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INVESTIGATING PARTICIPATION IN ONLINE POLICY DISCUSSION FORUMS OVER TIME: DOES NETWORK STRUCTURE MATTER?

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Abstract

Online policy discussion forums can be construed as a social network where citizens interact and collectively deliberate on policy issues. It is believed that citizen participation in such forums can help in the formulation of well-deliberated policy solutions. A key concern for governments is to promote participation in such forums. Social network literature reveals that the evolving interaction patterns between network participants can influence their collective behaviors. Thus, this study aims to investigate the longitudinal effects of network structural properties on forum participation using time series analysis. Our findings reveal that network structure can have both positive and negative effects on participation in terms of the number of postings and unique ideas contributed. This theoretically grounded empirical study on e-participation, employing ARIMA modeling with transfer function analysis on social network measures, contributes to the diversity of theories and methods in IS research. Implications for practice are also discussed.

Keywords: E-participation, online policy discussion forums, network structural properties, social network analysis, time series analysis, ARIMA modeling, transfer function analysis
Introducción

Se creyó que la informática y las tecnologías de comunicación (ICT), particularmente la Internet, tienen el potencial para fortalecer la democracia (Anttiroiko 2003; Barber 1998; Macintosh 2004; Watson and Mundy 2001). Con la maduración de los programas de e-gobierno (Gronlund 2002a), se ha intensificado el esfuerzo por utilizar electrónicamente a los ciudadanos en la toma de decisiones (Moon 2002; Phang and Kankanhalli 2005). A menudo, los programas de participación ciudadana (henceforth referred to as e-participation) pueden explorarse a nivel global, e.g., Denmark’s Nordpol.dk (http://www.nordpol.dk), Israel’s SHIL (http://shil.shil.info/), y Singapore’s REACH (http://www.reach.gov.sg), y US’s Regulations.gov (http://www.regulations.gov/). El impulso por tales iniciativas podría aportar a la conciencia de los gobiernos sobre la necesidad de obtener más gobernanza democrática (Coleman and Gotze 2001), y de hacerlo con un apoyo de la parte pública en general en el potencial de ICT para empoderar a los ciudadanos (Hart-Teeter 2003).

Mientras que se ha realizado un gran volumen de investigación IS en e-gobierno en años recientes, e.g., en las áreas de su adopción (e.g., Himnant and Looney 2004; Phang et al. 2006), desarrollo e implementación (e.g., Chan and Pan 2006; Ma et al. 2005), evaluación (e.g., Abhichandani and Horan 2006), e incluso, e-participación (e.g., Srinastava and Teo 2006), hay un escaso número de investigaciones empíricas de carácter teórico. Particularmente en el ámbito de la participación ciudadana en la toma de decisiones, o e-participación, un análisis de las literaturas muestra una predominancia de publicaciones conceptuales (e.g., Gronlund 2002b; Lourenc and Costa 2006) y descripciones de casos (e.g., Coleman and Gotze 2001; Finney 1999; Jensen 2003), o trabajo empírico hecho sin bases teóricas explícitas e inferencias (e.g., Jensen 2003; Stromer-Galley 2003) con excepciones (e.g., Ng y Detenber 2005; Tambouris et al. 2007; Thrane et al. 2004). Esto es porque el objetivo de esta investigación es avanzar hacia un análisis que combina tanto el conocimiento teórico como el empírico en e-gobierno, particularmente en el contexto de e-participación.

Un modo clave de e-participación es a través de los foros de discusión de políticas en línea, donde los gobiernos solicitan opiniones sobre temas específicos de política. Un foro de discusión de políticas en línea se considera un recurso de bajo costo y escalable para facilitar la toma de decisiones (Kumar and Vragov 2005). Proporciona un escenario para que los ciudadanos compartan sus opiniones, y colaboren para discutir un tema. Los foros de discusión de políticas en línea son un tipo distinto de red en comparación con otras redes de network, e.g., grupos de soporte social y foros recreativos, donde los participantes tienden a formar grupos de individuos similares con intereses similares. La investigación ha hallado que las redes políticas tienden a involucrar participantes de diferentes orientaciones ideológicas o puntos de vista que interactúan activamente en discusiones intelectuales y debates (Kelly et al. 2005). Una característica única de los foros de discusión de políticas en línea implica que se separan de los otros estudios.

La participación ciudadana en los foros de discusión de políticas en línea es considerada deseable para tanto los planificadores del gobierno y los ciudadanos. Para los planificadores del gobierno, estas iniciativas pueden ayudar a recoger las opiniones de los ciudadanos, lo que puede permitir formular políticas más comprensivas y bien recibidas por parte de los ciudadanos. Para los ciudadanos, la expresión de sus puntos de vista puede llevar a políticas más realistas en sus preferencias y necesidades (Irvin y Stansbury 2004). Aunque los foros de discusión de políticas en línea pueden idealmente facilitar la obtención de estos objetivos, las investigaciones han indicado resultados mixtos de tales foros (Finney 1999; Jensen 2003; Wilhelm 1999). Por ejemplo, Finney (1999) reportó un menor que esperado de participación de ciudadanos en un foro de discusión de política set up to solicit citizens’ views on genetic testing devices. Jensen (2003) observó que la presencia de participantes influyentes en un foro de discusión de política en línea parecía tener un impacto en los patrones de interacción entre los participantes. Sin embargo, la efectividad de tales patrones de interacción en general no está clara. Esto también pone en duda a qué grados de interacción puede llevar a una mayor participación activa en los foros de discusión de políticas en línea.

La red de análisis social (SNA) puede ayudar a la comprensión de patrones de interacción en una red en línea. Revela que los patrones de interacción entre individuos emergen en una red; para usuarios, el comportamiento colectivo de las propiedades estructurales de red pueden tener un impacto en sus comportamientos colectivos. La base es que los individuos tienden a adaptar su comportamiento condicionalmente a los comportamientos y expectativas de los demás en la red. En el contexto offline, las propiedades estructurales de red han demostrado influir en acciones colectivas, como movimientos sociales, protestas, y voluntariado (e.g., Gould 1993; Marwell y et al. 1988). De manera similar, las propiedades estructurales de red en el contexto online son encontradas para tener un impacto en los patrones y tipos de intercambio de conocimiento entre los miembros en red en línea de foros profesionales (Huang y DeSanctis 2005). Un análisis de la literatura relacionada con la participación ciudadana en los foros de discusión de políticas en línea muestra que los estudios existentes tienden a enfocarse en los patrones y características de dichos foros (e.g., Kelly et al. 2005), y de los resultados de la participación en estos foros (e.g., Finney 1999; Jensen 2003; Wilhelm 1999). Hay un desacuerdo en que...
of research that explores the relationships between the two. Additionally, existing studies that examine the effects of network structural properties (e.g., Gould 1993; Marwell et al. 1988) seldom consider the evolution of the social network and its corresponding impact on members’ participation in the network. The snapshot view of the phenomenon may result in ambiguous findings associated with cross-sectional correlations (Granger 1980).

With the above practical and theoretical motivations, the purpose of this study is to investigate the relationships between social network structural properties and citizen participation in online policy discussion forums over time. In other words, we aim to answer the following question: “How do overall patterns of interactions between citizens in an online policy discussion forum influence their contribution of inputs to the forum over time?” Accordingly, online policy discussion forum where citizens interact to deliberate on policy issues constitute the social network that is the unit of analysis in this study. Four relevant network structural properties are identified and analyzed, i.e., core-periphery, centralization, inclusiveness, and reciprocity. The hypothesized relationships between these network structural properties and participation in online policy discussion forums are empirically tested using time series data based on ARIMA (autoregressive integrated moving average) modeling with transfer function analysis. The study aims to contribute to the research as well as practice on e-government and participation in electronic networks. Simultaneously, it intends to enhance the diversity of theories and methods in IS research by studying a relatively under-explored domain (i.e., e-participation) using techniques (ARIMA modeling with transfer function analysis on social network measures) that have scarcely been employed in IS research.

**Conceptual Background and Hypotheses**

Core-periphery, centralization, and density are fundamental structural properties used to describe a network (Brass 1995; Wasserman and Faust 1994). These properties have been widely employed for the investigation of network structural effects in the non-policy discussion network contexts. For instance, centralization has been consistently shown to be undesirable for network-related outcomes e.g., in terms of group performance (Rulke and Galaskiewicz 2002; Sparrowe et al. 2001) and knowledge contribution (Huang and DeSanctis 2005). However, the effect of core-periphery is less clear. Cumming and Cross (2003) find that core-periphery is detrimental to group communication and performance; whereas Huang and DeSanctis (2005) show that this property may serve to encourage knowledge contribution behavior. This discrepancy will be further examined when we develop the hypothesis on core-periphery. Density is related to a less frequently employed network measure called inclusiveness, which, together with reciprocity, has been highlighted in the citizen participation literature as desirable for policy deliberation (Barnes 1999; Jensen 2003). However, the actual effects of these network structural properties (inclusiveness and reciprocity) on participation in online policy discussion forums have not been tested. Of these two related properties, only inclusiveness is examined in this study due to reasons that we will discuss during the development of hypothesis on inclusiveness.

In sum, there is a paucity of research that investigates the effects of the above-mentioned network structural properties (i.e., core-periphery, centralization, inclusiveness, and reciprocity) on participation in online policy discussion forums. We thus develop hypotheses about their longitudinal relationships with two participation outcomes of an online policy discussion forum i.e., number of postings and number of unique ideas gathered from the forum. Number of postings provides an indicator of the level of response obtained from a policy discussion forum. Policy makers may, however, be particularly interested in the number of unique ideas solicited from the forum. The measure does not look at the quantity per se, but the ideas that can be found within the postings contributed by participants, and whether they are unique relative to others. These unique ideas may serve to inform policy making and help in the formulation of more comprehensive policies (Irvin and Stansbury 2004). The hypotheses posit that the pertinent network structural properties (i.e., core-periphery, centralization, inclusiveness, reciprocity) in the previous time periods would influence the participation outcomes (in terms of the number of postings and unique ideas) in the subsequent time periods.

**Core-Periphery**

Core-periphery implies a dense, cohesive core that exists with a sparse or unconnected periphery (Cummings and Cross 2003). Figure 1 illustrates an example of this network structure. In this network structure, the core-subgroup consists of interconnected actors in some maximal sense, while the peripheral actors are more loosely connected to the core-subgroup and with each other (Borgatti and Everett 1999). Mathematically this can be expressed as the following (Borgatti and Everett 1999):
Where \( a_{ij} \) indicates the presence/absence of a tie between two actors \( i \) and \( j \); \( c_i \) refers to the class (core or periphery) that an actor \( i \) belongs to (similarly for \( c_j \)); and \( \delta_{ij} \) indicates the presence/absence of a tie between actors \( i \) and \( j \) in the ideal core-periphery structure for the network.

In the offline context, core-periphery structure is found to be detrimental to group communication due to the marginalization effect of peripheral members by the core-subgroups (Cumming and Cross 2003). However, it has been argued that such effect may be less applicable to the online context. In online forums, it is relatively easy for members to communicate with each other compared to the offline context (Koku and Wellman 2002). Information is shared by making both initial messages and subsequent responses available to all participants in the forums (Finholt and Sproull 1990). This effectively turns online forums into an information repository that stores previous communication and interaction among members.

Although this nature of online forums could virtually eliminate the communication barrier prevalent in the offline context, whether one is actually involved in communication and interaction with another should still matter. Specifically, the extent of influence that one receives when s/he is in the core-subgroup compared to when s/he is in the periphery is different. Individuals in the core-subgroup are by definition those who are more active and influential participants than those in the periphery (Borgatti and Everett 1999). Being engaged within the core-subgroup (i.e., involved in actual discourses with a cohesive group of participants) may thus subject one to higher influence to participate actively in accordance to the behavior and expectation of other members in the subgroup. The peripheral members, on other hand, might choose not to be involved within the core-subgroup even though it is theoretically easy to do so in the online context. This could be due to a reluctance to put themselves under the influence of the core-subgroup, or a lack of intention to become a dominant participant.

While the marginalization effect is relatively ambiguous in the online context, the existence of core-subgroups with high network closure (i.e., everyone in the subgroup is connected to each other) may serve to improve communication, and lead to a more reliable and coordinated exchange of information (Coleman 1990). The high network closure in the core-subgroups may even facilitate the formation of trust and norms over time (Coleman 1990), which may in turn encourage information sharing from members. The core-subgroups may also play the role of discussion leaders who coordinate the discussion, broadcast ideas contributed by members, and stimulate further contributions and participations (Huang and DeSanctis 2005). In the context of online policy discussion forums, the core-subgroups are likely to consist of members with diverse ideological backgrounds or viewpoints actively engaging in intellectual discourses (Kelly et al. 2005). An excerpt from the policy discussion forum that we examined (on the issue of whether to encourage citizens to use their social security savings for further investment purposes) may serve to illustrate this (see Table 1).
set of perspectives to other members connected to them. This may provide the intellectual stimulation (Blau 1977) that can help generate more postings and ideas from the participants over time. From the perspective of constructive controversy theory (Johnson and Johnson 2000), when individuals are faced with different perspectives based on other people’s information and perspectives, they become uncertain about the correctness of their views. This uncertainty motivates their “epistemic curiosity”, which then prompts them to formulate new ideas and perspectives in hopes of resolving the uncertainty. Hence, we expect the core-periphery structure to be associated with increased participation of members in an online policy discussion forum over time:

H1a, b: Over time, the greater the core-periphery structure exhibited in an online policy discussion forum, the higher the level of participation in the forum, in terms of (a) number of postings; and (b) number of unique ideas.

Table 1. Excerpt from Online Policy Discussion Forum under Study (Core-Periphery)

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>W</td>
<td>To K: With regards to buying annuity so early at 40 and expect to receive the annuity later is interesting. However I tend to think that … how well the returns of your money would depend on the competence of the insurer. Effectively you are just using the insurer like a fund manager and, active fund managers would fail to outperform the market average over a long term basis.</td>
</tr>
<tr>
<td>D</td>
<td>Dear K: Investing in annuity is like buying a life pension. If you expect to live a long life, go ahead. Some actuaries take the total of your parents’ age, divide it by 2, and add another 4 years, which [sort of predicts] how long you should live. Life expectancy is determined by genes and lifestyles.</td>
</tr>
<tr>
<td>W</td>
<td>To D: Acceptance of passive funds is a problem. Unfortunately even if there is a widespread acceptance, it is economically not in the interest of the country to see passive funds flourish.</td>
</tr>
<tr>
<td>K</td>
<td>Dear D: You wrote “Life expectancy is determined by genes and lifestyles”. I wish this is as simple as what you said. But seriously, our life expectancy will increase simply because of advancement in medical knowledge…</td>
</tr>
<tr>
<td>D</td>
<td>Hi W: [Passive funds would still be preferred]…Over 80% to 90% of actively-managed funds under-performed [according to] the benchmarks. The reason why banks don’t sell index fund is the low sales charges of 2% instead of 5% and the low annual fees that they can get.</td>
</tr>
<tr>
<td>M</td>
<td>To W: There seems to be a misunderstanding of passive vehicles like index funds. The problem with most mutual funds is that they are measured relative to the index….</td>
</tr>
</tbody>
</table>

Centralization

Network centralization refers to the extent to which a network is centralized around certain prominent actors in terms of connectivity among network members (Freeman 1979; Koku and Wellman 2002). There are three commonly employed types of network centralization i.e., degree centralization, closeness centralization, and betweenness centralization (Freeman 1979). Degree centralization focuses on centralized actors who have ties with a large number of other network members. Closeness centralization concerns centralized actors who are able to traverse a small number of relations to reach all other members in the network. Betweenness centralization is related to centralized actors who occupy positions between two or more otherwise unconnected members.

In this study, we will focus on degree centralization as we are interested to study the effect of having interactions in a network concentrated on a few centralized actors on participation. The high degree-centralized actors act as “hubs”, such that discourses in a policy discussion forum revolve around them. For closeness centralization, the centralized actors play an important role in that network members can establish ties with these actors in order to reduce their distance to others in the network. For betweenness centralization, the centralized actors act as the “middle persons” between two or more network members which grants them control over the flow of information throughout the network. The importance of the roles played by high closeness-centralized and betweenness-centralized actors may diminish in the context of an online discussion forum (as in the policy discussion forums under study) where interactions among participants are made visible to all and one member can readily post a message to another with a click of a button.

To further illustrate the property of degree centralization that we will investigate, the most extreme case of such structure is shown in Figure 2. This is a “star” network where everyone in the network is connected to a single
central actor. The mathematical formula for degree centralization (henceforth referred to as centralization) is expressed as follows:

\[
\text{Centralization} = \frac{\sum [c_i - c^\ast]}{\max \sum [c_i - c^\ast]},
\]

where \(c_i\) is the centrality of actor \(i\) and \(c^\ast\) is the centrality of the most central actor. Centrality, then, is expressed as:

\[
c = \sum_{i,j} a_{ij}, \quad \text{where} \quad a_{ij} = \begin{cases} 1 & \text{if } a_i \text{ and } a_j \text{ are connected} \\ 0 & \text{otherwise} \end{cases}
\]

Centralization and core-periphery are two distinctive network structures, although both reflect the closure and cohesion of a network to certain degree. The difference is that in centralized networks, communication is centered on individuals, who are not closely connected in a subgroup as in the case of core-periphery structure. Relating to Table 1 (excerpt from the policy discussion forum under study) that illustrates core-periphery, a centralization scenario would entail, for instance, participants D, K, and M all communicating with W, while D, K, and M did not communicate among themselves (i.e., a “star” network structure centered on the participant W). While there is a tendency to treat a core-subgroup simply as an individual with high centrality, the two differ in their information processing capacity (Burt 1992) and the potentially diverse viewpoints held by individuals who engage in discourses in the subgroup.

In general, a network with high centralization is found to hinder communication and information exchange (Huang and DeSanctis 2005; Rulke and Galaskiewicz 2002; Sparrowe et al. 2001). Previous studies have thrown light on this relationship from the perspective of structural equivalence (Burt 1992). Structural equivalence denotes a situation where two individuals have the same contacts. This results in redundancy, as information acquired from the same contacts is likely to be the same. Hence in a highly centralized network, many individuals are subject to structural equivalence because they are connected to the same central actor (Burt 1992). In the context of online policy discussion forums, participants connected to the centralized actors may thus subject themselves to influence from a potentially more limited set of different perspectives.

Another line of logic for the negative effect of centralization has to do with the cost of having to maintain contact with many people for the centralized actors (Burt 1992). The centralized actors may be overwhelmed by the effort needed to maintain connections with a large number of individuals to engage in active discourses. When the number of such highly centralized actors are many (i.e., a highly centralized network), the efficiency of communication in the network as a whole is likely to be undermined over time. The overwhelmed centralized actors may be inclined to repeat similar postings or views to different actors connected to them. The overall decline in perspectives and views being discussed in the forum may then as a whole dampen the motivation of network members to formulate new ideas and perspectives in deliberating a policy issue (Blau 1977; Johnson and Johnson 2000). Overall then, we expect high network centralization to be associated with lower participation in an online policy discussion forum over time:

\(H2a, b: \text{Over time, the greater the network centralization exhibited in an online policy discussion forum, the lower the level of participation in the forum, in terms of (a) number of postings; and (b) number of unique ideas.}\)

**Inclusiveness**

Inclusiveness of a network refers to the total number of actors in a network minus the number of isolated actors, who do not have any connection with other members (i.e., those who do not interact with any other actors in a network). Inclusiveness is expressed as a ratio of connected actors to the total number of actors present in the network (Brass 1995; Monge and Contractor 1999):

\[
\text{Inclusiveness} = \frac{N_c}{N}, \quad \text{where} \quad N_c \text{ is the number of connected actors, and } N \text{ is the total number of actors in the network.}
\]

It is a concept related to the more widely-employed network density, as both of them are concerned with whether network actors are connected or not connected. However, the network density measure also considers the numbers of ties that exist between actors, not only whether the two actors are connected. It deals with the proportion of all
possible ties that are actually present. Mathematically, density is defined as the sum of the total number of ties divided by the total number of all possible ties in a social network (Hanneman and Riddle 2005):

\[
Density = \frac{2L}{N(N-1)}, \text{ where } L \text{ is the number of ties in the network, and } N \text{ is the total number of actors in the network.}
\]

The difference between the two properties is depicted in Figure 3.1 and Figure 3.2, which show that a network achieving optimal inclusiveness (Figure 3.1) may not be the same as the one that has the highest density possible (Figure 3.2). Of the two properties, we decided to employ inclusiveness in this study as the measure of density has often been problematic. Using simulation, Friedkin (1981) showed that density is a problematic index of structural cohesion if a network has subgroups (such as a dense core). Additionally, comparisons of density measures across networks that differ in size can be misleading (Friedkin 1981). In contrast, inclusiveness highlights the presence of isolates (i.e., network actors who are not connected to each other). This allows us to focus on the effect of a network with high percentage of isolates on the overall participation in an online policy discussion forum.

The presence of isolates is deemed to be undesirable in the organizational context (Balkundi and Kilduff 2005; Roberts and O’Reilly 1979). They tend to withhold information, express less commitment, and are rated as low performers (Roberts and O’Reilly 1979). Reasons for this include a lack of affection and a feeling of alienation of isolates towards other members in the group, which deter them from communicating with others (Roberts and O’Reilly 1979). In the context of online policy discussion forums, isolates are those who merely state their own views without engaging in discussion with others. This could be due to their apathy towards discussions in the forum, or they may feel alienated by the views of other participants in the forum. A network with low inclusiveness (i.e., one with a large number of isolates) implies that, as a whole, only few in the network engage in discourses with others. The lack of discourses among participants may in turn impede the intellectual stimulation that is favorable to promote active participation in deliberation (Blau 1977; Johnson and Johnson 2000) over time. Conversely, high inclusiveness is believed to be favorable to citizen participation in deliberation as it may bring about a diversity of perspectives and experience among the participants (Barnes 1999). Therefore, we postulate that:

\[H3a, b: \text{Over time, the greater the inclusiveness exhibited in an online policy discussion forum, the higher the level of participation in the forum, in terms of (a) number of postings; and (b) number of unique ideas.}\]

**Reciprocity**

Reciprocity refers to the extent that relationships between participants in a social network are symmetric (Wasserman and Faust 1994). The term is often used synonymously with mutuality (e.g., Monge and Contractor 2003). Reciprocity arises when pairs of actors (i.e., dyads) in the social network have a bidirectional response link (i.e., A talked to B and B also talked to A). Mathematically, reciprocity can be expressed as:

\[\text{Reciprocity} = \frac{D_r}{N_c}, \text{ where } D_r \text{ is the number of symmetrical (reciprocated) dyads, and } N_c \text{ is the number of connected actors in the network.}\]

An excerpt from the policy discussion forum under study (on the issue of adjustment of foreign worker quota in the service sector) serves to illustrate the occurrence of reciprocity, in which the participants N and A engaged in mutual discourses with each other (Table 2):

Reciprocity has been considered one of the defining attributes of social networks, both in the offline (Seabright 2004) and online contexts (Wellman and Hampton 1999). Figure 4 illustrates an ideal case of reciprocity in a network, where all connected members in the optimal inclusiveness scenario (Figure 3.1) have a reciprocal link with each other.
Table 2. Excerpt from Online Policy Discussion Forum under Study (Reciprocity)

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<table>
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</thead>
<tbody>
<tr>
<td>N</td>
<td>To A: The value of [local] workers to businesses must be higher than that of other countries in order for them to command higher wages. This is simple economics. In a free economy, a worker can demand any amount he wants for his services, but ultimately it is his employer who decides whether he is worth paying the amount for his skills, irrespective of the availability of foreign workers quota.….</td>
</tr>
<tr>
<td>A</td>
<td>Dear N: The low-wage earners may be slumbering. But, the fact that they are the low-wage earners, to put it nicely, means that they are at the bottom rung. This could be due to [reasons that were out of their control]… [It is unfair] to put them to the line of fire [having to compete with foreign workers] just because of that. There must be real efforts to help them e.g., by re-educating, re-training them….</td>
</tr>
<tr>
<td>N</td>
<td>To A: The government has put up the infrastructure and financial support for skills upgrading and retraining of our workers to meet the needs of the new economy. Some workers have taken advantage of them. But most of them have not. Most workers are simply too short-sighted to see the need to retrain…</td>
</tr>
</tbody>
</table>

Reciprocity in general has been found to be favorable for members’ participation in a social network (Kollock 1999; Lakhani and von Hippel 2003; Wang and Fesenmaier 2003). Previous studies show that the existence of reciprocity is one of the major motivations driving individual’s contribution in online communities (Wang and Fesenmaier 2003). When there is a high level of reciprocity in a network, it creates a general confidence that other members in the network will respond to one’s contribution, so that such contribution will not go unnoticed. This may then create the motivation for one to continue to participate towards the generation of public good (e.g., collectively deliberating a policy issue) in the network (Kollock 1999). Specific to the context of online policy discussion forums, reciprocity is considered a core element that completes the deliberating process because it shows that participants have taken into account the information and perspectives of each other (Jensen 2003; Gutmann and Thompson 1996). The two-way information and perspective exchange resulting from reciprocal discourses may serve to enhance the intellectual stimulation that fuels for further ideas and thoughts over time (Blau 1977; Johnson and Johnson 2000). Therefore, we expect reciprocity to have a positive relationship with the overall participation in an online policy discussion forum over time:

\[ H4a, b: \text{Over time, the greater the reciprocity exhibited in an online policy discussion forum, the higher the level of participation in the forum, in terms of (a) number of postings; and (b) number of unique ideas.} \]

Figure 5 shows the model and hypotheses developed in this study.
Research Method

We employ social network analysis with UCINET v.6.157 (Borgatti et al. 2002) to obtain measures of the network structural properties of interest: core-periphery, centralization, inclusiveness, and reciprocity over a period of approximately one year (54 weeks) in the target online policy discussion forum. For the dependent variables, we identified and counted the number of postings as well as the number of unique ideas contributed by participants in the forum for the same period of time. Time series analysis based on the autoregressive integrated moving average (ARIMA) modeling with transfer function analysis using SPSS v15.0 was then employed to test the hypotheses about the longitudinal effect of network structural properties on participation in the online policy discussion forum.

Research Context

The study was conducted in an Asian country where the government has been actively promoting citizen participation in online policy deliberation in recent years. As part of a national citizen feedback portal, an online policy discussion forum has been initiated by the government agency in-charge to engage citizens in deliberating specific national policy issues. These issues belong to areas such as community, transport, environment, human resource, and security. Examples of these issues include “smoking ban in more public premises”, “extending retirement age”, “use of social security savings for further investment purposes”, and “adjustment of foreign worker quota in the service sector”. The agency that initiates the policy discussion provides the background of the issue and any relevant documents that may help in understanding the issue. Citizens may use pseudonyms to participate in the forum. The forum is lightly moderated to the extent that defamatory postings are deleted from time to time to help maintain a conducive environment for participation. For each week of data collected from the policy discussion forum, we recorded the following: a unique identifier for each participant, date of each posting, and the content of the posting. On average, there were 77 postings contributed by 44 participants per week, and a total of 4,147 postings contributed to the discussion of 58 policy issues in the forum over the 54-week period. A survey that we conducted as part of our larger research program on e-participation revealed a negligible number of participants who knew each other prior to participating in the forum, and who communicated with other members through other means than the forum itself (less than 4% for both).
Independent Variables - Network Measures

For each week of the time series data, we constructed social network matrices based on the interactions among participants in the forum. In electronic networks, a dyadic link is created between two individuals when one responds to another’s posting (Ahuja et al. 2003). As an indicator of interaction between two participants, we recorded instances where a participant posted a reply message by referring to another participant’s pen name or by manually quoting his/her posting (there was no “reply” or “quote” button in the forum). Using this information, we created an adjacency matrix for each week with UCINET (Borgatti et al. 2002), in which both columns and rows represented participants and a “1” in the cells represented the presence of interaction between two participants (Figure 6). Participants in the rows are the ones who initiated the interaction (i.e., posted a reply message) with participants in the columns. The adjacency matrix forms the basis for the computation of the four network measures: Core-periphery, centralization, inclusiveness, and reciprocity (Scott 1991).

<table>
<thead>
<tr>
<th></th>
<th>Alex</th>
<th>John</th>
<th>Catherine</th>
<th>George</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alex</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>John</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Catherine</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>George</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Names in the figure are fictitious and provided for illustration purposes only

The core-periphery measure was obtained from UCINET which produced a measure of core-periphery structure for the adjacency matrix for each week of the forum (Borgatti et al. 2002). The continuous measure of fit was employed in which UCINET uses a genetic algorithm to compute the value of the network measure (Borgatti and Everett 1999). Centralization was computed with UCINET based on Freeman’s (1979) graph centralization approach. It computes the percentage of variability in the participants’ degree of centrality (including both in- and out-degree) in an observed network relative to that in a star network of the same size (Borgatti et al. 2002). The measure of network inclusiveness was computed as the ratio of connected participants over the total number of participants in the forum (Monge and Contractor 1999). Both the total number of participants and the number of connected participants in the network were determined from the adjacency matrix generated by UCINET. For reciprocity, we adopted the most frequently employed empirical measure, which is based on un-weighted ties and differentiates between null and asymmetric (unreciprocated) dyads versus mutual (reciprocated) dyads (Wasserman and Faust 1994). All the network measures mentioned can range from zero to one.

Dependent Variables - Number of Postings and Number of Unique Ideas

We counted the number of postings contributed in each week in the discussion forum. For the number of unique ideas, one of the researchers served as the primary coder who read through the contents of each posting in the discussion forum. From the start of the discussion on a particular policy issue, the researcher identified ideas from each posting, and made records of whether each idea is new or repeated in the discussion forum log file (in Excel format). The records allowed for tracking at a later time to check if the number of unique ideas found in the policy discussion was correctly identified and counted. Several meetings were held among the researchers in the beginning to check for the reliability of the coding. A second researcher independently identified the number of unique ideas in a series of 50 postings. Discrepancies in the coding of unique ideas were reviewed and resolved after each meeting. Inter-coder reliability using Cohen’s kappa (Cohen 1960) was 0.82 at the end of the exercise, indicating adequate agreement. Given the accuracy of the inter-coder reliability, the researcher responsible for coding then proceeded to code the rest of the postings in the discussion forum. Subsequently, the researchers would meet to discuss any ambiguities in the coding. This is deemed justifiable as the identification of unique ideas (i.e., determining whether an idea is new) requires less subjective interpretation compared to other measures that are multidimensional and multilevel e.g., idea quality (Dean et al. 2006).
Data Analysis and Results

The longitudinal analysis in this study requires time series models that can represent temporal changes in variables, as well as to test causal hypotheses relating two or more data series. Specifically, the autoregressive integrated moving average (ARIMA) model (Box and Jenkins 1976) with transfer function analysis using SPSS v15.0 was employed. ARIMA is one of the most advanced and widely employed time series modeling techniques (Maddala 2001; O’Donovan 1983). ARIMA is named so because it consists of three components (p, d, q): The autoregressive component (p) refers to the degree that variation in a series is dependent on its past history; the integrated component (d) models the trends in the data, if there is any (0 if the series is stationary); and the moving average component (q) indicates the number of lags over which a current time series observation is dependent on past error terms in the data. Given a time series of data $X_t$ where $t$ is an integer index, an ARIMA (p, d, q) model is given by 

$$
(1 - \sum_{i=1}^{p} \phi_i L^i)(1 - L)^d X_t = (1 + \sum_{i=1}^{q} \theta_i L^i)\epsilon_t,
$$

where $\phi_i$ represents the parameters of the autoregressive component, $\theta_i$ represents the parameters of the moving average component, and $\epsilon_t$ is the error term. $L$ is the lag operator that operates on element of a time series to produce the previous element, such that $L^i X_t = X_{t-i}$. ARIMA models are preferred for longitudinal data analysis because model estimates obtained from this method are considered more reliable and relatively unbiased compared to those obtained from traditional econometric modeling (Hamilton 1994). The transfer function analysis relates the dependent series to one or more predictor series. Between the dependent series and each of the predictor series, the transfer function analysis yields estimates of transfer function coefficients, which are similar to regression coefficients except that they represent the dynamic and cyclical relations between the series rather than static and linear relations. The coefficient for each time lag between the dependent series and the predictor series might be different, and only a few are statistically significant in practice (Monge et al. 1992). In other words, the dependent series might react to the predictor series with a time lag that is distributed across several time periods (Pankratz 1991).

Modeling the three ARIMA components (autoregressive, integrated, and moving average) requires an iterative process which Box and Jenkins (1976) describe as identification, estimation, and diagnosis. Identification involves the initial determination of p, d, and q values that represent the variation in a series. Estimation yields the actual values for each of the p, d, and q components in the identified model. Diagnosis evaluates the adequacy of the estimated model. Identification and diagnosis can be accomplished by examining the autocorrelation functions (ACF) and partial autocorrelation functions (PACF). ACF is the correlation of a variable with itself at each possible time lag; whereas PACF is similar to ACF except that it also controls for all intervening time lags. Overall the criterion for accepting an ARIMA model is a random pattern in the residuals of the model. The randomness of residuals can be checked from the Ljung-Box Q-statistics (Box and Jenkins 1976). An insignificant Q-statistics value (i.e., > 0.05) indicates that the model is correctly specified, in that there is no structure in the observed series that has not been accounted for by the model.

Before testing the hypotheses, we examined the inter-construct correlations and performed a multicollinearity test. The inter-construct correlations with a highest value at 0.547 and VIF values that range from 1.3 to 2.1, which are less than the recommended threshold value of 10 (Hair et al. 1995), indicated no serious multicollinearity problem with the constructs. All measures were also standardized to avoid scale issues. Table 3 provides the descriptive statistics of the constructs.

<table>
<thead>
<tr>
<th>Table 3. Descriptive Statistics of Constructs (N=54)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core-Periphery</td>
</tr>
<tr>
<td>0.43</td>
</tr>
<tr>
<td>Centralization</td>
</tr>
<tr>
<td>Inclusiveness</td>
</tr>
<tr>
<td>Reciprocity</td>
</tr>
<tr>
<td>Number of Postings</td>
</tr>
<tr>
<td>Number of Unique Ideas</td>
</tr>
</tbody>
</table>
Apart from the ACF, PACF, and Q-statistics, the adequacy of an ARIMA model can also be assessed based on the R-squared (proportion of the total variation in the series that is explained by the model), RMSE (root mean square error), normalized BIC\(^1\) (Bayesian Information Criterion is an indicator of the overall model fit that attempts to account for model complexity with smaller value indicating a better fit), and the number of outliers detected. Competing ARIMA models were compared and assessed for their adequacy based on the preceding indicators\(^2\). The resulting models along with the relevant model statistics, as well as the results of hypotheses testing for the number of postings and number of unique ideas based on the models are summarized in Tables 4 and 5 respectively. The Q-statistics values exceeding 0.05 for both models (Tables 4 and 5) indicate that they are adequately specified.

**Table 4. Results of Hypotheses Testing for Number of Postings**

* * p<0.05, ** p<0.01. For variables without any significant effect detected, only Lag 1 coefficient is shown.

Value in **boldface** indicates the corresponding hypothesis is supported;

Value in italics means the relationship is significant, but in the opposite direction as hypothesized.

<table>
<thead>
<tr>
<th>ARIMA (0, 0, 1) Independent Variables</th>
<th>Lag (week)</th>
<th>Estimate</th>
<th>Standard error</th>
<th>t-value</th>
<th>Sig. (p)^</th>
<th>Hypotheses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual error term (q)</td>
<td>1</td>
<td>0.99</td>
<td>2.45</td>
<td>0.41</td>
<td>0.690</td>
<td>-</td>
</tr>
<tr>
<td>Core-periphery (H1a)</td>
<td>1</td>
<td>0.49</td>
<td>0.13</td>
<td>3.80</td>
<td>0.001**</td>
<td>Supported</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>0.31</td>
<td>0.12</td>
<td>2.61</td>
<td>0.016*</td>
<td></td>
</tr>
<tr>
<td>Centralization (H2a)</td>
<td>5</td>
<td>-0.31</td>
<td>0.15</td>
<td>-2.15</td>
<td>0.043*</td>
<td>Supported</td>
</tr>
<tr>
<td>Inclusiveness (H3a)</td>
<td>5</td>
<td>0.39</td>
<td>0.14</td>
<td>2.76</td>
<td>0.011*</td>
<td>Supported</td>
</tr>
<tr>
<td>Reciprocity (H4a)</td>
<td>1</td>
<td>-0.22</td>
<td>0.09</td>
<td>-2.53</td>
<td>0.019*</td>
<td>Not supported</td>
</tr>
<tr>
<td>No. of policy issues</td>
<td>1</td>
<td>0.26</td>
<td>0.21</td>
<td>1.22</td>
<td>0.234</td>
<td>-</td>
</tr>
</tbody>
</table>

**Table 5. Results of Hypotheses Testing for Number of Unique Ideas**

* * p<0.05, ** p<0.01. For variables without any significant effect detected, only Lag 1 coefficient is shown.

<table>
<thead>
<tr>
<th>ARIMA (1, 0, 0) Independent Variables</th>
<th>Lag (week)</th>
<th>Estimate</th>
<th>Standard error</th>
<th>t-value</th>
<th>Sig. (p)^</th>
<th>Hypotheses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autoregressive term of no. of unique ideas (p)</td>
<td>1</td>
<td>-0.14</td>
<td>0.23</td>
<td>-0.62</td>
<td>0.543</td>
<td>-</td>
</tr>
<tr>
<td>Core-periphery (H1b)</td>
<td>1</td>
<td>0.53</td>
<td>0.17</td>
<td>3.01</td>
<td>0.005**</td>
<td>Supported</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>0.50</td>
<td>0.18</td>
<td>2.83</td>
<td>0.009**</td>
<td></td>
</tr>
<tr>
<td>Centralization (H2b)</td>
<td>5</td>
<td>-0.68</td>
<td>0.20</td>
<td>-3.46</td>
<td>0.002**</td>
<td>Supported</td>
</tr>
<tr>
<td>Inclusiveness (H3b)</td>
<td>5</td>
<td>0.51</td>
<td>0.17</td>
<td>2.92</td>
<td>0.008**</td>
<td>Supported</td>
</tr>
<tr>
<td>Reciprocity (H4b)</td>
<td>1</td>
<td>-0.24</td>
<td>0.13</td>
<td>-1.83</td>
<td>0.080</td>
<td>Not supported</td>
</tr>
<tr>
<td>No. of policy issues</td>
<td>1</td>
<td>0.55</td>
<td>0.34</td>
<td>1.63</td>
<td>0.117</td>
<td>-</td>
</tr>
</tbody>
</table>

\(^1\) BIC and RMSE are typically employed for the purpose of comparing competing models. There are no absolute recommended values for these indicators.

\(^2\) Due to space limitation, we do not show the model statistics of the competing models.
The results show that core-periphery positively impacted both the number of postings and unique ideas (i.e., \(H1a\) and \(H1b\) are supported), and the time lags for these effects based on the transfer function analysis were 1 and 5 (i.e., after 1 and 5 weeks). On the other hand, higher centralization led to both lower number of postings and unique ideas contributed by participants in the forum (i.e., \(H2a\) and \(H2b\) are supported), and this effect occurred at time lag 5. Contrary to expectation, reciprocity negatively affected number of postings in the forum (i.e., \(H3a\) is not supported, and the relationship is significant in the opposite direction) with a time lag of 1. However, reciprocity does not seem to affect the number of unique ideas (i.e., \(H3b\) is not supported). The last variable of interest i.e., inclusiveness, is seen to be positively influencing both the number of postings and the number of unique ideas (i.e., \(H4a\) and \(H4b\) are supported) with a time lag of 5. The results are robust after controlling for the number of policy issues being discussed in the forum each week.

**Discussion**

Our research represents a unique approach to the study of participation in electronic networks in a field setting. While the use of time sensitive methodologies have often been suggested (e.g., Monge 1990, Huang and DeSanctis 2005), there are few examples to be found in the IS literature (two exceptions are Evans and Costa (2003) and Monge et al. (1992)). The present study is an initial attempt to employ ARIMA modeling with transfer function analysis on social network measures to study how network structural properties influence participation in an online policy discussion forum over time.

Our findings show that network structure does matter in influencing participation in online policy discussion forums. Specifically, centralization is found to negatively affect both the number of postings and unique ideas contributed by participants over time. On the other hand, both core-periphery and inclusiveness are found to be favorable for promoting the contribution of postings and unique ideas in the forum. Interestingly, reciprocity is found to be detrimental to the contribution of postings, instead of encouraging it. A possible reason for this could be that when two actors engage in a mutual discourse with each other, they may become highly involved in the debate of the policy issue of interest. This may be particularly likely for political discussion networks where participants engaging in discourses tend to hold different ideological positions or viewpoints (Kelly et al. 2005). For instance, the two actors may argue over whether to go for a smoking ban in more public premises. Consequently, other participants may be deterred from joining the discussion involving the two reciprocal actors. This is in contrast to the core-periphery structure that involves individuals engaging in discourses in groups that are connected to peripheral members; and inclusiveness that does not necessarily entail bi-directional communications in dyads. Ceteris paribus, the existence of many dyads engaging in reciprocal communication in a network (i.e., high reciprocity) may thus discourage the overall participation of other members in the network over time. However, further studies are required to validate this reasoning.

Additionally, the ARIMA modeling with transfer function analysis reveals that some network structural properties took a longer time period to have a significant effect on participation (e.g., a lag of 5 weeks for centralization and inclusiveness), while others took a shorter time period (e.g., a lag of 1 week for core-periphery and reciprocity). This may be explained by examining the mechanism behind the positive/negative effects of the respective network structural properties on participation. For instance, centralization is posited to negatively impact participation because of the bottleneck effect on the part of centralized actors. As the centralized actors interact with a sizeable set of other participants over time, they may feel an increasing burden to maintain interactions with these participants. The bottleneck effect gradually builds up to a point such that the centralized actors become overwhelmed by the cost needed to maintain the interactions. Likewise for inclusiveness, when participants engage in discourses (rather than being isolates), a lapse of certain time period may be required for sufficient intellectual stimulation to develop and become effective in promoting further contributions. In contrast, the effect of network structural properties seems to take shorter time to materialize when participants are coordinated in groups (as in the case of core-periphery); or when they engage in bi-directional interactions (as in the case of reciprocity). In the case of core-periphery, several participants are tightly-bound in a core-subgroup in discussions and debates; whereas for reciprocity, pairs of participants engage in mutual exchange of views. These interaction patterns that involve core-subgroups or pairs of participants may be more visible in attracting the attention of surrounding participants, thus posing a more immediate influence on their participation behavior. Additionally, the benefits of coordinated discourses offered by the core-periphery structure may also lead to significant improvement of participation at a later time (i.e., apart from time lag 1, there is also a significant positive effect of core-periphery on participation at time lag 5).
Theoretical Implications

The study offers several theoretical contributions. First, it can serve to add to the diversity of research approaches in IS research by demonstrating the applicability of ARIMA modeling with transfer function analysis on social network measures. Previous studies that employed social network analysis have indicated the dynamic and evolving nature of social networks over time (White 2004). However, such evolving nature of social networks and its corresponding impact on relevant outcomes e.g., participation in online policy discussion forum, is seldom explored. Time series approach allows the evolving nature of a network to be modeled. Particularly, the combined approach (ARIMA modeling with transfer function analysis on social network measures) allows the effect of evolving network structural properties on participation (in terms of number of postings and unique ideas contributed) to be tested. The findings indicate a considerably high variance in the series of the two participation variables that is accounted for by the network structural properties (93% for the number of postings; and 84% for the number of unique ideas). The approach also allows for the evidence of time-ordered causality to be established. The time-ordered causality is important because it eliminates the potential ambiguities in findings associated with cross-sectional correlations (Granger 1980).

Our study also serves to enrich research in e-government, particularly in the area of e-participation, that is an emerging IS research area in recent years. Specifically, our study contributes to theoretically grounded empirical research in this area that has thus far been dominated by conceptual studies and descriptive cases (Gronlund 2005). It extends the application of social network and time series analyses to a particular phenomenon of e-government, i.e., the use of online discussion forums to engage citizens in policy deliberation. The study further highlights the fact that the mere presence of ICT does not always guarantee desirable outcomes such as, the contribution of postings and ideas by participants in electronic networks. Rather, the patterns of interaction among individuals via the ICT can play a part in affecting the outcomes. This is consistent with the findings from Huang and DeSanctis (2005), who applied social network analysis to the context of knowledge sharing in online professional forums.

The findings from this study need to be interpreted with respect to existing research. Specifically, the benefits of core-periphery and inclusiveness may be particularly salient in the context of online policy deliberation. As observed by Kelly et al. (2005), online political discussion networks often involve individuals from different ideological backgrounds or viewpoints actively engaging in intellectual discourses. Based on this finding, the presence of these two properties in a policy discussion forum may be particularly favorable in providing the intellectual stimulation for further contribution of ideas (Johnson and Johnson 2000) i.e., the involvement of participants in discourses (rather than being isolates); and especially in the form where several individuals engage in discourses together in a core-subgroup. The core-subgroups may also bridge and trigger communications and discourses so as to keep the discussion more active and sustainable over time. Consistent with existing research that found centralization as undesirable (e.g., Huang and DeSanctis 2005; Rulke and Galaskiewicz 2002; Sparrowe et al. 2001), the current study extends the finding to the context of participation in online policy discussion forums. The relatively long time lag for the negative effect of centralization to manifest may serve to indicate that the bottleneck effect is a better explanation for the negative effect of centralization than the structural equivalence effect. However, further studies are needed to validate this reasoning.

Practical Implications

Considering the findings as a whole, our study suggests that managers of online policy discussion forums should try to induce the formation of core-subgroups of discussants and avoid the emergence of highly centralized actors as well as isolates in the forum. Moderators can play a proactive role in these aspects. Previous literature has argued that moderators can serve to enhance participation in online policy discussion forums (Edwards 2002). This is echoed in OECD (2003), which states that active promotion and competent moderation are key drivers in online policy deliberation. Our study serves to suggest more specifically what moderators can do to enhance participation in online policy discussion forums. In particular, moderators can help to identify isolates and encourage them to respond to postings of others. For instance, they can attempt to engage isolates by way of informing them that “Person A talked about something that is similar / opposite to your view, would you like to respond to him / her?” The positive effect of core-periphery and the negative effect of centralization on participation suggest that the moderators or forum managers could try to actively link centralized actors into core-subgroups of discussants. They can identify and understand the different views held by the centralized actors and try to engage them in discourses together. It may be easier to engage individuals with opposing perspectives in such pursuits (Kelly et al. 2005). This
way, a highly centralized network structure may be converted into a core-periphery structure that is desirable. This may subsequently expose the rest of the participants (the peripheral members) to the influence of more diverse perspectives in the forum as a whole. As a caveat, the moderators should assume the role of facilitators and avoid inducing a feeling that they are authoritative figures. In this respect, volunteers among citizens may be a better choice than government officials for the moderator role.

Additionally, sophisticated software can be incorporated into online policy discussion forums. Network scanning tools may be developed to monitor network structure formation and development in real time or at regular intervals (e.g., weekly basis could be a reasonable option based on the findings from this study). Interaction among participants could be automatically captured with facilities of buttons for replying and quoting a message. Such information may allow forum managers to devise appropriate interventions to encourage the formation of desirable network structures (e.g., through the moderators), thus improving the likelihood of gathering more inputs to help in the policy deliberation process.

Limitations and Future Research

A few limitations need to be recognized when interpreting the results of this study. First, as with most other studies employing social network analysis, our research does not account for individual-level factors (e.g., motivations, barriers) that may influence participation of citizens in policy deliberation (Phang and Kankanhalli 2005). As noted by Wetherell (1998), the focus of social network analysis on structural relationships tends to minimize the role of individual agency. However, this should be less of an issue for this study as our focus is on the network-level outcome (i.e., the collective contribution of postings and ideas in the policy discussion forum). Future research may nonetheless attempt to employ surveys and interviews to augment this approach in a coherent manner so as to obtain a more holistic understanding of the issue under study. Second, the sample size employed could be increased in future studies to improve statistical power.

Third, our study was conducted in the context of the specific e-government initiative (i.e., online policy discussion forums) in a single nation. Future studies may be conducted in other countries with different cultures and political institutions to further validate our results. Additionally, online political discussions that are initiated by citizen groups or civic organizations could also be investigated in the future. Future research may also investigate whether network structure influences participation outcomes of a more qualitative nature e.g., quality of inputs contributed by participants (Jensen 2003). Specifically, reciprocity that involves participants engaging in mutual and involved deliberation may serve to improve the quality of argumentation of their viewpoints. Further, there could be bidirectional effects between network structural properties and participation over time, which the current study did not capture. Future research may try to explore such effect to improve our understanding of the phenomenon.

With the increasing ubiquity of ICT, the expansion of IS research into the area of e-government, particularly e-participation, is timely and serves to contribute to the diversity of the IS research tradition. Methodology-wise, our approach of combining ARIMA time series modeling with transfer function analysis on social network measures may offer value in uncovering longitudinal relationships between network structural properties and participation in electronic networks. As governments around the globe attempt to leverage the potential of e-government initiatives, studies of this nature can serve to inform the theory and practice of how ICT can be more effectively employed and managed to enhance the participation of citizens in policy deliberation.

References


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