disadvantage that one has to symmetrize the non-symmetric citation matrix in advance. The disadvantage of log-linear is that one needs to set parameters for each possible pair of journals in the sample. The log-multiplicative model (Clogg, 1982; Clogg & Shihadeh, 1994; Goodman, 1979) combines the strengths of multidimensional scaling and log-linear analysis and does not have their disadvantages; thus, we used it in this study.

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[1] Discrepancy in the number of journals arose due to the unavailability of data for the periods in which the journals did not exist.
[2] Note that, while we collected data for four periods, we used the 1999-2000 and 2013-2014 periods to examine stability. The time from 1999-2014 is a substantive period in the history of the IS discipline that included established and emerging IS journals. Thus, we believe the comparison between the 1999-2010 period and 2013-2014 period can provide compelling evidence of stability because a longer time span has higher chance of capturing variation between periods.

To examine journal cohesion, we estimated the model in Equation 1, which we explain in Appendix B. We used LEM software (Vermunt, 1997) to estimate log-multiplicative models to obtain association parameters of each dimension according to citing and cited data between journals in the network (Pieters & Baumgartner, 2002). We selected the Bayesian information criteria (BIC) to finalize the most appropriate number of dimensions (Raftery, 1986). The lower value calculated by BIC, the better fit obtained. Therefore, we estimated a symmetric log-linear model (Stigler et al., 1995) as a benchmark for both two-year periods.

3.4 Structural Influence as an Alternative to Journal Influence

We used the structural influence measure that Salancik (1986) proposes to evaluate journal influence, and Equation 1 embodies the three requirements we discuss in Section 3.3:

$$\begin{bmatrix} Influence_A \\ Influence_B \\ Influence_C \end{bmatrix} = \begin{bmatrix} 0 & Dependence_{AB} & Dependence_{AC} \\ Dependence_{BA} & 0 & Dependence_{BC} \\ Dependence_{CA} & Dependence_{CB} & 0 \end{bmatrix} \times \begin{bmatrix} Influence_A \\ Influence_B \\ Influence_C \end{bmatrix} + \begin{bmatrix} Intrinsic_A \\ Intrinsic_B \\ Intrinsic_C \end{bmatrix} \quad (1)$$

In the equation, the influence of journal A ($Influence_A$) is the sum of dependencies of all the other journals in the network ($Dependence_{AB}$ and $Dependence_{AC}$) on journal A and the intrinsic influence of journal A ($Intrinsic_A$). The dependency of journal B and journal C on journal A are weighted by their own influence.

Note that, when we calculate the journal influence, we measure the dependency of journal B on journal A by ratio (citations sent from journal B to journal A divided by the total citations from journal B) instead of absolute citation count.

We can also transform Equation 1 into a simpler version as below:

$$Influence = [I - D]^{-1} Intrinsic, \quad (2)$$

where I is an N×N identity matrix and D is an N×N dependency matrix.

We refer to the overall journal network as the IS-receptive network, which includes both pure IS journals and non-IS journals that are also receptive to IS work. The index of structural influence measures the influence of a journal not only in an IS-receptive network but also in subareas. As such, we could measure a journal's influence in the pure IS network and compare it with the one in the IS-receptive network. In general, we divided the IS-receptive network into non-overlapping subareas and then calculated the influence scores for each subarea with the equation:

$$Influence_{sub} = [I - D]^{-1} DM, \quad (3)$$

where $Influence_{sub}$ is an N×K matrix of subarea influence. N is the number of journals, while K is the number of subareas. Each score represents a certain journal's influence in a certain subarea. D is an N×N dependency matrix. M is an N×K matrix of zero and ones, and each score represents the membership of a certain journal in a certain subarea: 1 means the journal is classified in that area, while 0 means the journal is not in that area (e.g., if *MIS Quarterly* is in the pure IS subarea, its score in the pure IS subarea should be 1).

We derived other metrics such as impact factors from citations from all the journals in SSCI or SCI. In this study, the citation network comprised42 IS-related journals, which meant we could focus our analysis on the influence in an IS-receptive network and a pure IS network.

3.5 Inflation of Influence

Despite their advantages over impact factors, both SNA and the index of structural influence have a common drawback: the possibility of overestimating the influence of non-IS journals. If we consider any journal pool receptive to IS papers, it will include journals that exclusively publish IS papers and journals that reflect another discipline but are open to publishing IS papers (e.g., *Communication of the ACM* (*CACM*)*, Management Science* (*MS*)*, and Academy of Management Journal* (*AMJ*)). We need to include these journals because they are normally regarded as good IS outlets even if they belong to other disciplines or are interdisciplinary. However, after including non-IS journals, journals with a high score of centrality in SNA or a high score in index of structural influence analysis are not necessarily the most influential journals in the IS discipline because the mutual citation between the non-IS journals in a certain area (e.g., management) are also incorporated into the calculation of their ranking. In other words, the more non-IS journals from the same area we include, the greater the extent to which they inflate each other. Therefore, one can make conclusions regarding influence only for the complete network of journals rather than the IS discipline. The Bonacich power index and index of structural influence both discriminate between citations received from more popular journals versus less popular journals. The popularity is based on degree score of each journal (Polites & Watson, 2009), which means the more influential the non-IS journals are, the more they inflate each other.

Therefore, a dilemma arises because, on the one hand, we need to include non-IS journals in the ranking; on the other hand, journals from the same area tend to inflate each other, which causes one to overestimate their rankings. In this study, we propose one way to address this problem: to adopt the subarea equation (Equation 3 above) to calculate a journal's influence in a certain subarea. In this case, the subarea is “pure” IS journals. The equation considers only citations by pure IS journals and excludes citations by non-IS journals. In this way, the calculation does not include mutual citation between non-IS journals, and the ranking reflects the true influence of journals in the IS network.

In sum, we calculate journal influence in both the IS-receptive and pure IS networks and compare the two ranking results. In this way, we address the inflation problem and show the real evolution of IS research influence over the years.

4 Data Analysis

4.1 Stability in IS Discipline Based on Subarea Analysis

We conducted subarea analyses for two periods. To summarize the cohesive relationships, we conducted a hierarchical agglomerative clustering procedure and analyzed its results using Ward’s method on the journals’ scores (Ward, 1963). For the 1990-2000 period, we selected the five-dimension solution (BIC value of -5802.0368), which achieved a better fit compared to the other four dimensions. Likewise, for the 2013-2014 period, we selected the six-dimension solution (BIC value -9270.5951). We selected these solutions based on interpretability compared to higher dimensions, which signaled the iterative process of pursuing better fit could stop.

Appendix C summarizes these analyses. Tables C1 (1999-2000) and C2 (2013-2014) present scores of journal cohesion for the two periods. Figures C1 and C2 illustrate the clustering using a hierarchical tree for the two periods. For instance, Figure C1 lists all 33 journals along the left axis in abbreviations in the tree, and all the journals form a single cluster on the right side of the tree. From left to right, journals form gradually magnifying clusters based on the degree of cohesion in that cluster of journals. Smaller clusters (i.e., the clusters on the left side) share more citations and common interests than larger clusters on the right side, and, hence, we can identify possible subareas by observing how journals cluster.

Table 2 describes each subarea’s name and its members in two periods of time. Figure 1 indicates more clearly the subareas identified in the two periods and the changes over time. The left part shows the subareas in the 1999-2000 period, and the right part shows the subareas in the 2013-2014 period. Each cycle represents a subarea, and arrows exhibit the movement of the journals that transferred from one subarea to another over more than a decade. Some journals were isolated without being classified to any cluster such as *Harvard Business Review* (*HBR*)*, Journal of the ACM* (*JACM*), and *MIT Sloan Management Review* (*MIT*) due to the fact that they shared few citations with other journals in the network. It is especially noteworthy that *HBR* did not cite any journals in our network. We display isolated journals in the last row of Table 2.

Subarea I (see Figure 1) comprised the core IS journals, and the permanent members of this group, shared by both periods, were some leading journals in the IS discipline: *MIS Quarterly* (*MISQ*)*, European Journal of Information Systems* (*EJIS*)*, Information Systems Research* (*ISR*)*, Journal of Management Information System* (*JMIS*)*, Journal of Computer Information Systems* (*JCIS*)*, Journal of Strategic Information Systems* (*JSIS*)*, Decision Support Systems* (*DSS*)*, Information Systems Management* (*ISM*), and *Information and Management* (*IMA*). In the late period, the emerging journals *Journal of the Association for Information Systems* (*JAIS*) and *Information Systems Journal* (*ISJ*) that focus on theory and practice related to information technology and management of information resources aggregated with those prominent IS journals in subarea I. Further, hybrid journals such as *Omega, Decision Science* (*DS*), *and Communications of the ACM* (*CACM*) migrated from subarea 1 to other subareas.

Table 2. Subareas and Its Members in Two Periods

Subarea number	Subarea name	Members in 1999-2000	Members in 2013-2014
1	Core IS	*European Journal of Information Systems*, *Information Systems Management*, MIS Quarterly, *Information Systems Research*, *Journal of Strategic Information Systems*, *Information and Management*, *Journal of Computer Information Systems*, *Journal of Management Information System*, *Decision Support Systems*, *Decision Science*, *Omega International Journal of Management Science*, *Communications of the ACM*	*European Journal of Information Systems*, *Information Systems Management*, MIS Quarterly, *Information Systems Research*, *Journal of Strategic Information Systems* ST, *Information and Management*, *Journal of Computer Information Systems*, *Journal of Management Information System*, *Decision Support Systems*, *Information Systems Journal*, *Journal of the Association for Information Systems*
2	Management	*Academy of Management Review*, *Academy of Management Journal*, *Administrative Science Quarterly*, *Organization Science*,	*Academy of Management Review*, *Academy of Management Journal*, *Administrative Science Quarterly*, *Organization Science*, *Decision Science*, *Management Science*, *Interfaces*
3	Operations research	*Operations Research, Computers and Operations Research, Interfaces, Management Science*	*Operations Research, Computers and Operations Research, Omega International Journal of Management Science, Informs Journal on Computing*
4	E-commerce	NA	*International Journal of Electronic Commerce, Journal 0f Organizational Computing and Electronic Commerce*
5	Data engineering	*Information Systems, ACM Transactions on Database Systems, IEEE Transactions on Knowledge and Data Engineering*	*ACM Computing Surveys, Information Systems, IEEE Transactions on Knowledge and Data Engineering*
6	Software engineering	*Journal of Systems and Software, IEEE Transactions on Software Engineering*	*Journal of Database Management, Journal of Systems and Software, IEEE Transactions on Software Engineering*
7	Computational intelligence	*Expert Systems with Applications, Knowledge Based Systems*	*Expert Systems with Applications, Knowledge Based Systems*
8	Computer concepts	*Journal of the ACM, ACM Computing Surveys, ACM Transactions on Information Systems*	*International Journal of Human Computer Studies, IBM Systems Journal, Journal of the American Society for Information Science and Technology, ACM Transactions on Information Systems, ACM Transactions on Database Systems*
9	Practitioner oriented	*Computer, IBM Systems Journal*	*Communications of the ACM, Computer, Journal Of The ACM*
10	Isolated	*Harvard Business Review*	*MIT Sloan Management Review*

Subarea 2 comprised management journals: *Academy of Management Journal (AMJ*), *Academy of Management Review* (*AMR*)*, Organization Science* (*OS*), *and Administrative Science Quarterly* (*ASQ*). Interestingly, in 2013-2014, *Management Science (MS*) and *Interfaces* moved to the management area (subarea 2) from the operations research area (subarea 3) and *Decision Science* (*DS*) moved to the core IS area. *MS, Interfaces,* and *DS* all have a comparatively wide range of missions*. MS* and *Interfaces* publish manuscripts that focus on the practice of operations research and management science. *DS* covers research associated with decision making in organizations. This migration suggests that these journals broadened their emphasis to more diverse management research than specifically the operations research/IS type problems.

Subarea 3 comprised operation research journals. In the two periods, *Computers and Operations Research* (*COR*) and *Operations Research* (*OR*) were consistent members of this area. As a newer journal, *INFORMS Journal on Computing* (*ITC*)*,* which publishes papers at the intersection of operation research and computer science, appeared in the operations research area in the late period. *Omega* (*OIJM*) relocated from the core IS area (subarea 1) to the operations research area as well.

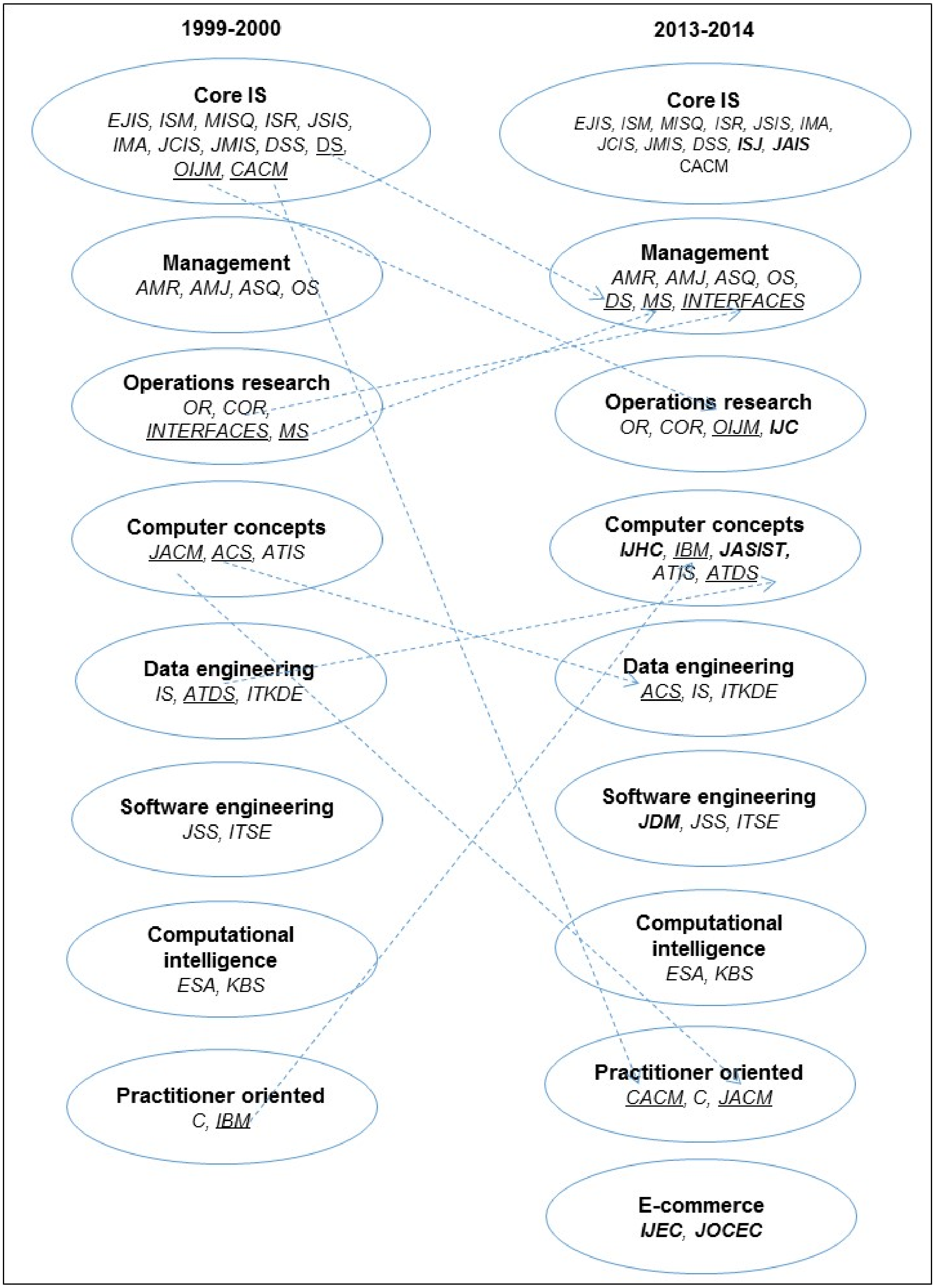

Figure 1. Changes in the Subareas from 1999-2000 to 2013-2014[3]

With the emergence and popularity of electronic commerce, *Journal of Organizational Computing and Electronic Commerce* (*JOCEC*) and *International Journal of Electronic Commerce* (*IJEC*) launched their issues after the 1999-2000 period. We examined these journals in the late period subarea analysis, and

[3] Underlined journals changed from one area to another one, while bold journals showed up in that area after the 1999-2000 period.

they made up the e-commerce subarea (subarea 4). Subarea 5 comprised the computational intelligence journals: *Knowledge-Based Systems* (*KBS*) and *Expert Systems with Applications* (*ESA*).

Subarea 6 comprised the computer concepts journals: *ACM Computing Surveys* (*ACS*), *Journal of the ACM* (*JACM*), and *ACM Transactions on Information Systems* (*ATIS*). *JACM* largely focuses on principles of computer science, and both *ACS* and *ATIS* heavily cited it in the 1999-2000 period. However, the two journals reduced citations to it during 2013-2014 and, hence, *JACM* left this subarea. This subarea collapsed in the 2013-2014 period, and some emerging IS and hybrid journals clustered with *ATIS* to form an information processing-oriented area. These journals included: *Journal of the American Society for Information Science and Technology* (*JASIST*), *ATIS*, *International Journal of Human-Computer Studies* (*ITHC), IBM Systems Journal* (*IBM*), and *ACM Transactions on Database Systems* (*ATDS*).

Subareas 7, 8, and 9 comprised computer science journals. Specifically, subarea 7 represented software engineering and had two stable journals: *IEEE Transactions on Software Engineering* (*ITSE*) and *Journal of Systems and Software* (*JSS*). However, in 2013-2014, *Journal of Database Management* (*JDM*) migrated to this subarea from the core IS area (subarea 1), which suggests that *JDM* might have shifted its attention to topics related to software engineering over general information system topics. Subarea 8 represented practitioner-oriented computer science journals and included *IEEE Computer* (*C*) and *IBM Systems* in 1999-2000. In the late period, *CACM,* which was in subarea 1 with pure IS journals, moved to subarea 8; this movement reflects its change from a general journal to one that deals with practitioner issues specific to computer science. *Journal of the ACM* (*JACM*) did not belong to any subarea in 1999-2000 but, due to its broad focus on principles of computer science, clustered with the journals in practitioner issues area. Subarea 9 represented the data engineering area and included *IEEE Transactions on Knowledge and Data Engineering* (*ITKDE*) and *Information Systems* (*IS*). *ACM Transactions on Database Systems* (*ATDS*), which focuses on data management issues, moved out of this group, and *ACS,* which publishes surveys from all areas of computing research, transferred from computer concepts to data engineering in 2013-2014.

4.2 Ranking of Journal Influence in the IS-receptive Network

In this section, we compute influence of journals in the (overall) IS-receptive network[4] and the pure IS network. Table 3 reports the total influence of journals in four periods via journal influence shares and ranking. To calculate the journal influence share, we subtracted the intrinsic influence of each journal (which equals one) from the influence score of the journal (i.e., structural influence index) so that the influence share had a minimum value of zero. We divided the resulting scores by the sum of the influence scores across the journals' entire network and multiplied them by 100.

During the 1999-2000 period, the most influential journal in the network was *Communication of the ACM*, whose influence share accounted for 13.48 percent in the IS-receptive network, followed by *MIS Quarterly* (#2) and *Management Science* (#3). During the 2004-2005 period, *Communication of the ACM, MIS Quarterly and Management Science* were still the top three journals in the network with *Management Science* (MS) as the most influential journal (influence share of 12.21%) followed by *Communication of the ACM* (#2) and *MIS Quarterly* (#3). During the 2009-2010 period, *MIS Quarterly* became the most influential journal: it possessed 12.50 percent of the total influence in the network. *Management Science* and *Information Systems Research* ranked second and third, respectively. *CACM* fell out of the list of the top three journals[5]. During the 2013-2014 period, the influence of *MIS Quarterly* and *Information System Research* continued to increase, while the influence of *Management Science* slightly decreased. However, their rankings remained the same.

Figure 2 shows the changes in influence share for the top 12 journals. Intriguingly, during this 16-year period, many IS journals gained influence in the network, such as *ISR* and *JMIS*, while several practitioner-oriented journals lost their influence substantially, such as *CACM* and *HBR*. Meanwhile, journals that stemmed from the management area maintained their influence ranking, while some journals in the operations research area dropped. Note that no computer science journal was among the top 12 journals during the 2013-2014 period.

[4] The network is the space represented by all the journals receptive to IS work and includes management, operations research, computer science, and so on.
[5] CACM went through several changes regarding its editorial policies and adopted a more pragmatic stance in the mid-1990s, which could have influenced this result.

Table 3. Journal Ranking and Share (%) in the IS-receptive Network

	1999-2000		2004-2005		2009-2010		2013-2014	
	Share	**Ranking**	**Share**	**Ranking**	**Share**	**Ranking**	**Share**	**Ranking**
MISQ	11.59	2	9.33	3	12.5	1	12.97	1
MS	11.08	3	12.21	1	11.89	2	11.14	2
ISR	2.39	12	3.87	11	7.34	3	7.57	3
OS	2.24	14	5.5	8	5.85	8	6.89	4
AMJ	5.65	6	5.95	5	6.06	6	6.26	5
AMR	5.37	8	5.84	6	5.94	7	6.05	6
ASQ	5.79	5	6.99	4	6.12	5	5.40	7
CACM	13.48	1	9.94	2	6.64	4	4.83	8
JMIS	0.03	35	4.42	9	5.62	9	4.50	9
OR	4.56	9	4.01	10	2.93	12	3.27	10
HBR	5.64	7	5.65	7	3.81	10	3.10	11
IMA	2.29	13	2.8	13	2.98	11	2.70	12
DSS	0.97	24	1.74	15	1.93	13	2.49	13
EJIS	0.62	25	0.95	19	1.4	16	2.03	14
JAIS	--	--	--	--	1.07	18	1.77	15
ITKDE	1.31	18	1.29	17	1.32	17	1.50	16
ESA	0.36	30	0.25	36	0.71	26	1.44	17
DS	3.11	11	2.15	14	1.6	14	1.38	18
COR	0.53	28	0.66	30	0.92	20	1.23	19
ITSE	4.04	10	1.48	16	1.43	15	1.08	20
JSIS	0.55	27	0.7	29	0.73	25	0.96	21
ISJ	0.35	31	0.3	33	0.78	24	0.94	22
JASIST	--	--	0.85	23	0.82	22	0.93	23
ACS	0.97	23	0.78	25	0.64	28	0.84	24
IJEC	--	--	0.79	24	0.96	19	0.83	25
OIJM	1.02	21	0.86	22	0.64	29	0.82	26
C	1.6	16	1.15	18	0.69	27	0.76	27
JACM	1.03	20	0.94	20	0.89	21	0.69	28
JSS	0.6	26	0.46	32	0.61	32	0.68	29
IJHC	0.47	29	0.62	31	0.64	30	0.66	30
MIT	--	--	0.23	37	0.43	36	0.64	31
ATDS	1.73	15	0.91	21	0.79	23	0.53	32
ATIS	1.43	17	0.74	27	0.44	35	0.50	33
IS	6.42	4	3.29	12	0.44	34	0.47	34
IJC	--	--	0.26	35	0.3	38	0.45	35
IBM	1.02	22	0.72	28	0.64	31	0.38	36
Interfaces	1.24	19	0.77	26	0.41	37	0.31	37
ISM	0.2 5	32	0.28	34	0.45	33	0.31	38
JCIS	0.04	34	0.03	40	0.29	39	0.30	39
KBS	0.23	33	0.15	39	0.1	41	0.19	40
JDM	--	--	--	--	0.18	40	0.13	41

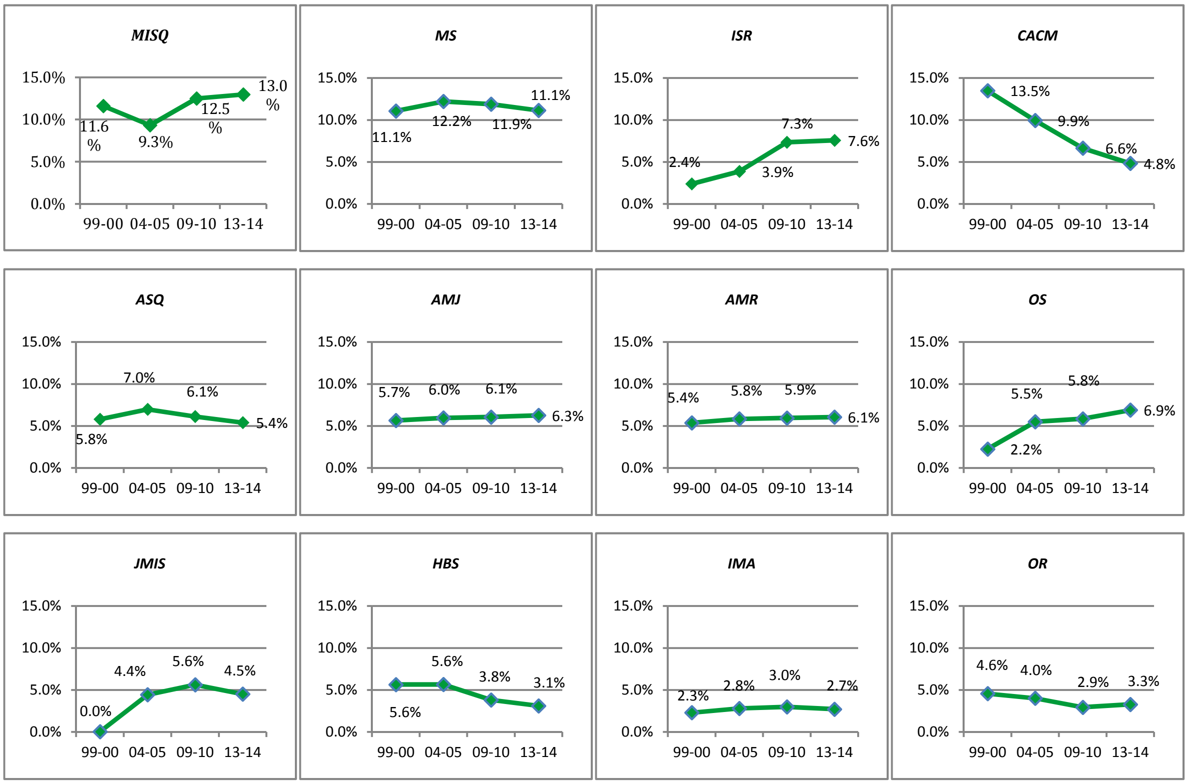

Figure 2. Influence Shares (%) of Top 12 Journals for the Four Periods

4.3 Journal Influence in the Pure IS Network

To calculate journal influence in the pure IS network, we needed to clearly define journal membership in pure IS and other disciplines (i.e., management and operation research). Rather than relying purely on clustering results, we leveraged journal categories identified in four previous studies (Peffers & Ya, 2003; Polites & Watson, 2009; Rainer & Miller, 2005; Walstrom & Hardgrave, 2001) and used a simple heuristic to determine the membership in each network:

1. If our clustering classified a certain journal into one area but none of the four previous studies did, then we removed it from that area. For example, our clustering analysis classified *Decision Science* as an IS journal, but all four studies did not classify it as IS journal. Hence, we removed it from the core IS area.
2. If the above four studies all classified a certain journal into the same area but our clustering results did not, then we followed those studies and added it into that area. For example, *Journal of the Association for Information Science and Technology* did not fall into the core IS area in our clustering analysis. However, both Peffers and Ya (2003) and Polites and Watson (2009) classified it into this IS area (the other two studies did not have it in their sample). Hence, we followed them and added it to the core IS area.
3. If we found any discrepancy in journal categories across these four studies, we examined the journal to justify and revise our classification.

Table A2 shows the journal memberships before and after integration. We calculated influence based on the journal memberships after integration. Some journals did not fall into any category either because we did not have the citation data for that period or because the journal did not belong to any of the following categories: pure IS, management, and operation research.

Next, we calculated journal influence in the pure IS network for comparison. Based on our journal classification above, we included citations only among pure IS journals to calculate the influence in that area (explicated in Equation 3). Table 4 shows the result of journal influence ranking and shares in the pure IS network during two periods (1999-2000 and 2013-2014). Compared to the journal influence in the IS-receptive network earlier, several conclusions stand out (see Table 5).

1. Pure IS journals' influence increased in both the IS-receptive and pure IS networks, but their influence was much larger in the pure IS network than in the IS-receptive network. More specifically, in the IS-receptive network, the total influence share of pure IS journals increased from 25.50 to 38.07 percent, while, in the pure IS network, the total influence share of pure IS journals increased from 41.52 to 57.60 percent. In addition, we note that, 16 years ago, management and operations research journals were more influential than most of the IS journals in the pure IS network, but, in 2014, IS journals gained the dominant positions in this network.
2. Management journals' influence exhibited insignificant but still noticeable changes. Overall, their influence increased in the IS-receptive network by 4 percent but decreased slightly by 1.57 percent in the pure IS network, while the operations research journals' influence dropped in both networks (2.55% in the pure IS network and only 0.34% in IS-receptive network).
3. With regard to the individual influence of management and operations research journals, however, most increased in the IS-receptive network but decreased in the pure IS network. More specifically, *Management Science*, *Organization Science*, *Academy of Management Review*, *Academy of Management Journal*, and *Administrative Science Quarterly* all increased in influence in the IS-receptive network. In contrast, in the pure IS network, the influence of all those journals dropped off (with the exception of *Organization Science*).

Table 4. Journal Ranking and Share in the Pure IS Network

	1999-2000		2013-2014	
	Share (%)	**Ranking**	**Share (%)**	**Ranking**
MISQ	19.67	1	21.11	1
ISR	3.78	9	11.11	2
MS	9.15	4	7.72	3
JMIS	0.00	35	6.36	4
OS	2.36	12	6.03	5
CACM	13.51	2	5.28	6
AMR	4.47	6	4.44	7
IMA	3.45	11	4.11	8
AMJ	4.15	7	3.35	9
EJIS	1.15	17	3.34	10
DSS	1.02	20	2.90	11
JAIS	--	--	2.77	12
ASQ	3.60	10	2.53	13
HBR	6.41	5	2.29	14
DS	3.97	8	1.85	15
ISJ	0.53	23	1.55	16
JSIS	1.10	19	1.37	17
ITKDE	0.81	21	1.12	18
IJEC	--	--	1.02	19
IJHC	0.23	30	0.82	20
ITSE	1.76	13	0.79	21
JASIST	--	--	0.73	22
ESA	0.32	28	0.72	23
JSS	0.49	26	0.68	24
OIJM	1.32	15	0.64	25
MIT	--	--	0.61	26
ACS	0.42	27	0.54	27

Table 4. Journal Ranking and Share in the Pure IS Network

ISM	0.51	25	0.52	28
ATDS	1.28	16	0.51	29
IS	10.26	3	0.50	30
ATIS	1.15	18	0.48	31
JCIS	0.06	34	0.48	32
IBM	1.32	14	0.40	33
C	0.53	24	0.40	34
JDM	--	--	0.21	35
OR	0.29	29	0.18	36
JOSCEC	--	--	0.14	37
JACM	0.14	31	0.11	38
COR	0.10	32	0.11	39
KBS	0.10	33	0.08	40
Interfaces	0.61	22	0.08	41
IJC	--	--	0.02	42

Table 5. Total Influence Share of Pure IS and Non-IS Journals

	1999-2000			**2013-2014**		
	Pure IS	Management	Operations research	Pure IS	Management	Operations research
IS-receptive network	25.50%	24.69%	16.17%	38.07%	28.34%	15.64%
Pure IS network	41.52%	20.99%	9.54%	57.60%	19.24%	8.01%

5 Discussion

In this paper, we take a unique approach to the IS discipline's impact on itself and its reference disciplines by examining journals and subareas associated with IS. While most introspective studies that have evaluated journal quality and subareas have simply adopted different journal pools, we used the "objective" notion of journal influence based on how journals relatively depend on each other through citation data. We analyzed networks of "pure" and "receptive" IS journals to examine cohesion (journal clusters) and their stability over time. Unlike most prior studies that have examined a single point in time, we examined discrete periods to effectively benchmark trends in the discipline. Based on the analyses, we draw certain conclusions regarding research in the IS discipline that complements current discourse regarding reference disciplines and cumulative tradition.

In the IS discipline's formative years (prior to the periods we studied), the discipline encompassed researchers from a diversity of areas including operations research and computer science. We suspect that a similar study conducted in the 1970s and 80s might have not clearly identified a pure IS subarea. In our study, we found that pure IS journals did form a cohesive subarea in our first period (1999-2000) separate from the operations research, management, or computer science areas. However, the pure IS journals still clustered with hybrid IS journals such as *CACM* and *OMEGA* (e.g., *CACM* mainly serves a computer science constituency with a relatively small portion of IS papers). The frequent citations from IS to those journals (e.g., *CACM*) caused them to cluster together.

More importantly, core members of the IS subarea (e.g., *MISQ, EJIS, ISR, JMIS, JSIS, IMA* and *JCIS)* remained relatively stable over time. In contrast, the hybrid journals (i.e., *CACM, Omega,* and *DS*) that used to tightly associate with IS journals decoupled from them in the 2013-2014 period. Our findings indicates that IS journals cited these journals much less in this period than they did before, which further signals that IS journals can provide references to papers in their own area and exclude other disciplines (e.g., computer science or management) from its own network. This result could indicate an evolution toward a relatively independent knowledge system that depends less on these associated disciplines.

Takeaway: Pure IS journals maintained their stability over time and reduced their tight association with some traditional reference disciplines over time.

Our analyses also indicated an expanding pool of IS journals in the cluster during the later years. Some emerging journals—*JAIS* and *ISJ*—aggregated with the IS cluster. This result indicates that the knowledge produced by emerging IS journals is proximal to knowledge in the IS discipline that has continuously produced. The newcomers have embraced the concepts in the sphere of IS journals and expanded this area and, thus, grown the knowledge base. The fact that these journals aggregated with the IS cluster instead of other clusters demonstrates the IS discipline's ability to attract new IS journals through homogeneity of knowledge over hybrid journals that are receptive to IS work.

Takeaway: The IS discipline has embraced newer pure IS journals over IS-receptive journals as part of an expanding knowledge cluster over time.

Our results suggest not only that the IS discipline has a stable and cohesive body of knowledge but also that its influence in both the local network and a broader network has increased. The broader network comprises journals that stem from IS discipline and other disciplines that are closely associated with IS (such as management, operation research, and computer science). Results from the clustering analysis indicate that IS has formed a stable and cohesive network with a cumulative tradition in the cluster. However, merely maintaining cumulative tradition cannot guarantee the IS discipline's prosperity. Given the IS discipline's nature, its knowledge network interweaves pure IS journals, hybrid journals, and non-IS journals. If the knowledge base of pure IS journals in the network stagnates or erodes due to journals' "taking up the slack" of IS-related topics, the discipline will not progress well. However, our results suggest that the influence of our core journals not only increased in the local network but also in the more global network, which signals a positive trend for the discipline.

Takeaway: The influence of knowledge from pure IS journals grew not only in the local IS network but also in the broader network of IS-receptive journals, which indicates that these pure IS journals transferred knowledge from the IS discipline to other disciplines.

In addition to increasing reliance on its own body of knowledge, the IS discipline's decreasing reliance on reference discipline journals could be a positive sign (Niederman et al., 2009). Grover et al. (2006) report that the sources that our discipline draws from have changed: while the discipline originally drew on techno-centric oriented sources (i.e., CS was a major reference discipline), it has since taken a more balanced socio-technical focus. Our study corroborates this finding. While we did not examine a broad repertoire of associated disciplines, our results suggest that the influence of the operation research discipline, one of the important and original reference disciplines for IS, noticeably decreased in both the IS-receptive and pure IS networks. This finding arguably reflects the discipline's changing focus toward the socio-technical. The management discipline's decreasing influence in the pure IS network is curious. It still has substantial influence, but it has decreased over time in both networks (though particularly in the pure IS network). This result could indicate the IS discipline's reduced dependence on management and/or its ability to contribute knowledge back to the management discipline. *Organizational Science* (*OS*), as a management journal, stands out for its increased impact on the IS network. *Management Science* (*MS*), the journal that used to have predominant influence in IS, experienced decreased impact in the pure IS network. We presume this finding reflects the inclination of IS research to draw more on operations research due to the increasing embeddedness of technologies in organizations (Grover, 2012) and less on multidisciplinary studies in MS.

Takeaway: The operations research and management subareas have decreasingly influenced IS over the years, which reflects the evolution of the IS discipline's nature.

Finally, our research illustrates the use of the index of structural influence in journal networks. By assessing the overall influence and subarea influence, we could obtain richer insight into an academic discipline's influence, which one cannot easily obtain with alternative measures. Furthermore, one of the dilemmas that institutions face in evaluating journal quality is how to treat journals that do not fall in disciplinary boundaries. One side of the coin is that, if disparate outlets are included in the journal basket and studied, these studies will add noise that undermines the validity of the rankings (Lewis, Templeton, & Luo, 2007). Also, some claim that researchers who conduct studies that mix pure IS journals and non-IS journals together undermine their face validity because they do not account for the different missions of various journal types (Adler & Bartholomew, 1992). Our study reveals that, when including other outlets that are not in the IS discipline but are receptive to IS work, high ranking scores are not necessarily commensurate with high influence. The structural influence index provides a flexible approach to assess the impact of journals and journal clusters in narrow and broader journal networks. We believe that this approach adds a unique contribution to prior studies.

6 Conclusion

We provide a rich portrait of the evolution of IS discipline based on the stability and cohesion concepts. By demarcating IS journals into those that are pure versus those that are associated with other disciplines but receptive to IS work, we examine the evolution of the IS discipline's sphere of influence. Our results indicate the IS discipline's stability and cohesion through its consistent ownership of an occupied area (cluster) has grown over time. Further, we found that the operations research and computer science journals separated from IS in the late period, which indicates that pure IS journals have increasingly independently sustained the IS knowledge product. This base also expanded with newer IS journals in the late period and not non-IS journals, which indicates a growing knowledge base. Importantly, pure IS journals substantially increased in influence in both the IS-receptive and pure IS networks. Overall, the results provide positive indication that the discipline has effectively exploited its own knowledge repository. Core IS journals have gradually gained dominance in their own network and even influenced the broader network.

We point out that, while the signs are encouraging, these metrics only provide a limited picture of the IS discipline. The journals we chose and the time period we considered limit our findings. These limitations notwithstanding, the increased influence of IS journals in the IS-receptive and pure IS networks indicate that the IS discipline has decreased its dependence on journals not central to it but provides no real indication of the type of knowledge being exchanged in these networks. We suspect that the IS discipline has increasingly drawn more from common theoretical frames in building its models given its increasing emphasis on theory, which might have contributed to our results. Several prominent voices might suggest that the discipline needs to carefully assess whether a cumulative tradition of building mid-level models is appropriate, whether the IS discipline should focus more on indigenous theory, and whether IS is really addressing important questions of our time. Further, in more recent years, several developments in social, cloud, mobile, and big data technologies have had a profound impact on practice. These pervasive, digital technologies are also affecting other research disciplines. As our research institutions and structures adapt, it would be very interesting to see how these knowledge dependence networks evolve in the future and whether IS can expand its sphere of influence into these networks.

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Appendix A: Journal Abbreviation and Membership

Table A1. Journals and their Abbreviations

Journal	Abbreviation
Academy of Management Journal	*AMJ*
Academy of Management Review	*AMR*
ACM Computing Surveys	*ACS*
ACM Transactions on Database Systems	*ATDS*
ACM Transactions on Information Systems	*ATIS*
Administrative Science Quarterly	*ASQ*
Communications of the ACM	*CACM*
Computers and Operations Research	*COR*
Decision Science	*DS*
Decision Support Systems	*DSS*
European Journals of Information Systems	*EJIS*
Expert Systems with Applications	*ESA*
Harvard Business Review	*HBS*
IBM Systems Journal	*IBM*
IEEE Computer	*C*
IEEE Transactions on Knowledge and Data Engineering	*ITKDE*
IEEE Transactions on Software Engineering	*ITSE*
Information Systems Management	*ISM*
Information Systems	*IS*
Information Systems Journal	*ISJ*
Information and Management	*IMA*
Information Systems Research	*ISR*
Informs Journal on Computing	*IJC*
International Journal of Human Computer Studies	*IJHC*
Interfaces (INFORMS)	*INTERFACES*
International Journal of Electronic Commerce	*IJEC*
Journal of Computer Information Systems	*JCIS*
Journal of Database Management	*JDM*
Journal of Management Information Systems	*JMIS*
Journal of Organizational Computing and Electronic Commerce	*JOCEC*
Journal of Strategic Information Systems	*JSIS*
Journal of the ACM	*JACM*
Journal of the Association for Information Systems	*JAIS*
Journal of the American Society for Information Science and Technology	*JASIST*
Journal of Systems and Software	*JSS*
Knowledge Based Systems	*KBS*
Management Science	*MS*
MIS Quarterly	*MISQ*
Omega International Journal of Management Science	*OIJM*
Operations Research	*OR*
Organization Science	*OS*
MIT Sloan Management Review	*MIT*

Table A2. Results of Journal Membership Classification

Journal	Walstrom & Hardgrave (2001)[a]	Peffers & Tang (2003)[b]	Rainer & Miller (2005)[c]	Polites & Watson (2009)[d]	This study[e]			
					99-00 (before)	99-00 (after)	13-14 (before)	13-14 (after)
AMJ	Non-IS	Allied	Mgmt	Mgmt	Mgmt	Mgmt	Mgmt	Mgmt
AMR	Non-IS	Allied	Mgmt	Mgmt	Mgmt	Mgmt	Mgmt	Mgmt
ACS	Hybrid	Allied	CS	NA	--	--	--	--
ATDS	Hybrid	Allied	CS	NA	--	--	--	--
ATIS	Pure IS	IS	CS	NA	--	--	--	--
ASQ	Non-IS	Allied	Mgmt	Mgmt	Mgmt	Mgmt	Mgmt	Mgmt
CACM	Hybrid	Prof	CS	NA	IS	--	--	--
COR	--	Allied	OR	OR	OR	OR	OR	OR
DS	Partial	Allied	OR	NA	IS	--	Mgmt	--
DSS	Pure IS	IS	MIS	IS	IS	IS	IS	IS
EJIS	Pure IS	IS	M	IS	IS	IS	IS	IS
ESA	Hybrid	Allied	--	NA	--	--	--	--
HBS	Non-IS	Prof	Mgmt	Mgmt	--	Mgmt	--	Mgmt
IBM	--	--	MIS	IS	--	--	--	--
C	--	Allied	CS	CS	--	--	--	--
ITKDE	Hybrid	Allied	--	NA	--	--	--	--
ITSE	Hybrid	Allied	CS	NA	--	--	--	--
ISM	Pure IS	IS	MIS	IS	IS	IS	IS	IS
IS	Pure IS	IS	--	IS	--	IS	--	IS
ISJ	--	IS	MIS	IS	--	IS	IS	IS
IMA	Pure IS	IS	MIS	IS	IS	IS	IS	IS
ISR	Pure IS	IS	MIS	IS	IS	IS	IS	IS
IJC	Hybrid	Allied	--	NA	--	--	OR	--
IJHC	Hybrid	IS	MIS	NA	--	--	--	--
Interfaces	Partial	Allied	MIS	NA	OR	--	--	--
IJEC	--	IS	--	IS	--	--	--	--
JCIS	Pure IS	IS	--	IS	IS	IS	IS	IS
JDM	Pure IS	IS	--	IS	--	--	--	IS
JMIS	Pure IS	IS	MIS	IS	IS	IS	IS	IS
JOCEC	Pure IS	IS	--	IS	--	--	--	--
JSIS	Pure IS	IS	MIS	IS	IS	IS	IS	IS
JACM	--	IS	CS	NA	--	--	--	--
JAIS	--	IS	--	IS	--	--	IS	IS
JASIST	--	IS	--	IS	--	--	--	IS
JSS	Hybrid	IS	--	NA	--	--	--	--
KBS	Hybrid	Allied	--	NA	--	--	--	--
MS	Non-IS	Allied	OR	OR	OR	OR	Mgmt	OR
MISQ	Pure IS	IS	MIS	IS	IS	IS	IS	IS
OIJM	Non-IS	Allied	MIS	NA	--	--	OR	--
OR	Non-IS	Allied	--	OR	OR	OR	OR	OR

Table A2. Results of Journal Membership Classification

OS	Non-IS	Allied	Mgmt	Mgmt	Mgmt	Mgmt	Mgmt	Mgmt
MIT	Non-IS	Prof	Mgmt	Mgmt	--	--	--	Mgmt

[a] Walstrom & Hardgrave (2001) categories:	Pure IS = “pure IS” journal
	Hybrid = “hybrid IS” journal
	Partial = “partial IS” journal
	Non-IS = “non-IS” journal
[b] Peffers & Tang (2003) categories:	Allied = allied discipline journal
	IS = information systems journal
	Prof = professional/managerial journal
[c] Rainer & Miller (2005) categories:	CS = computer science journal
	Mgmt = management journal
	MIS = “Pure” MIS journal
	OR = operations research/operation management journal
[d] Polites & Watson (2009) categories:	CS = computer science journal
	Mgmt = management journal
	IS = “pure” IS journal
	OR = operations research/operation management journal
[e] This study categories:	CS = computer science journal
	Mgmt = management journal
	IS = “pure” IS journal
	OR = operations research/operation management journal

Note: columns 2-5 shows the journal classifications in the four studies we refer to in this study. The last four columns show the results of subarea analysis in our study and the final results of journal membership classification after we integrated the four studies and subarea analysis during two periods. That is, column 6 (i.e., “99-00 (before)”) shows the results of subarea analysis in our study during the 1999-2000 period, and column 7 (i.e., “99-00 (after)”) shows the final results of classification of journal membership for the 1999-2000 period. Columns 8 and 9 follow the same logic. Some journals do not have any classification because they either did not belong to any of the three categories (i.e., management, operations research and pure IS) or we did not have the citation data for the journal during that period.

Appendix B: Explanation of the Symmetric Log-multiplicative Model

To describe the cohesion between journals in the network, we estimated the following symmetric log-multiplicative model:

$$logF_{sr} = u + u_s^S + u_r^R + \delta_{sr} + \sum_{m=1}^{M} \xi_s^m \psi^m \xi_r^m \quad (4)$$

The model we selected in the analysis is specified for the asymmetrix s*r matrix formed by the variables S and R. S is the short name of sending representing citing other journals and is row variable (s = 1, ..., 42 journals). R represents receiving (namely, being cited by other journals) and is column variable (r = 1, ..., 42 journals). For each cell sr in the matrix, F_{sr} means the expected cell frequency. In other words, we employed the frequencies of citing other journals, self-citation, and being cited by other journals to estimate the parameters of the log-multiplicative model. Subsequently, we could evaluate the frequency of each cell with the optimum model.

The u terms are standard log-linear parameters. The uS parameters express differences between journals in the overall volume of citing other journals in the network (the letter S refers to sending citations to other journals). The uR parameters express differences between journals in the overall volume of being cited by other journals in the network (the letter R refers to receiving citations from other journals). The log-linear parameters account for the effects of self-citations, which are in the diagonal of the citation matrix. The expression in Equation 4 is a log-multiplicative term as a form of the product of estimated row and column scores, which captures journal cohesion in the citation. Multiple dimensions of association (M > 1) can account for the association between S and R. The sum of products illustrates how the model represents the cohesion between journals by the distance between their scores. The smaller the distance between journals, the more cohesive they are in terms of having reciprocal citation relationships.

Appendix C: Results of Journal Clustering

Table C1. Journal Cohesion Scores and Clusters (1999-2000)

Journal	**Journal cohesion score**				
	dim.1	dim.2	dim.3	dim.4	dim.5
AMJ	0.1806	-0.0122	0.0604	-0.2837	0.0624
AMR	0.2438	-0.0327	0.0506	-0.2663	0.1422
ACS	-0.0777	-0.1992	0.1078	0.1452	-0.0686
ATDS	-0.1579	-0.2971	0.138	0.1079	0.0031
ATIS	-0.0266	-0.0694	0.1295	0.136	0.0153
ASQ	0.3635	0.1449	0.1516	-0.267	0.0349
CACM	-0.0891	-0.0033	0.0465	0.009	0.0578
COR	0.0273	0.0596	-0.1109	0.225	-0.3033
DS	-0.0482	0.0434	0.0576	-0.0508	-0.0703
DSS	-0.1169	0.0331	0.0472	-0.005	-0.0601
EJIS	-0.1377	0.0171	0.0452	-0.0936	-0.0085
ESA	0.0131	0.1745	-0.2147	0.3154	-0.2218
HBS	0.5436	0.5648	-0.2415	-0.2516	0.2322
IBM	0.1848	-0.2797	-0.4698	-0.3168	0.7515
C	-0.028	-0.0391	-0.6635	0.295	0.186
ITKDE	-0.1846	-0.2843	0.1072	0.1251	-0.0738
ITSE	-0.1861	-0.2133	-0.0152	0.0045	-0.0771
ISM	-0.0953	0.0467	0.064	-0.0907	0.0294
IS	-0.1772	-0.2684	0.1172	0.0737	-0.0239
IMA	-0.1299	0.0304	0.0282	-0.0906	-0.0024
ISR	-0.0895	0.0486	0.063	-0.041	0.0024
Interfaces	0.2447	0.2818	0.1292	0.1088	-0.1135
Journals	dim.1	dim.2	dim.3	dim.4	dim.5
JCIS	-0.127	0.0438	0.0253	-0.0672	0.008
JMIS	-0.0603	0.1224	0.0616	-0.0325	0.0285
JSIS	-0.0964	0.0765	0.0466	-0.1458	0.0754
JACM	0.058	-0.1785	0.1329	0.2337	-0.1117
JSS	-0.2265	-0.1954	-0.0123	-0.0508	-0.0674
KBS	-0.0698	0.058	-0.1882	0.2271	-0.1329
MS	0.1016	0.0458	0.1057	0.0561	-0.0999
MISQ	-0.104	0.043	0.0435	-0.108	0.0481
OIJM	-0.0419	0.0803	0.0785	-0.0315	-0.0991
OR	0.2457	0.1365	0.0022	0.2919	-0.2503
OS	0.0638	0.0215	0.0766	-0.1616	0.1074

Table C2. Journal Cohesion Scores and Clusters (2013-2014)

Journal	Journal cohesion score					
	dim.1	dim.2	dim.3	dim.4	dim.5	dim. 6
AMJ	0.2462	0.1674	0.0712	0.1277	-0.2454	-0.0997
AMR	0.3096	0.2393	-0.1761	0.3019	0.2085	-0.1159
ACS	-0.1162	-0.1041	-0.0595	-0.1785	-0.0444	0.0099
ATDS	-0.0502	-0.2227	-0.0735	-0.282	0.0702	0.421
ATIS	-0.0249	-0.3654	-0.1053	-0.1685	-0.0568	0.4156
ASQ	0.4202	0.3447	0.0463	0.1486	0.0477	-0.0006
CACM	0.0127	-0.1842	-0.147	-0.0927	0.0416	0.2071
COR	0.002	-0.1106	0.1378	0.0211	0.2964	-0.0597
DS	0.1075	0.0331	0.1425	0.2133	-0.0331	-0.0664
DSS	-0.0976	0.0401	0.0567	0.0182	-0.0519	-0.092
EJIS	-0.0797	0.0553	-0.1353	0.0568	0.0072	-0.0695
ESA	-0.1106	-0.0424	0.0885	-0.0621	-0.0948	-0.1375
IBM	0.0308	-0.0932	0.1026	-0.2089	-0.167	0.0154
C	0.1779	-0.4439	-0.3	-0.0943	-0.1469	0.2384
ITKDE	-0.1259	-0.0953	0.0613	-0.2319	-0.0818	0.0617
ITSE	-0.1665	-0.0717	-0.1694	-0.2014	0.086	-0.0719
ISM	-0.0682	-0.0004	-0.0977	0.1009	-0.012	-0.1052
IS	-0.1949	-0.0386	-0.0716	-0.2286	-0.0107	0.028
ISJ	-0.0619	0.0442	-0.1674	0.058	-0.031	-0.07
IMA	-0.0869	0.0665	-0.058	0.0595	-0.0943	-0.1297
ISR	-0.0512	0.102	0.0128	0.0035	-0.0357	-0.0108
IJC	0.0752	-0.0992	0.2039	0.0031	0.1419	0.0538
IJHC	-0.1665	0.0717	-0.0819	-0.1707	-0.1912	-0.1
Interfaces	0.2067	0.2023	0.6073	0.3533	0.0407	-0.1524
IJEC	-0.0951	0.1698	0.1183	0.0078	-0.1531	-0.133
JCIS	-0.1339	0.0668	-0.0802	0.0208	-0.0564	-0.1363
JDM	-0.162	0.0081	-0.1325	-0.1117	0.0851	0.0423
JMIS	-0.1209	0.1307	-0.0405	-0.0061	-0.011	-0.1149
JOCEC	-0.0544	0.0963	0.0327	0.1116	-0.1389	-0.15
JSIS	-0.0066	0.0733	-0.0773	0.1522	-0.0762	-0.0183
JACM	0.0534	-0.2753	-0.1258	-0.1378	0.4969	0.412
JAIS	-0.0781	0.073	-0.1102	0.0132	-0.0684	-0.0293
JASIST	-0.0423	0.012	0.0215	-0.0081	-0.2312	-0.009
JSS	-0.1797	-0.0827	-0.1583	-0.1646	0.006	-0.0812
KBS	-0.1497	-0.005	0.1157	-0.1302	-0.1021	-0.1358
MS	0.1211	0.1134	0.2325	0.0555	-0.0179	0.0504
MISQ	-0.0488	0.088	-0.0563	0.0522	-0.0566	-0.0425
OIJM	-0.0381	0.0234	0.1254	0.0563	0.2087	-0.1869
OR	0.0663	-0.0313	0.2092	-0.023	0.3087	0.0273
OS	0.2688	0.2194	0.1287	0.1898	-0.1612	0.0238
MIT	0.4124	-0.1749	-0.0913	0.3757	0.3243	0.3117

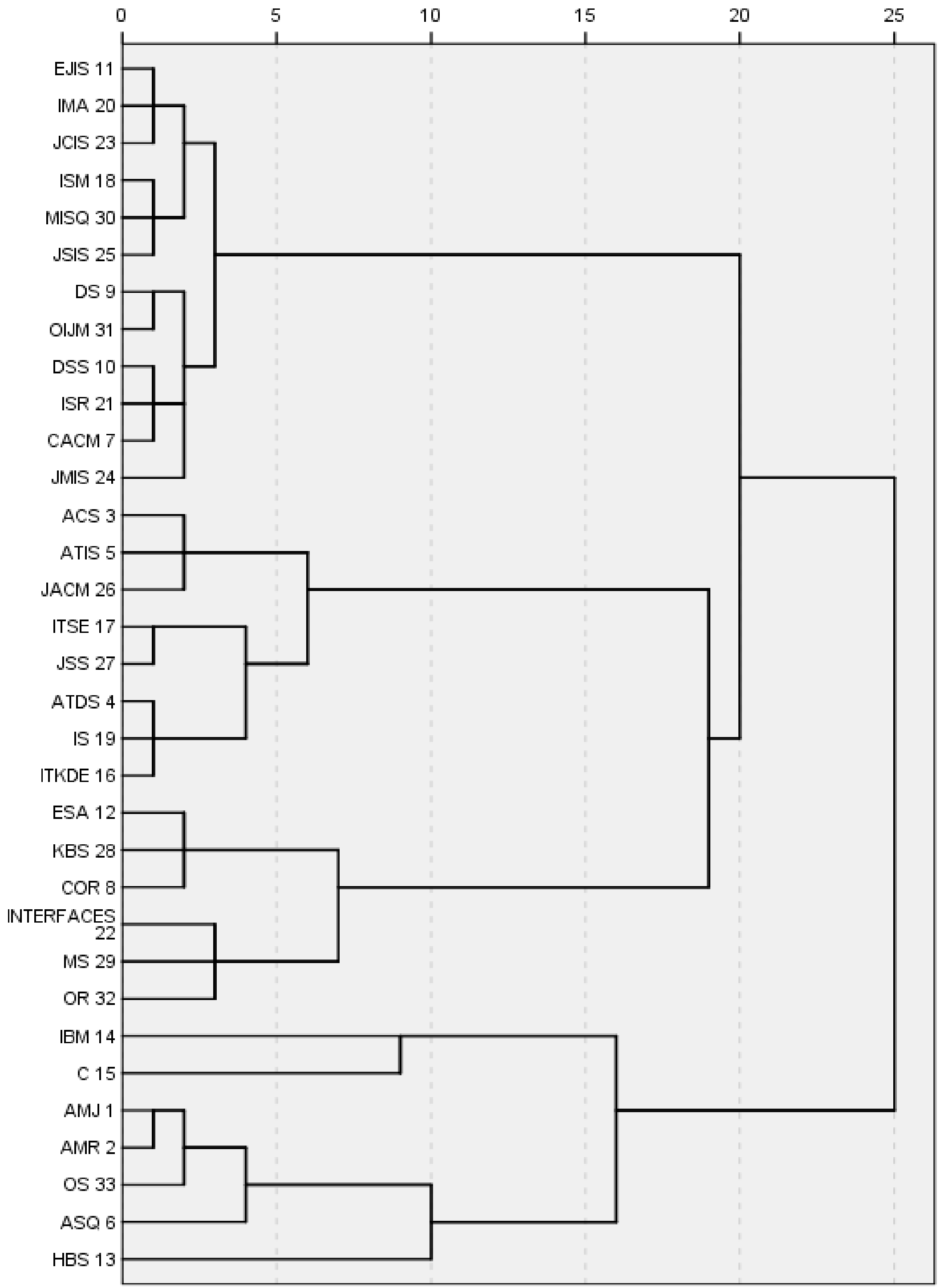

Figure C1. Clusters of IS journals Based on Citation Flows: 1999-2000

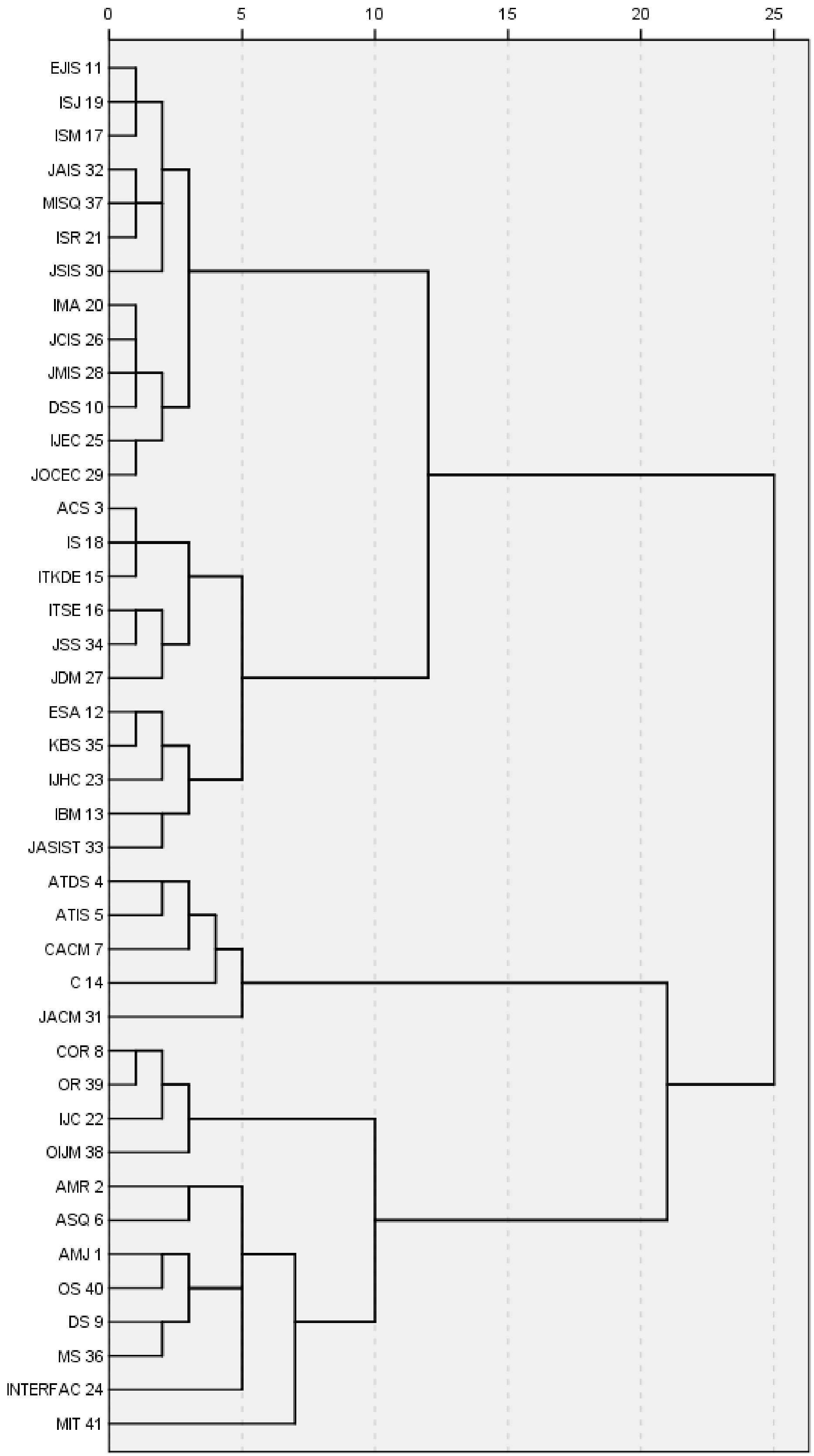

Figure C2. Clusters of IS journals Based on Citation Flows: 2013-2014

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