Network Closure, Brokerage, and Structural Influence of Journals: A Longitudinal Study of Journal Citation Network in Internet Research (2000-2010)

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Abstract

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Keywords: Internet Research, Network Closure, Brokerage, Citation Network, Scholarly Influence

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Network Closure, Brokerage, and Structural Influence of Journals: A Longitudinal Study of Journal Citation Network in Internet Research (2000-2010)

Journals have become the primary medium to create and diffuse scholarly knowledge in Internet research, indicated by the dramatically increasing number of Internet studies published in scholarly journals in the past decade (Peng et al., 2013). With the proliferation of journals in which Internet studies are published, it is of particular significance to study the relative influence of journals in an emerging area like Internet research. First, such an analysis can demonstrate roles of different journals in the exchange of ideas in Internet research, which can provide valuable insights into the development and current status of knowledge structure of the field (Leydesdorff, 2003). Secondly, it can be used as evidence of scholarship and making tenure/promotion decisions (Johnson & Podsakoff, 1994).

It has been empirically confirmed that journals differ in their influence in various disciplines (e.g., Cote et al., 1991; van Campenhout et al., 2008) and over time (e.g., Johnson & Podsakoff, 1994; Baumgartner & Pieters, 2003). These differences are usually attributed to journals' intrinsic characteristics (e.g., journals' age, number of articles published, aggregate quality of articles published in a journal). Although journals' intrinsic characteristics are surely necessary for journals to establish, maintain, and improve their influences, they are useless without the external structure in which to apply them (Burt, 1997). In other words, journals' influence may be affected by their positions in a social structure which is formed by exchange of citations between journals. Therefore, beyond the assessment of journals' influence, the study tries to address why some journals enjoy greater influences than others in Internet research from a structural and longitudinal perspective.

By analyzing a journal citation network in Internet research from 2000 to 2010, the study integrates network analysis with bibliometric analysis to: (1) assess journals' influence in Internet research; (2) describe the growth of journals' influence over time; and (3) uncover the underlying structural mechanism accounting for the inequality of journals' influence.

Literature Review

Journals' Structural Influence

The objective assessment of journals' influence often relies on citation-based measurements (Garfield, 1979; Amsterdamska & Leydesdorff, 1989). The most well-known one is the Impact Factor (IF) of ISI

(Garfield, 2006). However, the impact factor has its disadvantages which have been addressed in previous studies (e.g., Moed & Van Leeuwen, 1996; Moed et al., 1999).

Specifically, several limitations of the impact factor make it an inappropriate indicator of journals' influence in our study. First, the impact factor only measures a journal's influence based on articles that have been published by the journal in the last two years. Second, the impact factor is insensitive to the influence a journal may have on a specific field of inquiry (Leibowitz & Palmer, 1984; Johnson & Podsakoff, 1994). Third, the impact factor completely ignores the citation source in determining a journal's influence (e.g., Salancik, 1986; van Campenhout, et al., 2008). It has been argued that by whom the journal is being cited is of greater significance than merely the number of citations (Zhou et al., 2012). In other words, the value of each citation is not equal, which is contingent on the characteristics of the citers (i.e., journals sending out the citation).

On the basis of theories of organizational influence, Salancik (1986) proposed a citation-based importance index to measure journals' structural influence in a citation network. Salancik (1986) argued that a cited journal's influence is a function of (1) the sum of the number of direct citations made to it in other journals (dependencies), (2) the influence of the citing journals, and (3) the intrinsic value of the cited journal, independent of the network. The index has been used to assess journals' structural influence in different fields of inquiry, such as accounting (van Campenhout, et al., 2008), marketing (Baumgartner & Pieters, 2003), management (Johnson & Podsakoff, 1994), and information science (Kim, 1992). Salancik's (1986) index, which captures the sum of all direct and indirect dependencies of other journals on a particular one in a citation network, will be adopted in the study to measure journals' structural influence in Internet research.

Network Closure, Brokerage, and Journals' Structural Influence

From a structural perspective, a journal in a "better connected" (Burt, 2000, p. 348) position of a social structure will have greater influence over a journal in a poorly connected position (Coleman, 1988; Bourdieu & Wacquant, 1992; Putnam, 1993), as the latter will depend on the former for valued resources which "contribute significantly to the exchange of ideas in some field of inquiry" (Baumgartner & Pieters, 2003, p. 124). Two perspectives exist on what can be defined as "better connected" network structures: closure (e.g., Coleman, 1988) and brokerage (Burt, 1992). The impacts of these two network structures on structural influence were considered at odds, suggesting that the benefits of network closure should come at the expense of the benefits provided by network brokerage or vice versa (Reagans & McEvily, 2003). However, recent works argue that their impacts should be complementary rather than competitive, implying that an optimal network combines elements of network closure and brokerage (Burt, 2000; Podolny, 2001; Reagans & Zuckerman, 2001; Reagans & McEvily, 2003; Burt, 2004; Klenk et al., 2010). Moreover, it has been argued that the effects of network closure and brokerage are not fixed over time, which will evolve with the progressive development of a network (Ahuja, 2000; Hite & Hesterly, 2001). Following the complementary perspective on network closure and brokerage, the study tries to address: (1) whether network closure or brokerage is conducive to the accrual of journals' structural influence or not; and (2) how the impacts of network closure and brokerage change over time.

Network closure perspective argues that dense or closed networks in which nodes are highly connected to each other are the fundamental means of creating and maintaining social capital (Coleman, 1988). Journals, densely connected with other journals in a citation network, are expected to have shared publication interests and be well known and trusted by others (Burt, 2000), all of which can be advantageous to particular journals for knowledge diffusion and make them exert greater influences over other journals. Therefore, it is hypothesized that:

H1: Structural influence of journals is positively influenced by network closure.

Structural holes theory argues that group-spanning brokers may gain advantage by bridging structural holes, which are separate non-redundant sources of information (Burt, 1992). Loosely coupled networks rich in structural holes enable individual nodes to access fresh insights and obtain innovative ideas that are crucial ingredients in the production of original research. Those nodes in brokerage positions of a network are expected to "control the flow of information and resources between separate individuals and groups, thus gaining an advantage over individuals whose connections are solely within groups" (Burt, 2000, p. 353). Network brokerage has been found to be conducive to researchers' scholarly performance (e.g., Oh et al., 2005; Klenk, et al., 2010; Abbasi et al., 2011; Abbasi et al., 2012a), knowledge production (e.g., Jansen et al., 2010), and contribution to online public goods (e.g., Zhang & Wang, 2012). Following the similar logic, journals in a brokerage position in a citation network are expected to advance Internet research by introducing innovative ideas, research questions, and methods, which may make them more influential in the field. Therefore, it is hypothesized:

H2: Structural influence of journals is positively influenced by network brokerage.

Moreover, information needs of Internet researchers will change with Internet research growing from early stage to mature stage. At the early stage of Internet research, “existing competencies, technologies and paradigms” (Rowley et al., 2000, p. 373) will be exploited by researchers to address their concern. At this stage, a journal enjoys access advantages when its ties share membership in a closed, cohesive network structure (Rowley, et al., 2000; Hite & Hesterly, 2001). These closed networks are critical for journals to forming citation ties with other journals, because journals in a closed network are familiar with each other and have shared knowledge and common terminologies. Therefore, journals that own membership in such cohesive networks may be particularly advantageous in gaining influences in the citation network of Internet research at the early stage.

However, this relative advantage of journals in a closed structure will fade with Internet research developing from early stage mature stage. At the mature stage, fresh insights and innovative ideas are explored by researcher to answer their questions (Rowley, et al., 2000). The need for fresh insights and innovative ideas can’t be met within a closed network where information contained is likely to be high in redundancy and low in diversity (Burt, 2004). Thus, with the maturation of Internet research, journals need to “move beyond the initial, close and cohesive networks from which they emerge in order to find and develop new ties that can provide more available resources” (Hite & Hesterly, 2001, p. 281). As journals add new nonembedded ties and thus reduce cohesion, the most advantageous of these new ties for resource acquisition will be those brokers that help other journals to bridge structural holes (Rowley, et al., 2000). Journals in brokerage positions will enjoy greater structural influence at the mature stage of Internet research, as they can control the flow of innovative information or insights that others need and thus increase their added values (Burt, 2005). Therefore, it is hypothesized that:

H3: The impact of network closure on structural influence of journals will decrease over time.

H4: The impact of brokerage on structural influence of journal will increase over time.

Research Methods

The study will focus on journals listed in 13 major social scientific subject categories[1] as these journals are found to be major outlets for Internet research in the past decade (Peng & Zhu, 2012).

Data Collection

The data collection procedure is as follows: In the first stage, the *Journal Citation Report* (JCR) of ISI Web of Science has been used to identify journals listed in these 13 subject categories from 2000 to 2010. In the end, information for 1,413 journals was retrieved (i.e., journal titles and annual impact factors). In the second stage, the *Social Sciences Citation Index* (SSCI) of ISI Web of Science has been used to retrieve Internet studies[2] published in 2000-2010. Article-level information for 24,705 Internet studies was retrieved, including author(s), article title, journal title, abstract, author keywords, and cited reference. Journal citation exchanges implied in these 24,705 Internet studies were extracted.

Finally, by matching the journal citation exchanges extracted from Internet studies with the journal information retrieved from JCR, we identified 1,210 journals (85.6% of 1,413 journals), which have been cited by or citing other journals in retrieved Internet studies during 2000-2010[3]. Therefore, a journal citation network including these 1,210 journals will be analyzed in the study to assess journals' structural influence in Internet research during 2000-2010.

Measurement of Journals' Structural Influence

As stated earlier, Salancik's (1986) importance index is adopted to measure journals' structural influence, which can be calculated as:

$$SI = \left[I - D \right]^{-1} INT$$

[1] These 13 subject categories include "Business", "Business, Finance", "Communication", "Economics", "Education & Education Research", "Education, Special", "Information Science & Library Science", "Management", "Political Science", "Psychology, Applied", "Psychology, Social", "Sociology", and "Psychology, Multidisciplinary". "Fortune" and "Forbes" are excluded in the study as they are considered more as popular magazines rather than scholarly journals. "Science" and "Nature" are included in the list as they are considered as two prominent flagship journals by the general scientific community.

[2] Three query words (i.e., Internet, web, and cyberspace/cyber-space) were used to search titles/abstracts/keywords of Internet-relevant articles from 2000 to 2010. Article language was limited to English, and document type was limited to scholarly journal articles.

[3] Specifically, out of 1,413 journals listed in 13 subject categories, 871 (61.6%) journals published Internet studies and were cited by Internet studies, 293 (20.7%) were only cited in Internet studies without any Internet studies published, 46 (3.3%) only published Internet studies with any citations received, and 203 (14.4%) didn't publish Internet studies and were not cited by Internet studies.

where SI is an N-dimensional vector of structural influence values, I is an $N \times N$ identity matrix, D is an $N \times N$ matrix of dependency values of each journal j upon journal i, and INT is the vector of intrinsic values. No journal should be assumed to be more or less intrinsically important than others, so each journal was assigned an equivalent intrinsic value. Using an intrinsic value of 1.00 for all journals will result in an intuitively meaningful interpretation of the ratings. If a journal is cited by no other journals in the network, its influence value will be one, its intrinsic value alone. If journal *X* gets a structural influence score equal to 3 and journal *Y* gets a score equal to 2, it is meaningful to say that within all journals included in the citation network, journal *X* is 50% more influential than journal *Y*, and what this means is the journals in the network are that much more dependent on journal *X* than journal *Y* for knowledge and information.

Measurement of Network Closure and Brokerage

Network closure is measured with triadic closure which refers to the degree to which a node's partners are also partners with each other in a network. It is measured by clustering coefficient which was originally introduced by Watts and Strogatz (1998) and has become a very popular measurement of triadic closure in social networks (Easley & Kleinberg, 2010). The clustering coefficient of journal i can be calculated as the following equation:

$$C_i = 2N_i / k_i(k_i - 1)$$

where N_i is the number of links that connect the selected k_i nodes to each other. In general, clustering coefficient of a node ranges from 0 to 1. The greater the clustering coefficient is, the more closed and dense connection a journal will have with its neighbors. Therefore, journals with greater clustering coefficient in the citation network are expected to have greater structural influence in Internet research.

Network brokerage is measured with betweenness centrality and network constraint, which are two distinct measures of network brokerage (Burt, 2001). Betweenness centrality was firstly proposed by Freeman (1979) as a measure of the number of times a particular node lies "between" the various other nodes in the network. Betweenness centrality of journals in a citation network is defined as the portion of the number of shortest paths that pass through the given journal divided by the number of shortest path between any pair of journals (Borgatti, 1995). The betweenness centrality of journal k can be calculated as the following equation (White & Borgatti, 1994; Abbasi, et al., 2011; Abbasi et al., 2012b):

$$C_B(p_k) = \sum_{i<j}^{n} \frac{g_{ij}(p_k)}{g_{ij}}; i \neq j \neq k$$

where g_{ij} is the geodesic distance (shortest paths) linking p_i and p_j and $g_{ij}(p_k)$ is the geodesic distance linking p_i and p_j that contain p_k. Journals with high betweenness centrality play the role of broker or gatekeeper to connect the journals and sub-groups in a citation network (Abbasi, et al., 2012b). Therefore, journals with higher betweenness centrality in the citation network are expected to have greater structural influence in Internet research.

Network constraint describes the extent to which an ego-network is concentrated in redundant contacts (Burt, 1992). The network constraint of journal *i* can be calculated as the following equation (for detailed discussion of this measure, please refer to Burt, 1992, pp. 50-71):

$$C_{ij} = (p_{ij} + \sum\nolimits_q p_{iq} p_{qj})^2, q \neq i, j$$

where p_{iq} is the proportion of journal *i*'s total connections accounted for by its relationship with *q*, p_{qj} is the proportion of journal *q*'s relationships accounted for by its relationship with *j*, and p_{ij} is the proportion of *i*'s relationships accounted for but its relationship with *j*. $\Sigma_i c_{ij}$ is the network constraint index *C* of journal *i*. Journals with lower network constraint will span a greater number of structural holes in a citation network, so journals' structural influence is expected to have a negative association with their network constraint.

Control Variables

In statistical tests of four hypotheses proposed, five journal-level attributes are controlled, which are journals' birth year, subject area, geographic region of their publishers, journals' normalized out-degree, and journals' impact factor. Journals' birth year is manually collected for each journal. The original 13 subject categories are recoded into eight subject areas which are "Business", "Communication", "Economics/Finance", "Education", "Information Science", "Political Science", "Psychology", and "Sociology". The geographical region of journals' publisher is manually collected and recoded it into a categorical variable with three attributes: "United States", "United Kingdom", and "Others". Normalized out-degree of a journal can be considered as an indicator of journals' activeness in Internet research. Journals' impact factor, representing the overall influence of a journal in scientific community, is directly retrieved from Journal Citation Report of ISI Web of Science.

Findings

To get an overview of journals' structural influence in Internet research in 2000-2010, network analysis is adopted in the study to analyze the full journal citation network representing citation exchanges between 1,210 journals in 2000-2010. We will first describe basic characteristics of the journal citation network, then report journals' structural influence in Internet research derived from the network, and finally test four research hypotheses proposed in the study.

Characteristics of Journal Citation Network in Internet Research (2000-2010)

The journal citation network in Internet research during 2000-2010 is a directed and weighted network. It consists of 1,210 nodes (i.e., journals) with 136,921 arcs (i.e., citation relationships). The out-degree of a node refers to the number of citations sent out by a journal to other journals and the in-degree of a node refers to the number of citations received by a journal from other journals.

The out-degree and in-degree distributions for nodes of the network demonstrate a clear long-tail pattern. The average degree for both distributions is 113. The median out-degree is 21 and the median in-degree is 17. However, neither distribution can be said to follow a power-law when they are tested within a principled statistical framework[4] (Clauset, et al., 2009). Therefore, the journal citation work in Internet research can't be considered as a scale-free network (Barabasi & Albert, 1999), which is consistent with what has been found on a citation network with 6,708 journals (Franceschet, 2012).

The long-tail pattern in out-degree and in-degree distributions suggests that most journals send out and receive a relatively small number of citations in Internet research, but there exist some journals sending out a large number of citations and some receiving a large number of citations in the network. *Computers in Human Behavior* has the maximum out-degree (5,782) in the network, whereas *Journal of the American Society for Information Science and Technology (JASIST)* has the maximum in-degree (3,943) in the network. Furthermore, the out-degree and the in-degree are positively correlated[5] as shown in Figure 1, implying that journals sending out more citations will get more citations back and vice versa.

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[4] Clauset et al. (2009) combines maximum-likelihood fitting methods with goodness-of-fit tests based on the Kolmogorov–Smirnov statistic and likelihood ratios to discern and quantify power-law behavior in empirical data. First, power-law models are fitted to the observed long-tail distributions of in-degree/out-degree. Two coefficients are estimated for both distributions: scaling parameters α and lower bound on the scaling region x_{min} (In-degree Distribution: $\alpha = 1.77$, $x_{min} = 46$; Out-degree Distribution: $\alpha = 1.93$, $x_{min} = 97$). Then, goodness-of-fit tests are performed to tell whether the power-law model is a good match to the data or not. It turns out that the power-law model is a poor fit for both distributions ($p < 0.001$).

[5] Spearman rank-order correlation between in-degrees and out-degrees is 0.56 ($p < .001$).

Figure 1 about here

The journal citation work is a small world characterized by small network diameter and large clustering coefficient (Watts & Strogatz, 1998). The diameter of the journal citation network is 7, which is quite close to the widely touted "six degree of separation" between two randomly chosen people in the world (Milgram, 1967). The average clustering coefficient of the network is 0.29, which is far greater than that of a corresponding random network[6]. The large clustering coefficient suggests that the presence of a citation between journals *A* and *B*, and another between *B* and *C*, makes it likely that there will also be a citation between *A* and *C*.

An Overview on Journals' Structural Influence in Internet Research (2000-2010)

The distribution of journals' structural influence demonstrates a long-tail pattern, implying that only very limited number of journals are quite influential in Internet research. The median structural influence score is 1.07. Out of 1,210 journals, 71 journals have the structural influence score equal to 1, suggesting that no other journals in the network depend on these 71 journals for references. The most influential 100 journals in Internet research is reported in Table 1 along with their structural influence score in the network.

Table 1 about here

The top two most influential journals in Internet research are the *American Economic Review (AER)* and the *Journal of Personality and Social Psychology (JPSP)*. *AER* and *JPSP* can't be considered as active in Internet research, as indicated by their relatively low out-degree centrality (92 for *AER* and 128 for *JPSP*, respectively). But their structural influences outweigh those active journals. As reported earlier, *JASIST* has the greatest in-degree (3,943) in the network. The in-degree of *AER* and *JPSP* are 1,199 and 2,955 respectively, which are much less than that of *JASIST*. However, the structural influence of *JASIST* is just one third of that of *AER* or *JPSP*.

Out of the most influential 100 journals reported in Table 1, 30 journals are from "Economics/Finance", 22 from "Business", 16 from "Psychology", 12 from "Communication", 7 from "Information Science", 4 from "Political Science", 4 from "Sociology", and 3 from "Education". An interesting finding is the relative position of two journals that are not typically considered to be social

[6] The average clustering coefficient for the random network is 0.027.

sciences journals ---- *Science* and *Nature*. Both journals are quite influential in this set of 1,210 journals, occupying the 30th and 41st positions, suggesting that Internet researchers depend heavily on those high-quality scientific articles published in *Science* or *Nature*.

Journals in eight subject areas differ significantly in their mean structural influence. On average, journals in "Business" have the greatest structural influence (μ_{SI} = 1.51), followed by those in "Economics/Finance" (μ_{SI} = 1.43), "Communication" (μ_{SI} = 1.395), "Information Science" (μ_{SI} = 1.392), "Psychology" (μ_{SI} = 1.35), "Sociology" (μ_{SI} = 1.17), "Political Science" (μ_{SI} = 1.136), and "Education" (μ_{SI} = 1.135). The most influential journals in the eight subject areas are: *Management Science* in "Business", *Journal of Personality and Social Psychology* in "Psychology", *Communication Research* in "Communication", *Public Opinion Quarterly* in "Political Science", *American Sociological Review* in "Sociology", *MIS Quarterly* in "Information Science", *American Economic Review* in "Economics/Finance", and *Educational Research* in "Education".

Network Closure, Brokerage, and Journals' Structural Influence

A Hierarchical Linear Modeling (HLM) approach[7], which has become an increasingly important approach for analyzing longitudinal data (Kwok et al., 2008), is adopted to test research hypotheses proposed in the study. To avoid the confounding effect of network size on journals' structural influence (Salancik, 1986) and achieve an adequate sample size for HLM analysis, a citation sub-network are extracted from the full network with 1,210 journals.

The citation sub-network is composed of 628 journals which consistently send citations to or receive citations from other journals over four time periods (i.e., 2000-2002, 2003-2005, 2006-2008, and 2009-2010). The sub-network includes 119,956 arcs accounting for 87.6% of the arcs in the full network with 1,210 journals. The HLM analysis is performed with Mixed Procedure in SPSS (SPSS, 2005). The HLM results are summarized in Table 2.

Table 2 about here

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[7] HLM outperforms traditional approaches (e.g, repeated ANOVA, MANOVA) in analyzing longitudinal data in several aspects, such as decomposition of fixed and random effects, treatment of time predictor, and inclusion of time-variant predictors (for a detailed discussion of HLM for longitudinal data, please refer to Raudenbush, 2001; Hedeker, 2004; Peugh & Enders, 2005).

First, an unconditional mean model (Model 1 in Table 2) is estimated without any predictors included. It is found that there is significant between-journal variation in their structural influence in Internet research, as indicted by a significant intercept variance of Model 1 (τ_{00} = 0.024, $p < 0.001$). To further determine the proportion of the total variance in structural influence that lies systematically between journals, intra-class correlation (ICC) coefficient is calculated. ICC is equal to 0.88[8], implying that 88% of variance in citations of Internet studies can be attributed to between-journal effects (Hox, 2002). This high ICC coefficient suggests that multi-level modeling performs better than the traditional method (e.g., ANOVA) in estimating fixed effects (De Leeuw & Kreft, 1995).

On average, journals' structural influence in Internet research is found to increase over time. An unconditional linear growth model (Model 2 in Table 2) is estimated to examine the initial status and change of journals' structural influence. The mean estimated initial status and linear growth rate are 1.072 (*s.e.* = 0.005, $p < 0.001$) and 0.015 (*s.e.* = 0.001, $p < 0.001$), respectively. In other words, the average journals' structural influence in Internet research at the first time of observation (i.e., 2000-2002) was 1.072, which will increase 0.015 units every three years. Moreover, there is a positive correlation between initial status and growth rate (τ_{01} = 0.002, $p < 0.001$), indicating that those journals which begin with greater structural influence tend to experience greater change over time.

Journals are found to deviate from the population trend in terms of both initial statues and growth rate, as shown in Figure 2 which describes the individual growth trend of structural influence of 15 journals randomly selected from 628 journals in the sub-network. In these 15 journals, *American Sociological Review* (AM SOCIOL REV in the Figure) has the greatest initial status and growth rate in structural influence, while the structural influence of *Population and Development Review* (POPUL DEV REV in the Figure) demonstrates little growth over time.

Figure 2 about here

[8] In educational research, ICC with cross-sectional design generally ranges between 0.05 and 0.20 (Snijders & Bosker, 1999). The high ICC from the study is due to the longitudinal nature of the data, as ICC is also a measure of the average autocorrelation of the outcome variable over time (Singer & Willett, 2003; Kwok, et al., 2008).

Finally, a conditional linear growth model[9] (Model 3 in Table 2), incorporating all substantive and control variables, are estimated. Triadic closure is found to exert nil-impact on journals' structural influence, while network constraint and betweenness centrality are found to exert significant impacts on journals' structural influence. The impact of triadic closure degree on journals' structural influence is positive, although not statistically significant (β = 0.01, *n.s.*). Therefore, H1 is not accepted in the study.

Journals' network constraint is found to exert a negative impact on their structural influence (β = -0.029, $p < 0.10$), implying that journals with less redundant contacts in a citation network will have greater structural influence. Journals' betweenness centrality exerts a positive impact on their structural influence (β = 0.902, $p < 0.05$), implying that journals, which have greater number of times it acts as a bridge along the shortest path between two other journals, have greater structural influence. Therefore, H2 is accepted in the study.

The impacts of network constraint and betweenness centrality on journals' structural influence are found to vary across time, while the impact of triadic closure is not conditioned by the time. The moderation effect of time on the impact of triadic closure on journals' structural influence is not significant ($\beta_{Time*Triadic\ closure}$ = -0.011, *n.s.*). Therefore, H3 is not accepted in our study. However, the direction of the moderation effect is consistent with our hypothesis, which means the impact of triadic closure on journals' structural influence will decrease over time.

Figure 3 and Figure 4 about here

The negative impact of network constraint on journals' structural influence is negatively moderated by time ($\beta_{Time*Network\ Constraint}$ = -0.028, $p < 0.01$), suggesting that the impact of network constraint on journals' structural influence will increase over time as shown in Figure 3. The positive impact of betweenness centrality on journals' structural influence is positively moderated by time ($\beta_{Time*Betweenness\ Centrality}$ = 0.678, $p < 0.001$), suggesting that the relational strength between betweenness centrality and journals' structural influence will increase over time as shown in Figure 4. Therefore, H4 is accepted in the study.

[9] Technically, four conditional linear growth models are estimated with four blocks of variables (i.e., control variables, network brokerage variables, network closure variables, and interaction terms) added to the model in a stepwise way.

Discussions and Conclusion

The structural perspective, longitudinal dataset, and multi-level design employed in the study result in some expected as well as interesting findings. The study supports the usefulness of the index of structural influence (Salancik, 1986) to map the knowledge landscape for Internet research and assess journals' influence in Internet research. As Internet research is a booming field without a clear disciplinary identity in the family of social sciences (Baron, 2005), it is quite difficult to provide an objective knowledge map for it and a valid assessment of journals' structural influences in Internet research. Salancik's index, drawing on a substantive theory of influence in exchange networks, has demonstrated several advantages in doing that. First, the index allows us to assess journals' influence in a subset of journals most relevant to Internet research. Second, the index can allows us to assess journals' influence in Internet research within different time frames. Third, the index "takes into account the influence of the dependent journal and incorporates indirect dependencies" (Baumgartner & Pieters, 2003, p. 127).

Moreover, the study uncovers the structural mechanisms underlying journals' structural influence from a dynamic perspective. With a longitudinal research design and multivariate analytical design, the causal relationship between network structures and journals' structural influences is well established. The results of this study contribute to not only our understanding of knowledge structure of Internet research, but our understanding of roles of network structures in growth of structural influence in a network, which is a long-standing issue in social/organization network studies.

Knowledge Map of Internet Research

The first contribution of the study is that it comprehensively assess the structural influence of 1,210 social scientific journals from a network perspective in an emerging subject area (i.e., Internet research), which helps us understand the creation and diffusion of scholarly knowledge in Internet research.

Internet research is a rapidly maturing subject area, as indicated by the sheer volume of journals involved in the study accounting for 85% of 1,413 journals listed in the 13 subject categories. Therefore, in terms of number of journals, Internet research is not "a homogeneous filed of inquiry with a single broad group of tightly knit journals" (Baumgartner & Pieters, 2003, p. 136). However, most citation exchanges are found to occur among journals within the same subject area, suggesting that Internet research is still on its way to so-called "interdisciplinarity".

Internet research has not developed to be an independent academic discipline, as it still heavily depends on established journals in traditional social scientific areas (e.g., Economics/Finance, Psychology, and Business) for reference. In contrast, those active journals in Internet research are found to be of weaker influence, implying that knowledge created by these active journals are of limited value for Internet research in comparison with the knowledge created by those established journals.

It is exciting to observe that journals in the "Communication" discipline emerge to be an important source of influence in Internet research. Out of 65 communication journals, 12 are in the list of top 100 influential journals in Internet research, among which *Communication Research* is ranked at 33rd, *Cyberpsychology, Behavior & Social Networking* at 36th, and Journal *of Computer-Mediated Communication* at 40th, *Journal of Communication* at 43rd, and *Journal of Advertising Research* at 48th.

Network Closure, Brokerage, and Journals' Structural Influence

The second contribution of the study is that it takes a theory-driven approach to uncover the structural mechanism underlying journals' structural influence. Drawing on theories of network closure (Coleman, 1988) and structural hole (Burt, 1992), the study examines the impacts of two network structures (i.e., network closure and brokerage) on journals' structural influence. Network closure theory argues that actors embedded in a densely connected structure are more likely to accrue influence, as this densely embedded structure will allow actors to formulate trust and norms and develop cooperative behaviors. On the contrary, structural hole theory argue that actors in a brokerage position are more likely to accrue influence, as the loosely coupled networks rich in structural holes enable individual actors to access fresh insights and control information flow (Oh, et al., 2005). It is found that network closure structure does not affect journals' structural influence, while two dimensions of brokerage structure (i.e., betweenness centrality and network constraint) have consistent impacts on journals' structural influence.

Triadic closure, as an operationalization of network closure, doesn't exert significant impact on journals' structural influence. Triadic closure represents a network structure in which the neighboring journals of a journal are connected with each other. A journal with great triadic closure degree suggest that the journal has a large amount of knowledge shared with its neighboring journals (Berg et al., 1982) and may contain redundant information (Burt, 1992). As redundancies can be considered as potential substitutes for each other (Wang et al., 2010), journals with greater triadic closure degree may be substituted by similar journals for reference. Therefore, triadic closure will exert nil-impact on journals' structural influence. The nil-effect finding about the impact of network closure on journals' structural influence may result from the uniqueness of journal citation network examined in our study. It has been argued that "evidence in support of the positive effects of network cohesion typically comes from contexts in which the pursuit of individual goals requires the active cooperation of other players and in which there is uncertainty about whether such cooperation will be forthcoming" (Gargiulo & Benassi, 2000, p. 184) . In the context of journal citation network examined in the study, there is not such an explicitly stated goal that requires cooperation between journals. Therefore, it is reasonable to find nil impact of network closure in the accrual of journals' structural influence in our study.

Our study demonstrates clear support for the impact of network brokerage on journals' structural influence. Journals with greater betweenness centrality and less network constraint are found to accrue greater structural influence, which is consistent with the structural hole theory (Burt, 1992, 2005). The influence of journals in brokerage positions stem from their enhanced access to scarce or valuable information (Stovel & Shaw, 2012), what Burt (2010) has referred to as the "vision advantage". When all other journals in a citation network must go through an intermediary journal in order to access valued information or knowledge, the journal playing a broker role can use its structurally advantageous position to exert influences on other journals.

These findings are of practical significance for editors of scholarly journals. Editors of scholarly journals should achieve a balance between the quality of articles and quantity of articles published in a journal. To achieve great structural influence for their journals in certain research areas, editors should try to publish high-quality articles in their journals, which can attract direct citations from other journals. However, publishing many articles in a journal which send out a lot of citations to other journals will devalue the journal's structural influence.

Time-variant Impact of Network Structure

The third contribution of the study is that it takes a dynamic perspective to examine how the impacts of network closure and brokerage on journals' structural influence evolve over time. The dynamic perspective allow us to specify "the mechanisms for functional relationships" (Cohen et al., 2003, p. 571) between network structures and journals' structural influence, which has been infrequently addressed in citation network analysis. The impact of network brokerage on journals' structural influence is found to rise over time.

As Internet research dynamically progress from early stage toward maturity, the needs for reference resources of Internet studies may evolve in regular and predictable ways (Hite & Hesterly, 2001). Researchers will *exploit* familiar and available information for references at the early stage of Internet research, while they will *explore* new and additional information for references at the maturing stage of Internet research. "The differences between the information requirements for exploitation and exploration lead to different structural embeddedness prescriptions" (Rowley, et al., 2000, p. 374). Journals in closed structures are more influential or more dependent by other journals at the early stage of Internet research, because they provide researchers a deeper understanding of specific information, which can be formulated in a densely connected structure. However, with the development of Internet research, information contained in densely connected will become redundant or outdated. Journals in brokerage positions begin to gain their influences, because they can provide unique information and new perspectives needed by other journals.

Limitations and Future Research

However, the study has its limitations deserving further studies. A major limitation is that the content of citation exchanges between journals is not considered in our study. A citation can be a criticism of established theories, a comparison of competitive arguments, or a mere reference (Brown & Gardner, 1985; Bryant & Miron, 2004). Future research should bring the content of the citation ties into account, which can help us further understand the creation and diffusion of knowledge in Internet research.

Table 1 Top 100 Journals with the Greatest Structural Influence (SI) and Their In-degree

Title	Subject Area[(1)]	Structural Influence[(2)]	Title	Subject Area[(1)]	Structural Influence[(2)]
AM ECON REV	ECON	12.70 (1)	J MASS COMMUN Q	COMM	2.64 (51)
J PERS SOC PSYCHOL	PSYCH	12.48 (2)	NATL TAX J	ECON	2.64 (52)
J POLIT ECON	ECON	8.95 (3)	INT J IND ORGAN	ECON	2.63 (53)
ECONOMETRICA	ECON	8.61 (4)	SOC SCI COMPUT REV	IS	2.59 (54)
Q J ECON	ECON	8.50 (5)	PSYCHOL SCI	PSYCH	2.57 (55)
MANAGE SCI	BUS	7.29 (6)	REV ECON STAT	ECON	2.55 (56)
J MARKETING RES	BUS	6.98 (7)	J LAW ECON	ECON	2.54 (57)
J CONSUM RES	BUS	6.48 (8)	J PUBLIC ECON	ECON	2.53 (58)
J MARKETING	BUS	6.26 (9)	ORGAN BEHAV HUM DEC	BUS	2.51 (59)
J FINANC	ECON	6.26 (10)	J BUS RES	BUS	2.48 (60)
J IND ECON	ECON	5.93 (11)	PERS PSYCHOL	PSYCH	2.44 (61)
PSYCHOL BULL	PSYCH	5.78 (12)	J MANAGE	BUS	2.43 (62)
AM PSYCHOL	PSYCH	5.39 (13)	TELECOMMUN POLICY	COMM	2.41 (63)
J APPL PSYCHOL	PSYCH	4.70 (14)	ANNU REV SOCIOL	SOC	2.40 (64)
ACAD MANAGE J	BUS	4.66 (15)	REV FINANC STUD	ECON	2.36 (65)
J FINANC ECON	ECON	4.66 (16)	J ECONOMETRICS	ECON	2.33 (66)
RAND J ECON	ECON	4.65 (17)	J EXP SOC PSYCHOL	PSYCH	2.33 (67)
STRATEGIC MANAGE J	BUS	4.61 (18)	RES POLICY	BUS	2.31 (68)
REV ECON STUD	ECON	4.48 (19)	J ACCOUNTING RES	ECON	2.29 (69)
MIS QUART	IS	4.47 (20)	SCIENTOMETRICS	IS	2.28 (70)
ACAD MANAGE REV	BUS	4.45 (21)	AM J POLIT SCI	PS	2.28 (71)
MARKET SCI	BUS	4.45 (22)	INFORM SOC	IS	2.28 (72)
HARVARD BUS REV	BUS	4.40 (23)	J BUS	BUS	2.28 (73)
AM J SOCIOL	SOC	4.40 (24)	PERS INDIV DIFFER	PSYCH	2.25 (74)
ADMIN SCI QUART	BUS	4.21 (25)	J APPL SOC PSYCHOL	PSYCH	2.24 (75)
J AM SOC INF SCI TEC	IS	4.12 (26)	SOC FORCES	SOC	2.18 (76)
PUBLIC OPIN QUART	PS	4.00 (27)	J PERS	PSYCH	2.16 (77)
AM SOCIOL REV	SOC	3.92 (28)	POLIT COMMUN	COMM	2.15 (78)
COMPUT HUM BEHAV	PSYCH	3.66 (29)	MIT SLOAN MANAGE REV	BUS	2.13 (79)
SCIENCE	----	3.56 (30)	J INTERACT MARK	BUS	2.12 (80)
J ECON THEORY	ECON	3.45 (31)	J ACCOUNT ECON	ECON	2.08 (81)
PSYCHOL REV	PSYCH	3.45 (32)	J BROADCAST ELECTRON	COMM	2.07 (82)

COMMUN RES	COMM	3.44 (33)	ECON LETT	ECON	2.06 (83)
J ECON PERSPECT	ECON	3.40 (34)	COMPUT EDUC	EDU	2.06 (84)
ORGAN SCI	BUS	3.33 (35)	NEW MEDIA SOC	COMM	2.04 (85)
CYBERPSYCH BEH SOC N	COMM	3.25 (36)	INF ECON POLICY	ECON	2.04 (86)
PERS SOC PSYCHOL B	PSYCH	3.23 (37)	INT J ELECTRON COMM	BUS	2.04 (87)
ECON J	ECON	3.11 (38)	REV EDUC RES	EDU	2.04 (88)
J ECON LIT	ECON	3.08 (39)	HUM COMMUN RES	COMM	2.04 (89)
J COMPUT-MEDIAT COMM	COMM	3.07 (40)	ADV CONSUM RES	BUS	2.03 (90)
NATURE	----	3.04 (41)	ECON INQ	ECON	2.03 (91)
J RETAILING	BUS	3.03 (42)	J ECON BEHAV ORGAN	ECON	2.03 (92)
J COMMUN	COMM	2.99 (43)	J ADVERTISING	COMM	2.01 (93)
EDUC RES-UK	EDU	2.94 (44)	J POLIT	PS	2.00 (94)
J ACAD MARKET SCI	BUS	2.92 (45)	AM J AGR ECON	ECON	2.00 (95)
AM POLIT SCI REV	PS	2.86 (46)	ADV EXP SOC PSYCHOL	PSYCH	2.00 (96)
INFORM SYST RES	IS	2.85 (47)	GAME ECON BEHAV	ECON	1.96 (97)
J ADVERTISING RES	COMM	2.69 (48)	J VOCAT BEHAV	PSYCH	1.94 (98)
INFORM MANAGE-AMSTER	IS	2.65 (49)	INT ECON REV	ECON	1.94 (99)
ANNU REV PSYCHOL	PSYCH	2.64 (50)	J LABOR ECON	ECON	1.94 (100)

Note:
(1) BUS = Business; COMM = Communication; EDU = Education; ECON = Economics/Finance; IS = Information Science; PS = Political Science; PSYCH= Psychology; SOC = Sociology.
(2) Number in the parenthesis is the rank of journals by structural influence.

Table 2 Hierarchical Linear Modeling Results

	Model 1 Unconditional Mean Model	Model 2 Unconditional Linear Growth Model	Model 3 Conditional Linear Growth Model
Intercept	1.096*** (0.006) (i)	1.072*** (0.005)	2.938*** (0.367)
Time		0.015*** (0.001)	0.018*** (0.003)
Network Closure			
Triadic Closure			0.010 (0.013)
Network Brokerage			
Network Constraint			-0.029† (0.017)
Betweenness Centrality			0.902* (0.453)
Interaction Terms			
Time * Triadic Closure			-0.011 (0.008)
Time * Network Constraint			-0.028** (0.009)
Time * Betweenness Centrality			0.678*** (0.184)
Control Variables			
Journals' Birth Year			-0.001*** (0.0001)
Journals' Activeness in Internet Research			-0.0003† (0.0002)
Subject Area 1(ii)			0.063*** (0.016)
Subject Area 2(ii)			0.018 (0.005)
Subject Area 3(ii)			0.027 (0.021)
Subject Area 4(ii)			-0.003 (0.023)
Subject Area 5(ii)			-0.003 (0.019)
Subject Area 6(ii)			0.049* (0.019)
Subject Area 7(ii)			0.072*** (0.017)
Region 1 (USA = 1, Others = 0)			0.040** (0.015)
Region 2 (UK = 1, Others = 0)			0.012 (0.016)
Impact Factor			0.017*** (0.002)
Random Effects			
σ^2	0.003 ***	0.002***	0.002***
τ_{00}	0.024 ***	0.015***	0.011***
τ_{01}		0.002 ***	0.002***
τ_{11}		0.001 ***	0.0004***

Note: † $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.
(i) Numbers in the parenthesis are standard errors of the estimates; (ii) Subject Area 1 to Subject Area 7 are seven dummy variables generated for the variable "Subject Area": Subject Area 1 (Business = 1, Education = 0); Subject Area 2 (Psychology = 1, Education = 0); Subject Area 3 (Communication = 1, Education = 0); Subject Area 4 (Political Science = 1, Education = 0); Subject Area 5 (Sociology = 1, Education = 0); Subject Area 6 (Information Science = 1, Education = 0); Subject Area 7 (Economics/Finance = 1, Education = 0).

Figure 1 Bivariate Relationship between Journals' In-degrees and Out-degrees

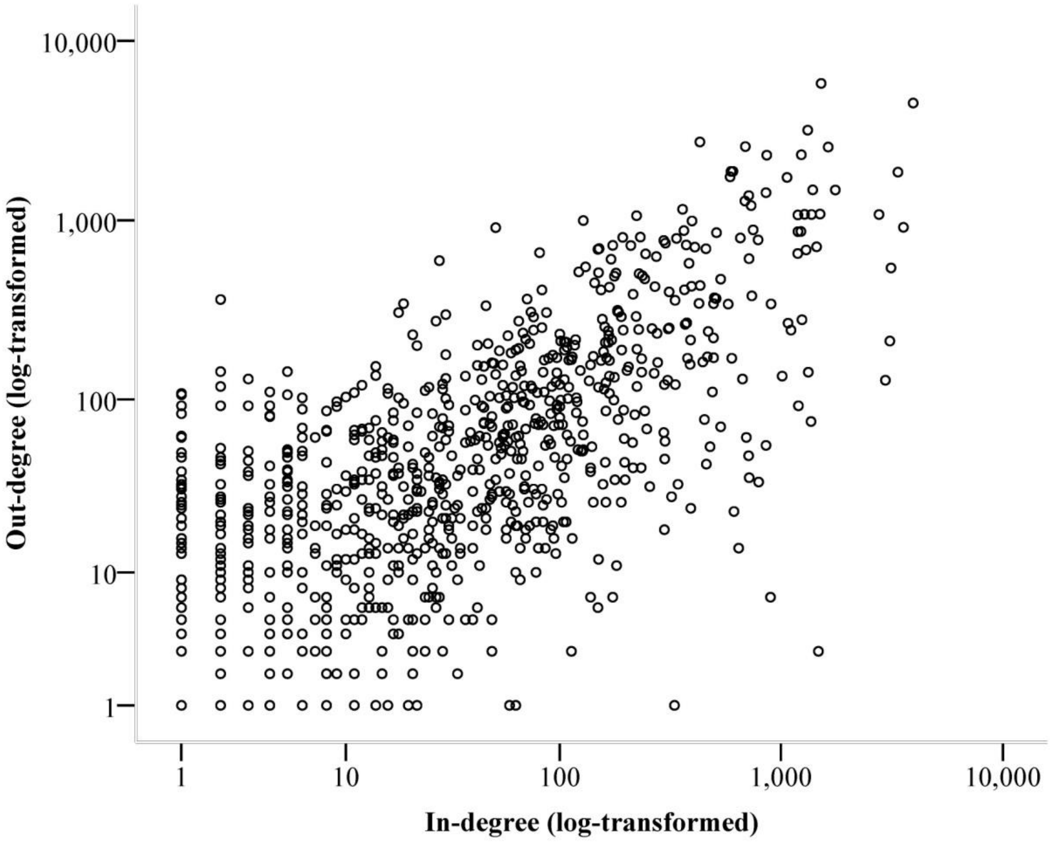


Figure 2 Between-Journal Variation in Growth Trend of Structural Influence

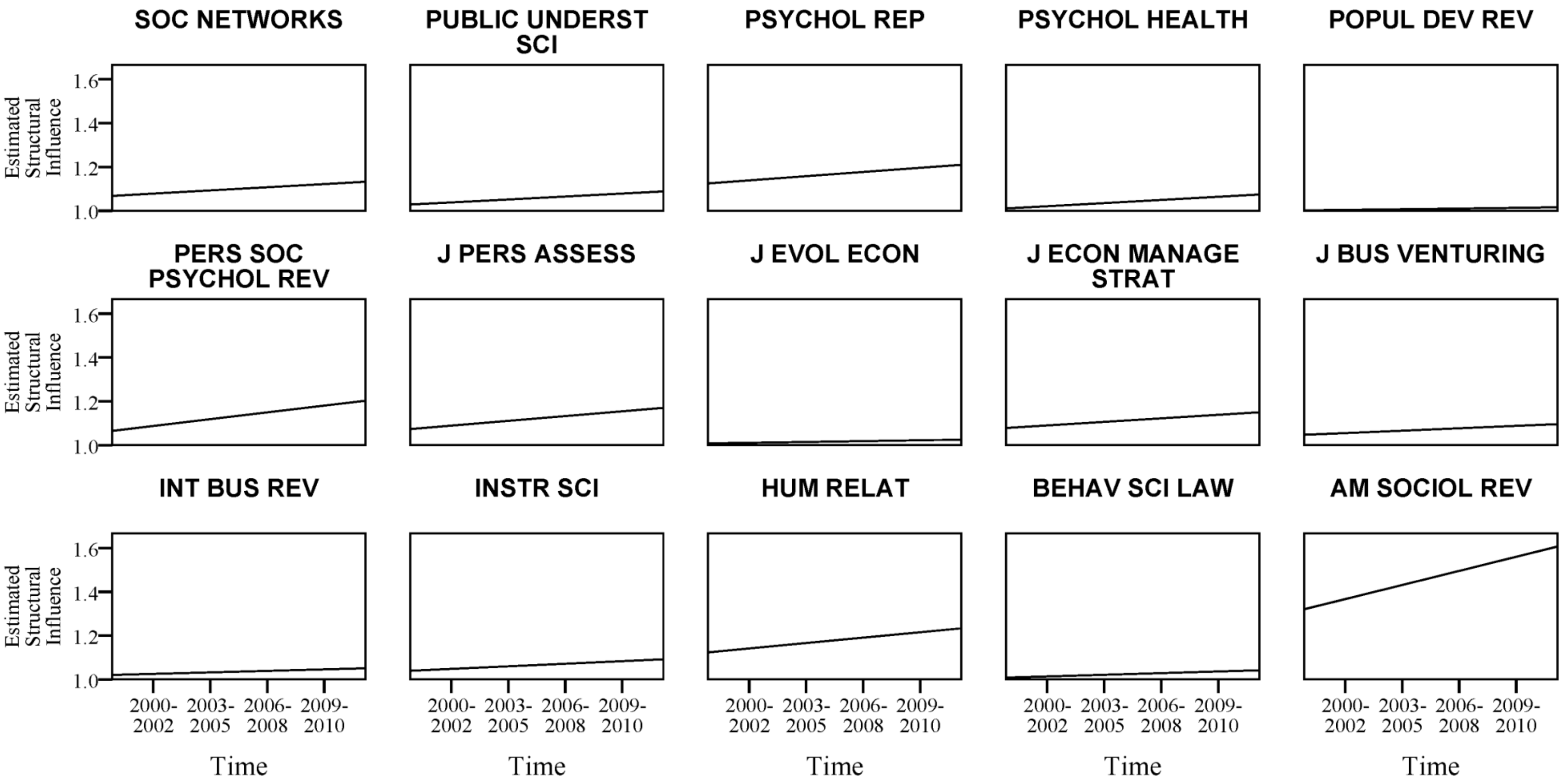


Figure 3 Moderation Effect of Time on the Impact of Network Constraint on Journals' Structural Influence

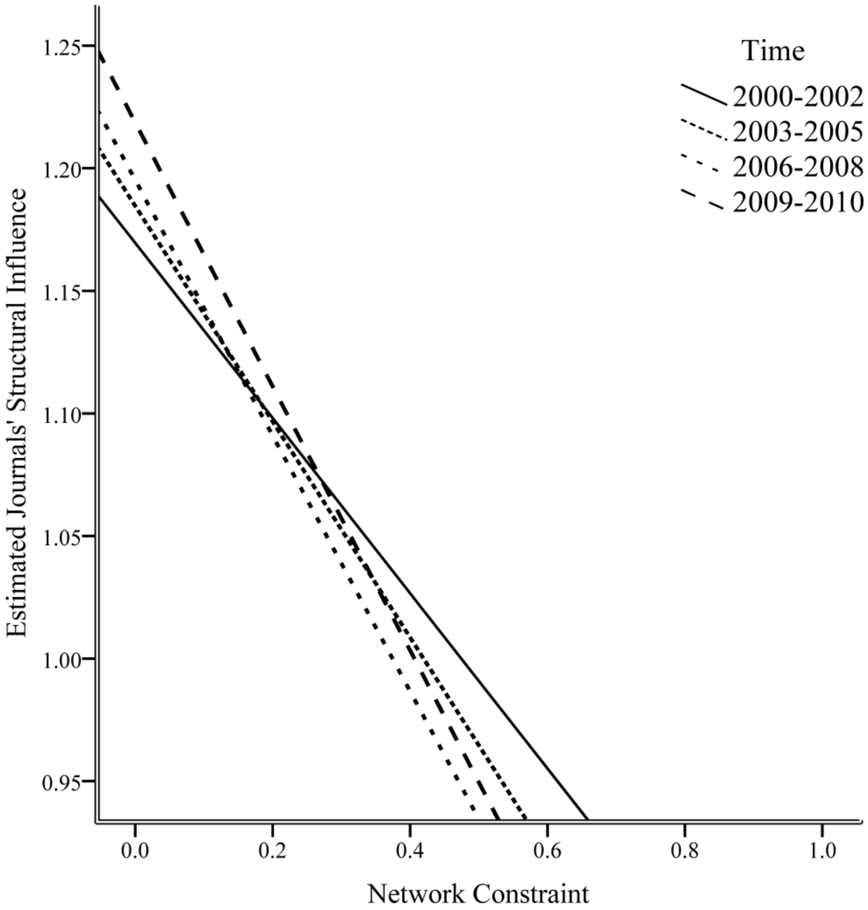
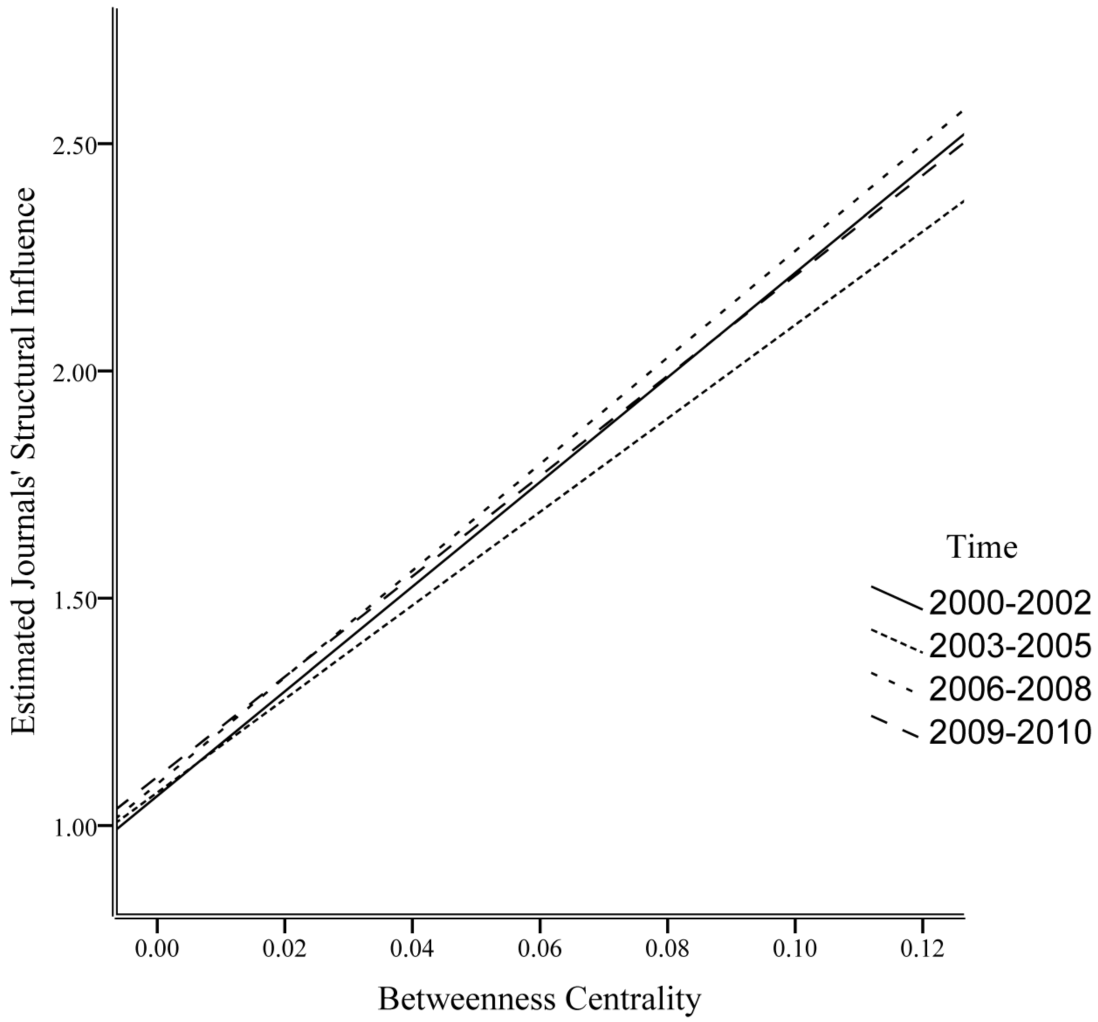


Figure 4 Moderation Effect of Time on the Impact of Betweenness Centrality on Journals' Structural Influence



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