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Thomas Mattson

University of Richmond, tmattson@richmond.edu

Elizabeth Davidson

University of Hawai'i at Manoa

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Promoting Domain-specific Forum Participation via Off-topic Forum Participation in Electronic Networks of Practice

Thomas Mattson

University of Richmond,
Management
tmattson@richmond.edu

Elizabeth Davidson

University of Hawai'i at Manoa
Information Technology Management
edavidso@hawaii.edu

Abstract:

In this paper, we investigate how members' participation in off-topic social forums in electronic networks of practice (eNoPs) influences their propensity to participate in their domain-specific forums. Currently, the literature offers two theoretical arguments that would predict opposing outcomes concerning the impact that off-topic forum participation has on domain-specific forum participation. We argue that investigating the network structure of the off-topic forum has the theoretical flexibility to reconcile these opposing theoretical arguments. Specifically, we hypothesize that an off-topic forum's overall network structure (network cohesion as determined by the global clustering coefficient) moderates the impact of off-topic forum participation on domain-specific forum participation. We theorize that, given equal conditions, off-topic forum participation creates social bonds that positively affect domain-specific forum participation when the off-topic forums have a highly cohesive network structure. Contrarily, however, we posit that off-topic forum participation becomes a noisy distraction when the off-topic forum has a less-cohesive network structure. We provide empirical support for these hypotheses via a 10-year longitudinal study of software developers' participation in an electronic network of practice (eNoP). Our paper highlights new theoretical insights on the network effects in an eNoP whereby network structures in one section (off-topic forums) have ramifications for behaviors in a different section (domain-specific forums).

Keywords: Electronic Networks of Practice, Domain-specific Participation, Off-topic Discussion Forums, Off-topic Participation, Informal Socializing Ties, Domain-specific Ties, Network Cohesion, Triadic Closure.

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1 Introduction and Study Motivation

Electronic networks of practice (eNoPs) typically contain hundreds of thousands of industry practitioners who virtually gather to discuss domain-specific problems related to their skill-based craft or profession (Vaast & Walsham, 2009; Wasko & Faraj, 2005). However, many eNoPs fail to gain a critical mass of members who participate in their domain-specific forums by contributing timely, relevant, and interesting domain-specific content (Ma & Agarwal, 2007; Peddibhotla & Subramani, 2007). Without these thought-provoking domain-specific contributions from a critical mass of members, an electronic network of practice (eNoP) will inevitably become a poor learning resource for industry practitioners and will have a high probability of failing (Kim, Jarvenpaa, & Gu, 2018; Lin, Featherman, & Sarker, 2017; Ray, Kim, & Morris, 2014). Therefore, encouraging members to participate in the domain-specific forums constitutes one core problem that eNoP administrators face (Amichai-Hamburger et al., 2016; He & Wei, 2009; Ma & Agarwal, 2007).

eNoP administrators have tried many tactics to encourage members to participate in the domain-specific forums, such as awarding titles based on posting milestones, ranking members based on contributions, and displaying scores in the reputation system (Faraj & Johnson, 2011; Khansa, Ma, Liginlal, & Kim, 2015; Zhao, Detlor, & Connelly, 2016). Although these tactics have been partially effective, they have far from fully solved the problem (Malinen, 2015). Somewhat counterintuitively, some eNoPs have purposefully created off-topic forums to, in part, encourage members to participate in their domain-specific forums¹. An eNoP's off-topic forums contain discussion threads about topics that do not relate to its skill-based craft or profession (Sassenberg, 2002). For instance, off-topic forums in a programming eNoP contain discussion threads about sports, religion, or politics, whereas the domain-specific forums contain programming-related discussion threads. eNoP members might participate in one or both forum types, but the eNoP's core purpose is to enable individuals to exchange knowledge and expertise through their domain-specific forums (Sassenberg, 2002; Wasko & Faraj, 2005).

Existing research, however, has provided contradictory guidance to eNoP administrators regarding whether to develop off-topic forums. On the one hand, prior research has proffered that off-topic discussions constrain members from participating in the domain-specific forums because they are time-consuming distractions (Phang, Kankanhalli, & Sabherwal, 2009; Preece & Shneiderman, 2009), which divert members' attention away from participating in the domain-specific forums. On the other hand, prior research has also argued that off-topic discussions are socializing mechanisms similar to office break rooms in traditional office environments whereby professionally likeminded members create social bonds and attachments with other professionally likeminded members (Ridings & Gefen, 2004; Ridings & Wasko, 2010). These social bonds and attachments then create a social structure that facilitates participation in the domain-specific forums (Ren et al., 2012a; Ren, Kraut, & Kiesler, 2007).

It is important to reconcile these contrasting arguments because eNoP administrators now must use their gut instincts without empirical support when deciding whether to include these types of off-topic socializing forums in their professional eNoPs. Certain eNoPs such as www.valueforum.com and www.codeproject.com have developed off-topic forums in their professional eNoPs, while others such as the StackExchange collection of eNoPs have avoided them. Anecdotally, it is easy to find instances that support both decisions. However, using the wrong anecdotal examples may result in eNoP administrators' making decisions that do not maximize their members' domain-specific participation, which can have deleterious effects on the eNoP's long-term survival. Therefore, it is important to provide empirical data and innovative theoretical insights to determine why, how, and to what extent members' activities in one area (off-topic forums) may positively or negatively impact their participation in other areas (domain-specific forums) in order to help eNoP administrators make more informed design decisions concerning off-topic forums.

As such, we investigate the following theoretically and practically important research question:

RQ: How does member participation in off-topic social forums in an eNoP influence their propensity to participate in the eNoP's domain-specific forums?

¹ We came to this conclusion from the off-topic forum "about" pages and/or discussion threads about off-topic forums from 2014 to 2015 at www.codeproject.com, www.dreamincode.net, and www.stackoverflow.com. To be clear, we do not claim that this complimentary purpose represents the only function associated with off-topic forums. However, our analyses did strongly suggest that supporting the primary learning objective (i.e., the domain-specific forums) was one of the primary reasons why eNoPs included off-topic forums.

Both of the aforementioned contrasting arguments provide logical, albeit different, answers to this question. Moreover, neither of the existing theoretical arguments offers the flexibility to explain why off-topic forum participation may sometimes benefit (positive) and other times burden (negative) participation in the domain-specific forums. For instance, if a scholar subscribes to the belief that off-topic discussions are time-consuming distractions, then it would be illogical for that scholar to make a counter argument that these types of off-topic discussions positively impact domain-specific forum participation. That would be theoretically contradictory and difficult to reconcile logically.

However, we argue that analyzing off-topic forum participation from a network perspective offers this type of theoretical flexibility because certain types of off-topic network structures may facilitate whereas others may hinder domain-specific forum participation. Specifically, we hypothesize that an off-topic forum's overall network structure (network cohesion as determined by the global clustering coefficient) moderates the impact that off-topic forum participation has on domain-specific forum participation. We theorize that, given equal conditions, off-topic forum participation creates social bonds that positively affect domain-specific forum participation when the off-topic forum has a highly cohesive network structure because highly cohesive network structures serve as an efficient governance mechanism to guard against domain-specific free-riding (Gargiulo & Benassi, 2000; Gargiulo, Ertug, & Galunic, 2009). Contrarily, however, we posit that off-topic forum participation becomes a noisy distraction when the off-topic forum has a less-cohesive network structure because less-cohesive network structures serve as an inefficient governance mechanism. To test these proposed effects empirically, we conducted a 10-year longitudinal study of member participation and the evolving network structures of an eNoP of software developers.

2 Theoretical Foundations and Research Hypotheses

eNoPs are initially formed around the practical purpose of learning a skill-based craft or profession (Vaast & Walsham, 2009; Wasko & Faraj, 2005). eNoPs are primarily utilitarian (i.e., professional development or practical-knowledge exchange) as opposed to social (i.e., general digital conversations about random topics such as those that often occur on Facebook or Weibo) (Fleming & Waguespack, 2007; Khansa et al., 2015; Zhao et al., 2016). For instance, the `datascience.stackexchange.com` eNoP formed to provide a utilitarian place for data scientists and statisticians to discuss a variety of quantitative issues related to their skill-based craft. Members may not discuss any topic not directly related to the statistics domain in this eNoP because their administrators argue that those unrelated topics distract members from its core purpose (i.e., to exchange statistics-related knowledge)². Other eNoPs, however, such as `www.codeproject.com` and `www.dreamincode.net`, have evolved to include socializing forums even though they remain primarily focused on the skill-based craft of software development. Among their purposes, these socializing forums compliment or support the core domain-specific forums (see Footnote 1).

The prior literature offers two contrasting predictions about the impact of off-topic forum participation on domain-specific forum participation in eNoPs. One school of thought suggests that off-topic forum participation is a time-consuming distraction for members (Phang et al., 2009; Preece & Shneiderman, 2009), which diverts their attention away from participating in the domain-specific forums. This argument seems logical because domain-specific contributors volunteer a relatively fixed amount of their time. Therefore, time spent socializing in off-topic forums is time not spent participating in the domain-specific forums. Additionally, the skill-based craft or profession that an eNoP focuses on defines the identity of the eNoP and its members (Lin et al., 2017; Ma & Agarwal, 2007; Ray et al., 2014). Off-topic forums, however, may dilute an eNoP's identity by diverting members' attention to unrelated discussion topics (Ray et al., 2014). As a result, discussion threads in off-topic forums may cause "the defining norm (the topic) to be violated and the main goal (exchange of topic-related information) to be lost" (Sassenberg, 2002, p. 32). This identity dilution may push members away from the eNoP or may result in its members' making fewer domain-specific contributions (i.e., participating less in the domain-specific forums).

An opposing school of thought suggests that off-topic forums serve a similar function to break rooms in physical office environments. In this offline office context, break rooms have the potential to offer a free space that provides employees a place to recharge or reenergize, which can increase their motivation to perform their daily work responsibilities (Kellogg, 2009; Oldham & Rotchford, 1983). A break room also offers the opportunity for employees to develop social relationships (as opposed to professional relationships) with likeminded coworkers, which may increase employee retention and job performance

² We came to this conclusion from analyzing a series of discussion threads at several of the stack exchange websites, which we manually downloaded in 2016.

(Oldham & Rotchford, 1983). Similarly, off-topic forums in an eNoP may represent virtual break rooms where members can take a break from the domain-specific forums. In these off-topic forums, professionally likeminded members create social bonds and attachments with other professionally likeminded members (Ridings & Gefen, 2004; Ridings & Wasko, 2010). These social bonds and attachments then create a social structure that facilitates domain-specific forum participation because these social attachments may create a sense of peer social pressure to not free ride in the domain-specific forums (Ren et al., 2012a; Ren et al., 2007; Wilson, 2000).

Both schools of thought are logical and well argued. Furthermore, it is easy to find anecdotal and/or qualitative examples that provide evidence for or against each argument. Therefore, we make the following two competing hypotheses that we objectively evaluate in our paper:

H1a: Given equal conditions, greater off-topic forum participation is associated with lower domain-specific forum participation.

H1b: Given equal conditions, greater off-topic forum participation is associated with greater domain-specific forum participation.

We conjecture that, given a long enough longitudinal empirical study of an eNoP, we will find evidence that supports each of these competing hypotheses in different periods because an off-topic forum's structure constantly changes. Members come and go in a fluid manner whereby the social structure might change significantly from period to period (Faraj, Jarvenpaa, & Majchrzak, 2011). Furthermore, these changing social structures may affect off-topic forum participants differently. Depending on the off-topic forum's social structure, less (greater) off-topic participation may lead to greater (less) domain-specific participation in some periods but less (greater) domain-specific participation in other periods. Therefore, we propose that it is necessary to contextualize off-topic forum participation in relation to the off-topic forum's social structure in order to explicate whether off-topic forum participation has a positive or negative effect on domain-specific forum participation. One way to evaluate the social structure of a single forum or a collection of forums in an eNoP involves investigating them from a networking perspective. Using a network perspective to investigate an eNoP makes sense since the network represents an eNoP's core construct (i.e., an electronic network of practice as opposed to a group or a community of practice). In eNoPs that contain thousands of members, scholars have theorized that network properties influence individual actions more so than any other social or individual characteristic (Gruzd & Wellman, 2014; Wasko & Faraj, 2005).

2.1 Network Theory

A network is a relational structure that comprises a set of actors who are interconnected by a collection of one or more relations, which are specific kinds of connections, ties, or linkages between actors (Wasserman & Faust, 1994). In general, the broad category of network theories explains human behavior as a function of the overall network structure, the context of the relations between individuals, and the position of the individuals in the network in conjunction with or instead of individual differences (Bunderson, Van Der Vegt, Cantimur, & Rink, 2016; Mehra, Kilduff, & Brass, 2001; Obstfeld, 2005). Network analysts seek to discover novel theoretical and empirical insights about a variety of social phenomena based on the structural forms and the content of the relations among actors in a network (Chewning & Montemurro, 2016; Kadushin, 2012). Network theories suggest that different individuals who occupy the same position or structurally equivalent positions in comparable network structures will tend to behave similarly because the network provides structural incentives or disincentives to engage in certain types of behaviors (Centola, 2010; Kilduff & Krackhardt, 1994; Oh & Jeon, 2007).

Scholars who use network theories to explain human behaviors share the core belief that individuals are embedded in broad social systems that connect (link) them to other individuals in a variety of ways that cannot be reduced only to the characteristics of the individuals in the social system (Chen, Sharma, & Rao, 2016; Kadushin, 2012). It is in this manner that the properties of the connections (relations) between individuals have a profound direct or indirect influence on each other's behaviors, perceptions, beliefs, and decisions (Christakis & Fowler, 2009; George, Dahlander, Graffin, & Sim, 2016). These effects occur because different network structures enable or constrain action by controlling how information flows among members and how members enforce norms, attain status, construct a reputation, and develop trust with other members (Granovetter, 1985; Ingram & Roberts, 2000; Tortoriello, Reagans, & McEvily, 2012).

Network structures and an individual's position in a network can vary sharply across different contexts, whereas individual attributes such as age, race, values, dispositions, perceptions, and ideologies do not vary from context to context. Therefore, using network theories to explain the variability of human behaviors across different contexts can be a more attractive alternative than simply using individual-centric theories (Christakis & Fowler, 2009; Emirbayer & Goodwin, 1994). For example, an individual may hold a peripheral position in a dense professional network but a more central position in a sparse community network. These network differences may partially explain why the individual takes a leadership role in one context and a followership role in another context. This network explanation can be more theoretically attractive than an individual difference explanation because the individual's specific characteristics do not vary across each context but the individual's actions do differ substantially.

Using a network perspective to explain individuals' behaviors in off-topic forums and their resulting behaviors in the domain-specific forums in eNoPs makes sense for three primary reasons. First, an eNoP's massive size and the depersonalized (virtual) relationships between members make explaining members' behaviors using group or community theories particularly problematic (Boyd & Ellison, 2007; Brown & Duguid, 2000; Wasko & Faraj, 2005). Second, certain members may be embedded in the off-topic forum whereby the social forces that surround that embeddedness may provide a structural incentive or disincentive to participate in both the off-topic and domain-specific forums. For instance, webs of social relations between members in the off-topic forum may create an additional sense of peer pressure to participate in the domain-specific forums because the domain-specific (professional) interactions keep those social (off-topic) relations intact. Third, an eNoP's off-topic forums are part of a broader social system that includes the eNoP's domain-specific forums. Therefore, investigating off-topic relations in conjunction with the domain-specific relations more appropriately captures the complexity of the social forces that influence members' behaviors more than simply investigating individual member differences in isolation.

2.2 Network Cohesion

Network cohesion, a structural property that captures the togetherness of a network, refers to the aggregate properties of network triads (Simmel, 1971; Wasserman & Faust, 1994). A network triad refers to a set of relations between three actors in a network. Network triads may be open or closed. To illustrate the distinction between an open triad and a closed triad, we can conceptualize the network connections between three actors (A, B, and C). If there is a relation between A and B and another relation between B and C, then this triad would be open because there is no relation between A and C to complete the triad. This triad would be closed if there was a relation between A and C whereby each actor is connected to each other in a closed triad (triangle of relations), which researchers refer to as triadic closure (Krackhardt, 1998). The properties of the closed triads associated with all vertices (individuals in our case) in the entire network determine how cohesive a network structure is.

A completely cohesive network contains triadic closure throughout (i.e., all possible three actor combinations form closed triads), whereas a less-cohesive network features open triads and loosely connected network sections (Ahuja, 2000; Burt, 2005; Friedkin, 2004). Network scholars have long argued that the degree of triadic closure as opposed to the density of direct relations associated with highly cohesive networks engenders belonging, trust, cooperation, and the enforcement of norms because the closed triads reduce individuality and effectively moderate conflict (Friedkin, 2004; Simmel, 1971).

Highly cohesive networks promote efficient flow but lower variety of information, serve as strong governance mechanisms, are less open to outsiders, and amplify the impact that actions have on the attainment or reduction of a members' reputation or status in the network due to indirect third-party connections (Coleman, 1988; Ganley & Lampe, 2009). Less cohesive networks promote inefficient flow but higher variety of information, serve as weak governance mechanisms, are more open to outsiders, and reduce the impact that actions have on the attainment or the reduction of a member's reputation or status in the network (Burt, 2005; Reagans & Zuckerman, 2008; Sosa, 2011).

Given the equivocal influences of network cohesion and other network variables, some network scholars have taken a contingency perspective. This perspective argues that network effects vary depending on the type of information that flows through the network and the context of the relations (Burt, 1997; Carnabuci & Dioszegi, 2015; Kijkuit & van den Ende, 2007). In an eNoP, this contingency perspective would suggest that the network effects of domain-specific network structures could differ from off-topic network structures because the context of the ties among the members are different in the two types of forums. For instance, in the off-topic forums, digitally conversing represents an end in itself. Therefore, in

this off-topic context, the diversity (i.e., politics, sports, and religion) and novelty of topics have no bearing on how much social value a member extracts from engaging in digital conversations (Phang et al., 2009; Sassenberg, 2002). In the off-topic forums, members extract value simply by engaging in the act of communicating (irrespective of the topics). In the domain-specific forums, however, members primarily extract value based on the diversity and novelty of discussion topics because this topical diversity increases their learning potential, which is a primary reason why members participate in the domain-specific forums (Vaast & Walsham, 2009; Wasko & Faraj, 2005). Therefore, the contingency perspective of network effects would suggest that the context (socializing versus learning) and the types of information (off-topic commentary versus domain-specific advice) that flow through the eNoP may affect how network structures influence members' behaviors.

2.3 Moderating Effect of Network Cohesion

The relational structures that arise from the informal social interactions that occur in the off-topic forums may create networks of virtual friendships among individuals who share a domain-specific (professional) interest in an eNoP of industry practitioners (Mehra et al., 2001; Oh, Chung, & Labianca, 2004). In this context, the network may socially as opposed to professionally integrate the member (Ren et al., 2012a) and may reduce the sense of anomie that comes from being a single member in a network with hundreds of thousands of members (Ransbotham & Kane, 2011). These social networks may further facilitate a collectivist norm or a sharing culture in terms of domain-specific forum participation (Van Den Hooff, de Ridder, & Aukema, 2004). We propose that these benefits will be greater for members who participate very frequently in an off-topic forum (or forums) relative to members who very infrequently participate in the off-topic forum(s) because frequent off-topic forum participation results in greater visibility in the off-topic network. Conceivably, more participation in the off-topic forum will also result in building a greater number of stronger social relationships (virtual friendships). These social relationships may provide significant peer social pressure to help the eNoP succeed, which requires members to participate in the domain-specific forums.

As previously mentioned, domain-specific forums represent an eNoP's core discussion forums (Sassenberg, 2002; Wasko & Faraj, 2005). eNoPs such as www.dreamincode.net or www.codeproject.com are professional websites first and socializing websites (a distant) second. This fact means that the vast majority of members initially come to the eNoP to exchange information concerning their professional domain and only secondarily to participate in any off-topic discussion (Phang et al., 2009; Ray et al., 2014). Therefore, members who participate in both off-topic and domain-specific forums have two networks of relations with the potential to influence their behaviors, whereas members who only participate in domain-specific forums have only one network of relations with the potential to influence their behaviors.

For instance, consider an "all work and no play" member (member A) who almost exclusively participates in an eNoP's domain-specific forums and a "some work and some play" member (member B) who participates in both its off-topic and domain-specific forums. Member A has only a single network (domain-specific network) to provide a structural incentive to continue to participate in the domain-specific forums. We are certainly not questioning the voracity of the positive effect of his domain-specific network on his continued domain-specific participation, but we are suggesting that having an additional but separate set of social relations (similar to member B) would further increase member A's likelihood of continuing to participate in the domain-specific forums.

Member B has a network of social relations (virtual friendships) along with a network of domain-specific relations (professional ties) to provide an additional structural incentive to continue to participate in the domain-specific forums. These two separate but related networks in the same eNoP may have similar members or different members³. Regardless, being embedded in the separate but related off-topic network means it may be both professionally and personally embarrassing for member B not to participate in the domain-specific forums. Member B (unlike member A) has relations in both contexts, and information concerning her free-riding behaviors (lack of contributing domain-specific content) will be visible in both network structures.

³ For instance, supporters of the same sports team might interact in the off-topic forum, whereas they might seek out other members with the same professional problems or issues in the domain-specific forums. Thus, members' relations could differ across distinct forum types (off-topic and domain-specific forums in our case).

However, not all network structures serve as efficient governance mechanisms to enforce a variety of norms (Loebbecke & Myers, 2017; Peters, Pressey, & Johnston, 2017; Reagans & McEvily, 2003). A fractured or less-cohesive network structure with minimal triadic closure acts as an inefficient governance mechanism, whereas the opposite applies for networks with high levels of triadic closure (Gargiulo & Benassi, 2000; Gargiulo et al., 2009). Therefore, certain network structures may act as structural facilitators to enforce the eNoP-level norm of participating in the domain-specific forums more than other network structures. Additionally, triadic closure makes networks less open to outsiders, which can increase or decrease the level of social inclusion depending on an individual's position in the network (Goh, Gao, & Agarwal, 2016; Huang, Tang, Liu, Luo, & Fu, 2016). Social inclusion or exclusion plays an important role in facilitating or inhibiting domain-specific forum participation because the existing literature has reported a positive (negative) correlation between social inclusion (exclusion) and the propensity to perform general altruistic behaviors (Twenge, Ciarocco, Baumeister, DeWall, & Bartels, 2007). Voluntarily participating in domain-specific forums is the primary type of altruistic behavior in an eNoP (i.e., contributing domain-specific commentary, questions, or answers). Consequently, we posit that whether a member's off-topic forum participation heightens or suppresses domain-specific participation depends (given equal conditions) on the overall network structure of the off-topic forum(s).

We specifically assert that a highly cohesive off-topic network structure will be more effective in promoting domain-specific participation for members who regularly participate in the off-topic forum because information spreads more efficiently in highly cohesive networks (relative to less-cohesive networks) (Huang et al., 2016). Individuals who participate in more off-topic discussion threads will develop a greater number of social relationships with other eNoP members. The large volume of off-topic posts will make this member highly visible to other off-topic members. Furthermore, in a highly cohesive off-topic network structure, information concerning a highly visible contributor's off-topic and domain-specific posting behaviors has a higher likelihood (relative to in less-cohesive off-topic network structure) of quickly spreading to a cohesive network of digital friends in the eNoP. In this type of highly cohesive network structure, there may be a heightened sense of altruism and obligation to the cohesive digital friendship network (Lakhani & Von Hippel, 2003; Nambisan & Baron, 2010).

Wilson (2000, p. 224) further suggests that these types of cohesive social ties "encourage manifold relations that can be used as 'side payments' to overcome the free rider problem; we do not want to let our friends down"⁴. Therefore, the highly cohesive network serves as a governance mechanism to ensure that the highly visible off-topic forum participants (i.e., off-topic forum members who make many off-topic contributions) do their part to contribute to the eNoP's long-term success, which means participating in the domain-specific forums. Contrarily, a less-cohesive off-topic forum may not as easily create this sense of obligation because the network contains many disconnected parts, which results in an inefficient flow of information. Therefore, information pertaining to the highly visible participant's posting behaviors may only spread to a small subset of the off-topic forum when it is less cohesive.

For members who participate in the off-topic forum very frequently, the effect of their highly frequent off-topic participation on their domain-specific participation will be significantly enhanced when the off-topic forum is highly cohesive (relative to when the off-topic forum is less cohesive). The effect of their highly frequent off-topic participation may even have a negative impact on their domain-specific participation when the off-topic forum is fragmented and not cohesive because less cohesive network structures serve as inefficient information conduits and lack the ability to enforce eNoP-level norms. As such, we hypothesize:

H2: Given equal conditions, the network cohesion of the off-topic forum will positively moderate the effect of high levels of off-topic participation on domain-specific participation.

For participants who infrequently contribute to the off-topic forum (i.e., low participation in the off-topic forum), we posit that a highly cohesive off-topic forum could have the opposite effect for two primary reasons. First, members who infrequently participate in the off-topic forum do not have as many social connections in the off-topic forum, which means that the efficient spreading of information characteristic of highly cohesive networks will make for a less-impactful governance mechanism (Gargiulo & Benassi, 2000; Reagans & McEvily, 2003). For instance, even if information regarding an infrequent off-topic forum

⁴ Wilson (2000) did not explicitly reference network cohesion in his discussion of social networks and volunteering. However, he did discuss issues related to interpersonal trust and social solidarity, which are typically characteristics of highly cohesive network structures (Coleman, 1988).

participant's domain-specific free-riding behaviors spreads efficiently, it will spread to a highly cohesive network that contains relative strangers in the off-topic forums. Thus, infrequent off-topic forum participants should experience less social pressure associated with the highly cohesive off-topic forum to conform to the eNoP-level norm of participating in the domain-specific forums.

Second, certain network structures promote exclusivity more than other network structures. Highly cohesive networks tend to have collegial, social, and personal interactions between core (known) members but tend to be less open to non-members or outsiders (Goh et al., 2016; Huang et al., 2016; Reagans & McEvily, 2003). From a networking perspective, socially excluded positions are those that contain a minimal number of relations (Daly & Silver, 2008). Members who infrequently contribute to off-topic discussion threads have fewer ties in the network and fewer social connections on the fringes of the off-topic network. Therefore, this type of member who attempts to participate in a highly cohesive network structure is more likely to be socially excluded than in a less-cohesive network. Furthermore, research has found greater levels of social exclusion to be negatively correlated with a variety of altruistic behaviors (Twenge et al., 2007). Thus, the social exclusivity that an infrequent off-topic poster may be subject to in highly cohesive networks could further dampen altruism. That is, socially excluded individuals may avoid devoting their time and energy by contributing answers or commentary to domain-specific questions if the community does not repay their time and energy with social belongingness.

In order to further conceptualize this proposed effect, consider again member A (the "all work and no play" member we discuss above). If member A chooses to socialize in a discussion thread in an off-topic forum for the first time, we suggest that he will have a higher likelihood of being rejected (socially excluded) or ignored if the network structure is highly cohesive relative to if the network structure is less cohesive. Furthermore, if member A has a negative experience in the off-topic forum (i.e., the highly cohesive off-topic network ignores or socially excludes him), then he may have a decreased likelihood of continuing to volunteer his time and energy in the domain-specific forums. Member A may contribute less frequently and answer fewer total questions (best case) or he may seek out an alternative eNoP among the countless, seemingly undifferentiated eNoPs on the Internet (worst case) whose members will accept him both professionally and socially. This prediction is relative to if the off-topic forum welcomed and socially included member A (a stranger or relatively unknown member in the off-topic forums), which is more likely to happen when the network structure is less cohesive relative to when the network structure is highly cohesive. Highly cohesive social networks tend to be more cliquish and weary of letting outsiders into their closed network (Friedkin, 2004).

We might better conceptualize this proposed relationship using an example of a non-electronic network of practice. For this example, assume a network of practice that contains a few thousand academics in a specialized field of research who physically (as opposed to virtually) gather at a large academic conference every year. The academic conference requires researchers to review papers voluntarily (conceptually similar to the domain-specific forums in an eNoP) in order to develop the academic program for the conference. Many (if not most) academic conferences also have social functions (conceptually similar to off-topic forums in an eNoP) where a subset of the members informally socialize with each other. For this example, assume that the subset of socializing members constitutes a highly cohesive network with triadic closure among the members who typically attend the social functions. Finally, assume that an "all work and no play" member (i.e., a member who just reviews papers but rarely attends any of the social functions) decides to attend one of the social gatherings but the other members exclude this member from their social conversations. We propose that this type of social exclusion, which has a higher likelihood of happening in more-cohesive networks relative to in less-cohesive networks, may reduce the member's likelihood of continuing to review papers for that conference. The member may review fewer papers, may not regularly review each year, or may stop reviewing entirely in favor of a different academic conference with different membership because the other members of this network of practice have not repaid the member's hard work with social (in addition to professional) belongingness. We suggest that a similar effect will happen in a highly cohesive off-topic forum in an eNoP when the off-topic socializing forums are highly cohesive. In these highly cohesive off-topic network structures, infrequent off-topic participants will have a higher likelihood of being socially excluded from the off-topic forums relative to when the off-topic forum is less cohesive. This social exclusion can then spillover into the member's participating less (possibly until they do not participate at all) in the domain-specific forums. Therefore, we posit that increasing network cohesion will reduce, rather than enhance, domain-specific forum participation for the infrequent off-topic forum participant. Thus, we hypothesize:

H3: Given equal conditions, the network cohesion of the off-topic forum will negatively moderate the effect of low levels of off-topic participation on domain-specific participation.

Figure 1 graphically displays our research hypotheses.

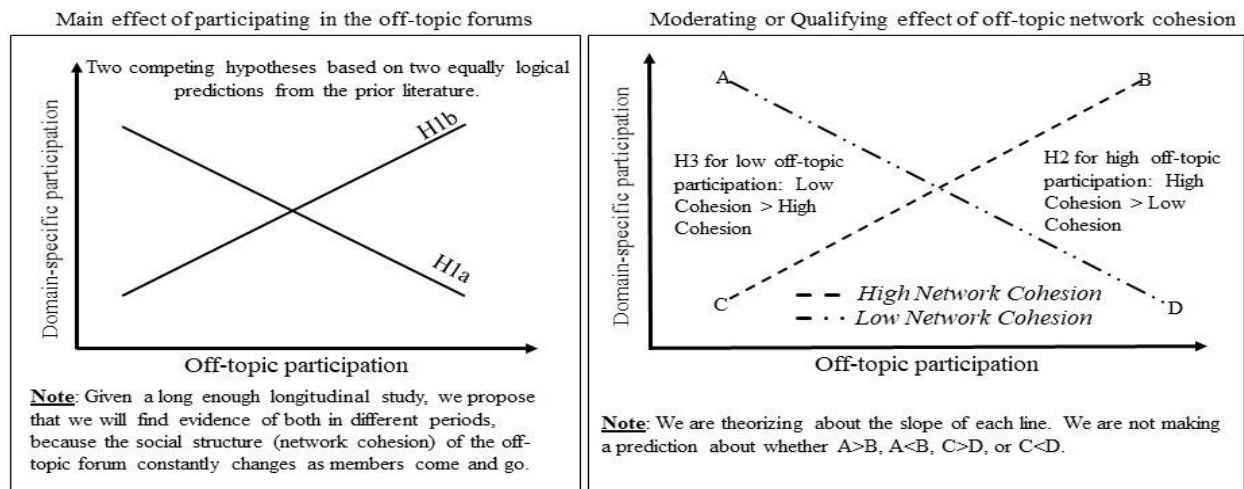


Figure 1. Research Hypotheses

3 Research Design and Methods

To test these research hypotheses, we empirically investigated an eNoP for software developers, which we refer to as TPC (pseudonym). At the time of our study, TPC contained domain-specific forums for various programming languages and an off-topic forum (referred to as the TPC café) where members discussed non-programming topics. In our study, we categorized posts in threads in any of the programming forums as domain-specific and posts in threads in the TPC café as off-topic. TPC used this classification to segment their forums at the time of our study. We used a hybrid manual and automated data-collection process consistent with ethical academic data-collection procedures (Allen, Burk, & Davis, 2006) that involved downloading all of the posts in each discussion thread in each forum for 10 years of posts. Our final sample contained 20,512 unique members who participated in 148,882 domain-specific threads and 10,145 TPC café threads over the 10-year period.

Our dependent variable was domain-specific participation. To estimate domain-specific participation, we counted the number of domain-specific posts that a member contributed in a given period. A member with a greater number of posts means that the member participated more in the domain-specific forums in a given period. If off-topic forum participation distracted a member from the domain-specific forums, then that member should have contributed fewer domain-specific posts (as the number of off-topic contributions increases). If off-topic forum participation had a positive impact on a member's domain-specific forum participation, then that member should have contributed more domain-specific posts (as the number of off-topic contributions increases).

Our study design consisted of 20 discrete six-month periods starting at 23:59 on 30 June, 2001, and ending at 23:59 on 31 December, 2010, where we traced the evolution of the TPC café's network structure and the domain-specific posting behaviors of all active members in each of the 20 discrete six-month periods. Figure 2 graphically displays our research design. Essentially, our study design consisted of 20 repeated longitudinal studies (at six-month intervals) of the domain-specific posting patterns of 20 different samples of active members. We compared the domain-specific posting behaviors of the 20 different samples based on the changing network structures (and a series of control variables) across the 20 discrete six-month periods. With this research design, we could compare the domain-specific membership patterns in relation to the changing network structure (cohesion) of the TPC café across the 20 discrete six-month periods.

In our study, each 20 discrete six-month periods had two time intervals: 1) the sampling frame (45 days) and 2) the window that we used to observe the domain-specific posting behaviors of those sampled

members (six months). We determined the sample of members as any member who had any (at least one) domain-specific or off-topic post in the preceding 45 days from the start of the discrete six-month period⁵. We included only those active members in order to not misrepresent the network structure by including inactive members (i.e., members who had a profile but no longer participated on the website). Additionally, our governance-mechanism arguments only apply for active members. We chose the 45-day interval to determine the sample of TPC members to observe (and to calculate our network cohesion variables) based on analyzing the posting behaviors of a subset of members who had been active TPC members for all of the 20 discrete periods. We found that none of these members became inactive (i.e., did not make a post to at least one domain-specific or off-topic forum) for more than 45 days⁶.

After we determined the sample of members, we calculated all of the network variables (both hypothesized and control) using the ties (linkages or relations) between those members. We then observed their domain-specific posting behaviors for the subsequent six months. At the end of the six-month observation period, we repeated the process (i.e., we resampled the active members, calculated all of the network variables, and observed the domain-specific posts for the resampled members for the next six months). We chose six months as our observation window because that length of time was long enough to observe a variety of different domain-specific participation patterns. We settled on six months instead of, say, five or seven months based on analyzing the variability of the domain-specific posting patterns of the sampled members in our first discrete period.

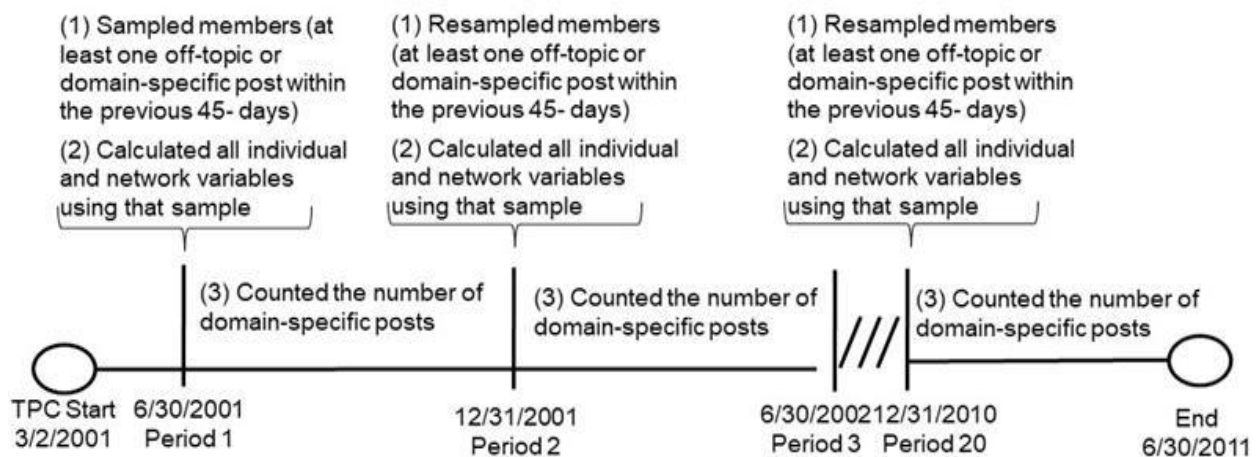


Figure 2. Research Design

Consistent with previous literature (Ahuja, Galletta, & Carley, 2003; Howison, Wiggins, & Crowston, 2011), we determined all network relations (ties) for all networking variables based on common thread participation between members. Based on common thread participation, we constructed unidirectional binary matrices (one for the domain-specific forums and one for the TPC café) consistent with the process that Wasserman and Faust (1994) outline using all posts in all threads in each type of forum (domain-specific forums and TPC café). Using these matrices, we calculated network cohesion using Watts and Strogatz's (1998) global clustering coefficient, a standard measure of network cohesion based on triadic closure. Appendix A provides additional details for all of the networking variables that we used in our study.

The previous literature has identified many additional factors that influence whether a member will participate in the domain-specific forums in an eNoP besides our hypothesized networking variables. Therefore, we controlled for the following additional factors in our study: 1) a variety of additional network variables, 2) each member's score in the reputation system, 3) paid membership, 4) number of domain-

⁵ To test H1a and H1b, we included all members in the data analyses. We did so in order to compare the domain-specific posting behaviors across all different types of members at TPC. To test the moderating hypotheses (H2 and H3), we included only the active off-topic members in the data analyses because these hypotheses are only related to members who participated in the off-topic forum. In other words, the network structure of the off-topic forum is meaningless to a member who never participated in the off-topic forum.

⁶ As a robustness check, we repeated the same analyses using a 15-day and a 30-day interval to determine the sample and to calculate the network variables. In both cases, the results were the same in terms of the sign, relative magnitude, and statistical significance of our hypothesized variables.

specific posts that a member contributes in the prior period, 5) period dummy variables, and 6) first contribution dummy variable (Algesheimer, Dholakia, & Herrmann, 2005; Chen, 2007; Fang & Neufeld, 2009; He & Wei, 2009; Khansa et al., 2015; Ransbotham & Kane, 2011; Ren, Kraut, Kiesler, & Resnick, 2012b; Tiwana & Bush, 2005). These variables cover alternative network explanations, habitual behaviors (prior posting behaviors), reputation effects, and TPC-specific factors that we identified as potentially influencing a member's propensity to participate in the domain-specific forums. Table 1 summarizes the operationalization of each variable that we used in our study.

Table 1. Sample Details and Variable Operational Definitions

Variable name	Operational definition
Sample	At each period, any member who had any domain-specific or off-topic post in the preceding 45-days.
Dependent variables	
Count of domain-specific posts	At each period, we counted the number of posts that each member made in any of the domain-specific forums in that current period.
Hypothesized independent variables	
Off-topic forum participation current period	At each period, we counted the number of posts in TPC café threads in the current period. We took the natural log and mean centered the values using each period's mean.
Network cohesion of the TPC Café Off-topic forum (off-topic network cohesion)	<ol style="list-style-type: none"> 1. We constructed a binary matrix of unidirectional ties determined based on common TPC café thread participation for all off-topic threads that occurred before the start of each period. 2. We calculated the local clustering coefficient for each active off-topic forum participant based on the binary matrix in step 1. 3. We calculated the global clustering coefficient, which was an average of the local clustering coefficients calculated in step 2. 4. We mean centered the values on the grand mean across all 20 discrete periods.
Control variables and alternative explanation variables	
Domain-specific participation prior period	At each period, we counted the number of posts in any domain-specific forum in the prior period. We took the natural log and mean centered the values using each period's mean.
Network cohesion of the domain-specific forums (domain-specific network cohesion)	<ol style="list-style-type: none"> 1. We constructed a binary matrix of unidirectional ties determined based on common domain-specific thread participation for all domain-specific threads occurring before the start of each period. 2. We calculated the local clustering coefficient for each active domain-specific participant based on the binary matrix in step 1. 3. We calculated the global clustering coefficient, which was an average of the local clustering coefficients calculated in step 2. 4. We mean centered the values on the grand mean across all 20 discrete periods.
First contribution	We set this categorical dummy variable to 0 for all members whose first contribution was in a domain-specific forum and to 1 for all members whose first contribution was in the TPC café forum.
Paid membership	We set this categorical dummy variable to 0 for all members who did not pay the voluntary donation and to 1 for all members who paid the voluntary donation. Data for this variable were only available beginning in period that began from 31 December, 2007 (i.e., the period when the program began).
Score in the feedback system	This continuous variable represents each member's score in the rating system at the start of each period using TPC's formula (the sum of the total of positive ratings minus the sum of the total negative ratings). Posts may be rated many times (i.e., a single post may have multiple positive ratings and/or multiple negative ratings). Therefore, a post with 10 positive ratings and 2 negative ratings will increase the author's reputation score by 8 points. Data for this variable began in May, 2008, which is when TPC implemented the system.
Individual cohesion	We calculated the local clustering coefficient for each member using a binary matrix of unidirectional ties based on common thread participation occurring before the start of each period across the entire eNoP (i.e., in both the domain-specific and off-topic forums).

Table 1. Sample Details and Variable Operational Definitions

Betweenness centrality	<ol style="list-style-type: none"> 1. For each pair of members (off-topic member and domain-specific member), we counted the shortest paths between them. 2. For each pair in step 1, we counted the number of paths that pass through a particular member. 3. For each member who participated in both the domain-specific and off-topic forums, we summed step 2 divided by step 1. 4. We mean centered the final values from step 3 on the average in each discrete period.
Centralization of the TPC café	<ol style="list-style-type: none"> 1. For each period, we calculated the sum of the differences in the degree centrality between the most central node in the TPC café and all other nodes in the TPC café. 2. We divided the quantity in step 1 by the theoretically largest such sum of differences in any network of the same size. 3. We grand mean centered the values across all 20 discrete periods.
Control variables and alternative explanation variables	
Centralization of the domain-specific forums	<ol style="list-style-type: none"> 1. For each period, we calculated the sum of the differences in the degree centrality between the most central node in the domain-specific forums and all other nodes in the domain-specific forums. 2. We divided the quantity in step 1 by the theoretically largest such sum of differences in any network of the same size. 3. We grand mean centered the values across all 20 discrete periods.
Density of the TPC café	<ol style="list-style-type: none"> 1. We counted the total number of connections between all members in the TPC café. 2. We determined the total number of potential connections between all members in the TPC café: $(n*(n-1))/2$. 3. We divided the result from step 1 by the result from step 2. 4. We grand mean centered the values across all 20 discrete periods.
Density of the domain-specific forums	<ol style="list-style-type: none"> 1. We counted the total number of connections between all members in the domain-specific forums. 2. We determined the total number of potential connections between all members in the domain-specific forums: $(n*(n-1))/2$. 3. We divided the result from step 1 by the result from step 2. 4. We grand mean centered the values across all 20 discrete periods.
Period dummy variables	We used four dummy variables to capture any time effect over our 10-year observation period. We grouped the 20 discrete periods in five equal buckets of four to represent the 20 discrete periods. We grouped the periods in these buckets to avoid any perfect correlation with our networking variables that we measured at each of the 20 discrete periods. We did not use a continuous variable to represent time because we had no reason to believe any differences would be linear.

4 Results

Table 2 and Table 3 display the descriptive statistics and the sample sizes in each of the 20 discrete periods for all of the variables that we used in our study. The total member observations (active domain-specific and off-topic members) across all 20 discrete periods was 24,709 (i.e., sum of the “active members (n)” rows in Tables 2 and 3). We used these members to test the first hypotheses (competing H1a and H1b predictions) related to the main effect of off-topic forum participation (i.e., what impact does off-topic forum participation have on domain-specific forum participation?). We included all members (not just the off-topic forum participants) in order to compare the domain-specific posting behaviors across all different types of members at TPC. We had to include all members (i.e., our “all work and no play”, “no work and all play”, and “some work and some play” members) in order to determine the direction of this main effect. Only including the off-topic forum participants would have resulted in a heavily biased statistical test of our first hypotheses.

However, we analyzed only the off-topic members to test the moderating hypotheses (H2 and H3) because these hypotheses only relate to members who participated in the off-topic forum. In other words, the network structure of the off-topic forum has no relevance to members who never participated in the off-topic forum. The sum of the active off-topic member observations across all 20 discrete periods was 2,738 (i.e., sum of the “TPC café only” and “both” rows in Tables 2 and 3). The values in Tables 2 and 3 show the non-transformed descriptive statistics for the 24,709 member observations (not just the subset of off-topic forum participants).

Table 2. Descriptive Statistics for the First 10 Discrete Periods (2001-2005)

	2001		2002		2003		2004		2005		
	June	Dec	June	Dec	June	Dec	June	Dec	June	Dec	
Active members (n)	59	102	166	145	106	87	86	116	217	291	
TPC café only	0	12	17	7	11	9	5	14	21	23	
Domain-specific only	52	40	88	74	49	40	44	76	165	209	
Both	7	50	61	64	46	38	37	26	31	59	
Off-topic forum participation ¹	Avg.	1.4	50.8	76.0	105.1	87.7	71.1	53.2	30.9	23.3	25.1
	SD	4.6	118.1	222.5	234.0	155.9	125.9	104.9	78.6	81.5	93.5
Off-topic network cohesion ²	0.858	0.789	0.825	0.877	0.884	0.898	0.889	0.925	0.873	0.849	
Domain network cohesion ²	0.692	0.793	0.779	0.743	0.755	0.815	0.747	0.707	0.595	0.654	
Off-topic centralization forum ²	0.333	0.542	0.466	0.288	0.234	0.141	0.200	0.166	0.290	0.465	
Domain centralization ²	0.685	0.678	0.748	0.642	0.591	0.558	0.549	0.818	0.947	0.946	
Density of the TPC café ²	0.905	0.486	0.510	0.708	0.819	0.892	0.886	0.880	0.665	0.506	
Domain density ²	0.228	0.284	0.191	0.255	0.317	0.356	0.367	0.173	0.059	0.052	
Betweenness centrality ¹	Avg.	22	37	68	52	33	22	25	43	112	139
	SD	47	80	177	103	67	37	52	187	774	1090
Score in the feedback system ³	Avg.	0	0	0	0	0	0	0	0	0	0
	SD	0	0	0	0	0	0	0	0	0	0
Number of domain-specific posts (prior period) ¹	Avg.	14.6	33.6	29.1	36.7	30.4	14.6	17.3	8.8	15.5	16.0
	SD	27.6	63.4	68.0	58.4	44.3	18.7	31.6	20.7	75.2	81.0
Individual cohesion ¹	Avg.	0.67	0.80	0.77	0.77	0.79	0.84	0.77	0.72	0.63	0.68
	SD	0.35	0.22	0.27	0.24	0.24	0.19	0.31	0.37	0.42	0.39
Paid membership (1 = yes, 0 = no) ⁴	1s	0	0	0	0	0	0	0	0	0	0
	0s	59	102	166	145	106	87	86	116	217	291
First contribution (0 = off-topic, 1 = domain)	0s	0	18	45	29	31	30	27	30	33	36
	1s	59	84	121	116	75	57	59	86	184	255
Period dummy ⁵	1	1	1	1	2	2	2	2	3	3	

¹ After taking the natural log of each of these values, we mean centered these variables based on the averages in each six-month observation period. For example, we centered the off-topic forum participation values on $\ln(1.4)$ for the June, 2001 period, and we centered the domain-specific values on $\ln(14.6)$ for this same period because $\ln(1.4)$ and $\ln(14.6)$ were the period means for those variables.

² We grand mean centered these variables on the averages across all periods.

³ The feedback system at the time of our data collection was implemented in May, 2008.

⁴ This program began for the period beginning on December, 2008.

⁵ The reference period group is group 1.

Table 3. Descriptive Statistics for the Second 10 Discrete Periods (2006-2010)

		2006		2007		2008		2009		2010	
		June	Dec	June	Dec	June	Dec	June	Dec	June	Dec
Active members (n)		283	811	945	1376	1999	3626	3675	4609	2775	3235
TPC café only		15	32	31	26	39	50	55	40	42	61
Domain-specific only		208	687	823	1222	1747	3323	3314	4318	2523	2969
Both		60	92	91	128	213	253	306	251	210	205
Off-topic forum participation ¹	Avg.	25.4	11.4	13.4	10.2	9.3	5.6	7.0	5.2	6.3	5.5
	SD	93.8	74.8	93.6	75.7	72.9	55.1	63.8	55.3	56.4	53.6
Off-topic network cohesion ²		0.850	0.831	0.830	0.842	0.833	0.819	0.826	0.817	0.813	0.818
Domain network cohesion ²		0.693	0.619	0.603	0.633	0.607	0.600	0.679	0.633	0.663	0.650
Off-topic centralization forum ²		0.394	0.591	0.516	0.574	0.684	0.668	0.614	0.568	0.592	0.590
Domain centralization ²		0.925	0.964	0.964	0.966	0.970	0.980	0.970	0.981	0.966	0.977
Density of the TPC café ²		0.635	0.398	0.452	0.397	0.277	0.303	0.351	0.405	0.385	0.372
Domain density ²		0.059	0.016	0.016	0.013	0.010	0.005	0.009	0.007	0.015	0.011
Betweenness centrality ¹	Avg.	156	529	622	882	1367	2543	2424	3106	1803	2096
	SD	839	3279	3741	6362	10674	25137	18982	37716	15550	22589
Score in the feedback system ^{1,3}	Avg.	0	0	0	0	0.2	0.9	2.3	3.5	12.0	16.0
	SD	0	0	0	0	2.1	9.0	21.7	34.0	82.8	120.5
Number of domain-specific posts (prior period) ¹	Avg.	20.2	11.8	12.8	13.9	15.3	13.7	20.1	18.0	26.7	20.7
	SD	70.3	56.9	67.0	80.4	92.5	87.4	115.5	114.0	155.3	142.9
Individual cohesion ¹	Avg.	0.71	0.63	0.60	0.62	0.59	0.59	0.66	0.62	0.66	0.64
	SD	0.37	0.41	0.42	0.42	0.43	0.42	0.38	0.40	0.37	0.39
Paid membership (1 = yes, 0 = no) ⁴	1s	0	0	0	42	46	78	60	112	89	100
	0s	283	811	945	1334	1953	3548	3615	4497	2686	3135
First contribution (0 = off-topic, 1 = domain)	0s	37	48	63	52	71	75	92	82	79	87
	1s	246	763	882	1324	1928	3551	3583	4527	2696	3148
Period dummy ⁵		3	3	4	4	4	4	5	5	5	5

¹ After taking the natural log of each of these values, we mean centered these variables based on the averages in each six-month observation period.

² We grand mean centered these variables on the averages across all periods.

³ The feedback system at the time of our data collection was implemented in May 2008. Across all periods after the system was implemented, the range of scores for members was -129 to 2708.

⁴ This program began for the period beginning on December, 2008.

⁵ The reference period group is group 1.

We used a series of negative binomial regression models to analyze our non-negative count dependent variable (i.e., number of domain-specific posts). A negative binomial regression model is particularly appropriate when the count data are over- or under-dispersed and do not contain an excessive number of zeroes (Cameron & Trivedi, 2013), which is the case with our data. In each reported model, we estimated the negative binomial dispersion parameter by maximum likelihood using a log link function. We used an independent working correlation matrix to account for members who appeared in more than one of the 20 discrete periods. Finally, we successfully screened both of our samples for potential collinearity issues between our independent variables and for potential outliers before running each model.

Table 4 displays the results of the five models that we used to test our hypotheses. Models 1 and 2 tested the first hypotheses using the full sample of active members (i.e., both domain-specific and off-topic active members). Model 1 tested the main effect of off-topic forum participation on domain-specific forum participation without any control variables. Model 2 tested whether the main effect of off-topic forum participation was consistent across the ten years that spanned all of our 20 discrete periods with all of the control variables. Models 3-5 tested the qualifying hypotheses in an incremental manner. Model 3 re-tested the main effect of off-topic forum participation using the subsample of active off-topic forum participants in order to ensure that a main effect to be moderated existed. Model 4 tested whether the main effect of off-topic forum participation was consistent across the ten years (using just the subsample of off-topic forum participants) that spanned all of our 20 discrete periods with all of the control variables.

Model 5 was our full model that tested the hypothesized moderating effect with both main effects, the interaction effect, and all of the control variables.

Table 4. Negative Binomial Results

	Model 1	Model 2	Model 3	Model 4	Model 5
	Parameter estimates (standard errors)	Parameter estimates (standard errors)	Parameter estimates (standard errors)	Parameter estimates (standard errors)	Parameter estimates (standard errors)
Intercept	4.33*** (0.14)	5.74*** (0.38)	4.72*** (0.09)	4.42*** (0.21)	4.35*** (0.27)
Off-topic forum participation	0.22*** (0.01)	0.03 (0.04)	0.29*** (0.02)	0.17** (0.08)	0.24*** (0.09)
Off-topic network cohesion					1.50 (3.39)
(Off-topic forum participation) * (off-topic network cohesion)					3.72*** (1.32)
Number of domain-specific posts (prior period)		0.34*** (0.03)		0.04*** (0.009)	0.04*** (0.01)
Domain network cohesion					1.22 (2.13)
(Number of domain-specific posts (prior period)) * (domain network cohesion)					-0.16 (0.26)
First contribution		0.37* (0.22)		-0.60*** (0.11)	-0.63*** (0.11)
Paid membership		0.30 (0.24)		0.14 (0.16)	0.14 (0.15)
Score in the feedback system		0.12*** (0.01)		0.10*** (0.01)	0.10*** (0.01)
Betweenness centrality		0.07*** (0.01)		0.15*** (0.01)	0.16*** (0.01)
Individual cohesion		0.12*** (0.01)		-0.89*** (0.05)	-0.86*** (0.05)
Reference period is (1,2,3,4)					
Period (5,6,7,8)		-0.88* (0.50)		-0.32 (0.29)	-0.43 (0.38)
Period (9,10,11,12)		-0.86** (0.43)		-0.82*** (0.26)	-0.67* (0.37)
Period (13,14,15,16)		-1.13*** (0.38)		-0.83*** (0.23)	-0.67 (0.42)
Period (17,18,19,20)		-1.88*** (0.37)		-0.94*** (0.22)	-0.72** (0.35)
(Off-topic forum participation)* period (5,6,7,8)		-0.004 (0.06)		-0.02 (0.13)	-0.36** (0.16)
(Off-topic forum participation)* period (9,10,11,12)		0.04 (0.05)		0.07 (0.11)	0.05 (0.11)
(Off-topic forum participation)* period (13,14,15,16)		-0.006 (0.04)		-0.21** (0.09)	-0.17 (0.10)
(Off-topic forum participation)* period (17,18,19,20)		-0.07* (0.04)		-0.19** (0.08)	-0.08 (0.11)
Member observations	24,709	24,709	2,738	2,738	2,738
Scale ¹	2.51	1.96	1.50	1.51	1.48
QIC ²	-699001	-1144310	-1347252	-1336931	-1394906
QICu ²	-699003	-1144316	-1347253	-1336932	-1394911

* Significant at the 0.10 level, ** significant at the 0.05 level, and *** significant at the 0.01 level or better.
¹ We computed the scale parameter for GEE estimation as the square root of the normalized Pearson's chi-square.
² The quasi-likelihood under the independence model criterion (QIC) statistic proposed by Pan (2001) is similar to the Akaike's information criterion (AIC) statistic used for comparing models. In our case, the AIC statistic is not available because the generalized estimating equations method is not a likelihood-based method.

Model 1 shows a statistically significant positive correlation between off-topic forum participation and domain-specific forum participation. Model 1 predicts that an average level of off-topic forum participation (value of 0 with our mean centered variable) will result in roughly 76 domain-specific posts. Model 1 also predicts that a member with a one standard deviation below (above) average number of off-topic posts will result in roughly 32 (182) domain-specific forum posts. However, model 1 assumes that this effect is the same across all 20 discrete periods. If we just look at model 1 without testing whether the effect is consistent over time, we might incorrectly conclude that off-topic forum participation is always beneficial.

Model 2 included all of the control variables in addition to the period dummy variables in order to test whether the main effect of off-topic forum participation was consistent over the 20 discrete periods. Table 5 displays the expected number of domain-specific posts for each period grouping based on different off-topic forum participation rates⁷. Even after controlling for the effect of the full complement of control variables, this model shows that the effect was not consistent over time. The effect of off-topic forum participation was positive in the first four period groupings, which supports H1b (off-topic forum participation is not a noisy distraction). However, the effect switches direction in the last period grouping, which supports H1a (off-topic forum participation is a noisy distraction). H2 and H3 help explain why this might be the case because the overall network cohesion of the off-topic forum changed over the course of the 20 discrete periods in our study.

Table 5. Main Effect of Off-topic Forum Participation (Model 2)

Periods	Off-topic forum participation			Conclusion
	1 st. dev. below grand mean	Grand mean	1 st. dev. above grand mean	
Periods (1,2,3,4) (reference group)	274 ¹	312	356 ²	H1b supported
Periods (5,6,7,8)	116	130	146	H1b supported
Periods (9,10,11,12)	100	132	175	H1b supported
Periods (13,14,15,16)	90	101	112	H1b supported
Periods (17,18,19,20)	56	48	41	H1a supported

* We calculated these predicted domain-specific counts by taking the exponent of each parameter estimate (from model 2) for the intercept, off-topic forum participation variable, the appropriate period group dummy variable, and the interaction effect of those variables. All other variables in model 2 were 0.

¹ This means that decreasing a member's off-topic forum participation by 1 standard deviation would result in 274 domain-specific posts $\exp(5.74+0.03*(-3.98))$ while holding all other covariates constant at 0.

² This means that increasing a member's off-topic forum participation by 1 standard deviation would result in 356 domain-specific posts $\exp(5.74+0.03*(3.98))$ while holding all other covariates constant at 0.

Models 3-5 tested the qualifying effect of network cohesion with just the subsample of active off-topic forum participants. Model 3 confirmed our findings from model 1 that (without any covariates) off-topic forum participation (on average) had a positive effect on domain-specific forum participation across all 20 discrete periods. However, model 4 demonstrates that the effect was not consistent across the five period groupings (similar to the findings from model 2). The effect was not always positive and not always negative in both the subsample of just off-topic forum participants and the full sample of all members (both off-topic and domain-specific).

Model 5 tested whether off-topic network cohesion moderates the effect that off-topic forum participation has on domain-specific forum participation. Model 5 shows a statistically significant interaction effect. This interaction term along with both main effects in model 5 provide evidence that the amount of triadic closure (network cohesion) in the TPC café moderated the effect that off-topic forum participation had on domain-specific forum participation.

Figure 4 graphically displays the moderating effect. Participants who participated a below-average amount in the off-topic forum participated more in the domain-specific forums when the off-topic network structure was less (compared to more) cohesive. However, the effect was reversed for members who participated an above-average amount in the off-topic forum. For these members, their off-topic participation increased

⁷ We also ran this model (Model 2) with 20 (19 with a reference period) period dummy variables instead of these groupings of five (four plus the reference period). The results were the same in terms of the direction of the effect changing in the last four periods (with the first period as the reference period).

their domain-specific participation when the off-topic network structure was more (compared to less) cohesive. This result means that greater network cohesion in the TPC café hindered domain-specific participation for members who contributed relatively infrequently to the off-topic forum. However, greater network cohesion in the TPC café facilitated domain-specific participation for members who had high participation rates in the off-topic forum. Finally, we found that network cohesion had a greater differential effect for individuals who had higher off-topic forum participation rates relative to individuals who had lower off-topic forum participation rates.

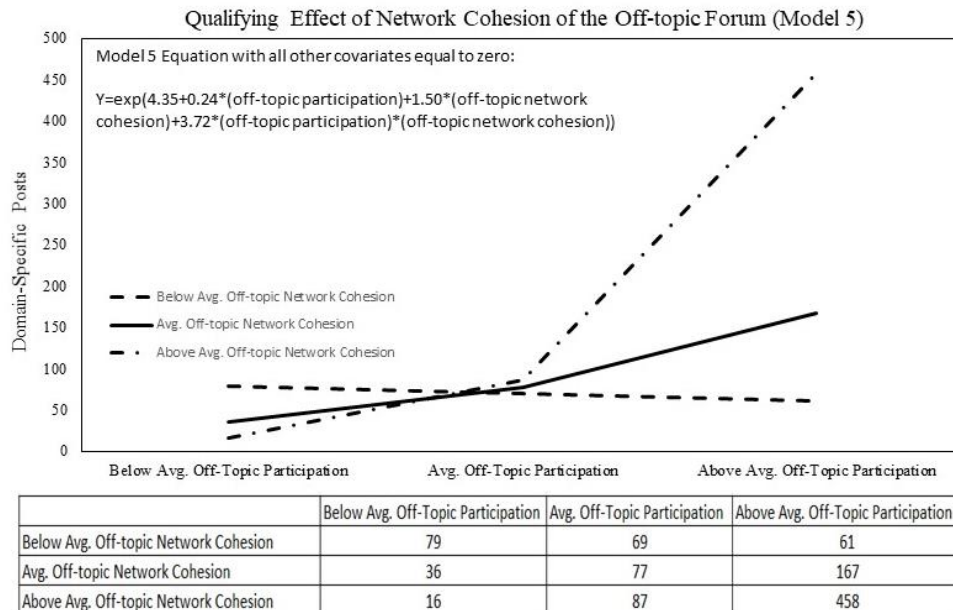


Figure 3. Qualifying Effect of Network Cohesion in Off-topic Forums

The control variables revealed several interesting relationships. First, models 2 and 4 revealed that the more domain-specific posts that a member contributed in the prior period, the higher likelihood the member would continue to contribute domain-specific posts in the next period. This finding is consistent with the idea that members contribute domain-specific content when regularly contributing domain-specific content becomes a habitual behavior. In model 5, the interaction effect of the domain-specific network cohesion variable and the number of domain-specific contributions variable was not statistically significant. Therefore, the network cohesion of the domain-specific forums did not moderate this main effect, which is unlike what we found in the off-topic forum. Second, models 2, 4, and 5 demonstrated that members in bridging network positions (betweenness centrality) had statistically significant higher domain-specific participation rates relative to members in non-bridging network positions. This finding supports the conjecture that bridging positions are structurally advantageous in many different contexts including our eNoP context (Burt, 2005). Third, models 2, 4, and 5 indicated a strong positive reputation effect in our data. Members who earned higher reputation scores in the feedback system had higher domain-specific participation rates relative to members who had lower reputation scores.

Finally, the models with just the subsample of off-topic forum participants and the full sample of all participants (both off-topic and domain-specific participants) revealed opposite effects for the first contribution categorical variable and the individual cohesion variable. In the full sample, 96 percent of the observations (23,744 data points) contained members whose first contribution was in one of the domain-specific forums, which resulted in a heavily biased statistical test for this control variable and only a marginal level of significance (0.1 level only). A better statistical test for the first contribution control variable was with the subsample of off-topic forum participants who had a more-balanced distribution (69% domain-specific forums first and 31% off-topic forum first). These models with just the subsample of participants revealed a highly significant negative effect, which means that members who came to the eNoP for the learning value first and the social value second contributed more domain-specific content. The individual cohesion results were more interesting because this variable changed signs and was highly significant in both the subsample and the full sample. These findings highlight that the effect was generally (on average) positive across all members, but members who participated in both the domain-specific

forums and the TPC café behaved differently. The subsample of off-topic forum participants was unique because participants in this subsample included members with very strong ties and members with very weak ties, which their individual clustering coefficient values reflected. However, most of the members in the full sample participated only in domain-specific forums, which resulted in a consistent strength of ties between members when we calculated the individual cohesion values. Therefore, the consistency of tie strength in an individual's local clustering coefficient may have influenced whether the effect was positive or negative.

4.1 Alternative Explanations

Table 6 summarizes the alternative explanations that we tested. We drew three primary conclusions regarding these additional analyses. First, the off-topic forum's network cohesion was not merely a proxy for the domain-specific forums' network cohesion. These forums had distinctively different network structures that affected members' domain-specific posting patterns differently. Second, other potential network moderators associated with off-topic relations such as network centralization and network density were not significant. Interestingly, these two alternative network structure variables do not include any element of triadic closure in their operational definition. Therefore, the triadic closure associated with the off-topic forums was an important element that affected the qualifying effect of the off-topic forums' overall network structure. Third, the overall off-topic forum's network cohesiveness rather than an individual's local clustering coefficient explained the qualifying effects associated with the entire off-topic forum's overall network cohesion. This finding means that the overall off-topic network structure and not the individual member's localized network structure was the differential factor that explained the variability in member's domain-specific posting behaviors.

Table 6. Possible Alternative Explanations

Alternative explanation	Test	Analysis
The off-topic forum's network cohesion was just a proxy for the domain-specific forums' network cohesion.	We replaced off-topic network cohesion with domain-specific network cohesion in the off-topic interaction effect in model 5.	The substituted interaction effect was not statistically significant.
The hypothesized interaction effect was related to the off-topic forum's network centralization and not to the off-topic forum's cohesiveness.	We replaced both the domain-specific and off-topic cohesion interaction effects from model 5 with network centralization interaction effects.	The off-topic interaction effect (off-topic forum participation by network centralization of the off-topic forum) was not statistically significant at the 0.05 level, so this non-significant term ruled out this alternative explanation for both H2 and H3.
The hypothesized interaction effect was related to the off-topic forum's network density and not to the off-topic forum's cohesiveness.	We replaced both domain-specific and off-topic cohesion network effects from model 5 with the network density interaction effects.	The off-topic interaction effect (off-topic forum participation by network density of the off-topic forum) was not statistically significant at the 0.05 level, so this non-significant term ruled out this alternative explanation for both H2 and H3.
The effects would have been the same if we measured all network variables across the entire eNoP instead of breaking down the website into separate but related (i.e., off-topic and domain-specific) network structures.	We calculated all variables across the entire eNoP website and ran a negative binomial regression model with all control variables and the cohesion by off-topic forum participation interaction effect at the eNoP level.	These models revealed the interaction effects were not statistically significant, so the higher level of granularity masked the differential effects that were evident when splitting the network into separate but related (i.e., off-topic and domain-specific) network structures.
An individual's local clustering coefficient (i.e., an individual's personal network of closed triads) would better explain domain-specific forum participation instead of the off-topic forum's overall structure.	We controlled for the main effect of each individual's local clustering coefficient in the full models (model 2 and model 5).	This variable was significant but had a positive effect in model 2 and a negative effect in model 5. Furthermore, controlling for this network effect did not adversely influence the direction and statistical significance of our theorized interaction effect.

4.2 Summary of Empirical Analyses

Table 7 summarizes our findings related to each hypothesis. In general, our “all work and no play” members contributed fewer domain-specific posts relative to our “some work and some play” members. However, the benefits for the “some work and some play” members depended on how much they “played” (i.e., how many off-topic posts they made in the TPC café) and the off-topic forum’s network structure (network cohesion). Greater off-topic forum participation for the “some work and some play” members significantly increased their participation in the domain-specific forum when the off-topic forum was highly cohesive. Infrequent off-topic forum participation for the “mostly work and rarely play” members significantly increased their participation in the domain-specific forum when the off-topic forum was less cohesive. Therefore, simply investigating off-topic forum participation without also investigating an off-topic forum’s network cohesion could lead to misleading conclusions. We found that the effect, given all of the other covariates, depended on the off-topic forum’s overall network structure.

Table 7. Summary of Findings

Hypothesis	Conclusion
<p>H1a: Given equal conditions, greater off-topic forum participation is associated with lower domain-specific forum participation.</p> <p>H1b: Given equal conditions, greater off-topic forum participation is associated with greater domain-specific forum participation.</p>	<p>Our cross sectional models (models 1 and 3) supported H1b.</p> <p>However, the longitudinal analyses with the period dummy variables in models 2 and 4 demonstrated that the effect varied over time. In model 2, the first four period groupings supported H1b, but the last period grouping supported H1a. In model 4, the first three period groupings supported H1b, but the last two period groupings supported H1a.</p>
<p>H2: Given equal conditions, the network cohesion of the off-topic forum will positively moderate the effect of high levels of off-topic participation on domain-specific participation.</p>	<p>Model 5 supports these two hypotheses.</p> <p>Members who had high participation rates in the off-topic forum participated more in the domain-specific forums when the off-topic network structure was highly cohesive relative to when the off-topic network structure was less cohesive.</p>
<p>H3: Given equal conditions, the network cohesion of the off-topic forum will negatively moderate the effect of low levels of off-topic participation on domain-specific participation.</p>	<p>Members who had low participation rates in the off-topic forum participated more in the domain-specific forums when the off-topic network structure was less cohesive relative to when the off-topic network structure was more cohesive.</p>

5 Discussion and Conclusion

Our paper makes several interesting revelations concerning the network effects of off-topic relations in eNoPs. First, when the off-topic forums had an above average network cohesion (high aggregate number of triadic closure), members who had high participation levels in the off-topic forum participated more in the domain-specific forums. This finding means that members who had high off-topic forum participation rates participated more in the domain-specific forums when the off-topic forum’s network contained triadic closure throughout. Second, we found the reverse effect for members who had low participation rates in the off-topic forum. In this case, we found lower levels of network cohesion were associated with greater domain-specific participation. Third, other network variables such as density and centralization did not have the same qualifying effect on off-topic forum participation that triadic closure (global clustering coefficient) did. Hence, the triadic closure associated with an off-topic network appeared to explain the differential effect more than direct relationships (density) or the degree to which the off-topic forum was centered on its most central participants (centralization).

5.1 Theoretical Contributions

Our study suggests that a network perspective offers the theoretical flexibility to reconcile the two contrasting arguments that previous studies have made about whether off-topic forum participation positively or negatively impacts domain-specific participation in eNoPs. Our proposed network perspective provides a more nuanced account of the influence that off-topic forum participation has on domain-specific

forum participation that depends on the overall network cohesion (global clustering coefficient) of the off-topic forum(s).

For our “some work and some play” member (Member B), this result means that greater off-topic forum participation may be distracting (negative effect) or social-bonding (positive effect) depending on the cohesiveness of the off-topic forum. If the network structure of the off-topic forum is fractured and less cohesive, greater off-topic participation has a negative effect on domain-specific forum participation. However, a highly cohesive off-topic forum’s governance benefits kick in for member B when she has greater participation in such a forum. Therefore, simply investigating off-topic forum participation without also investigating the qualifying effect of network cohesion would lead to a misleading conclusion for member B. For off-topic forum participants, higher (compared to less) participation does not always lead to higher domain-specific forum participation—an important theoretical insight given the contrasting predictions in the prior literature.

Our paper makes two additional theoretical contributions to the eNoP and networking literature more broadly. First, most network studies in the information systems (IS) literature investigate the main effects of network variables. These studies have revealed some interesting network effects. For example, Wasko and Faraj (2005), the seminal eNoP paper, demonstrate that degree centrality across an entire eNoP has a direct effect on its members’ propensity to share knowledge. This finding has motivated hundreds of additional studies to investigate this main effect in other networks. However, our findings suggest that scholars need to investigate qualifying effects of these types of network variables. It remains an empirical and theoretical question whether degree centrality moderates or is moderated by other variables, which might result in degree centrality sometimes having a positive or a negative impact on knowledge sharing. We need to investigate these types of qualifying relationships because failing to account for factors that reduce the strength of or change the sign of networking coefficients may adversely influence the generalizability of network research to other IS phenomena.

Second, many networking studies in the IS discipline theoretically and empirically investigate a single network using a single set of networking variables for the entire social structure, but this type of operationalization may be an oversimplification of the network structure (Matzat, 2004; Ridings & Wasko, 2010; Tortoriello et al., 2012; Wasko & Faraj, 2005). Many eNoPs, particularly those in the software development industry, have separate freelance, question-and-answer, off-topic, and industry sections whereby participation in one section may positively or negatively affect membership patterns in another. Had we simply measured all of the networking variables across the entire eNoP, we would not have uncovered many of our interesting qualifying relationships. Furthermore, scholars cannot understand how networking variables in one section of a network impact behaviors in a different section if they investigate the entire structure as a single network with one common set of networking variables. Future networking research can build off our results by investigating network structures at a more granular level to consider additional theoretical and empirical insights.

5.2 Practical Contributions

From a practical perspective, eNoP administrators have debated the usefulness of off-topic discussion forums for quite some time. When we wrote this paper, the stackexchange collection of eNoPs did not include off-topic discussion forums, whereas other eNoPs such as www.valueforum.com, www.dreamincode.net, and www.codeproject.com included both domain-specific and off-topic forums. Our empirical and theoretical analyses indicated that the answer to the positive or negative question regarding off-topic forum participation does not always have a straightforward yes or no answer due to differential network effects. Cross, Borgatti, and Parke (2002) suggest that managers (eNoP administrators in our case) should incorporate network analyses into their decision making processes in order to more fully understand the role of informal structures when managing people. Therefore, for our first practical recommendation, we recommend that eNoP administrators incorporate network analyses into their decision making processes. Simply attempting to manage membership by using the characteristics of the individual members does not completely capture the complexity of the social forces affecting members’ domain-specific posting patterns.

Second, eNoP administrators may seek to mitigate and identify evidence of social exclusion in highly cohesive off-topic networks by initiating discussion threads to engage members who may be socially excluded from the off-topic forums. This type of activity may help these members make connections with others and, thus, create closed triads that may not form naturally. This tactic will certainly require such administrators to actively manage the off-topic forums because network structures tend to be fluid and

constantly change (Faraj et al., 2011). However, our findings indicate that the effect of optimally matching the off-topic network structure with the off-topic members' participation rates can have up to a 50 percent increase in domain-specific participation. Our results suggest that eNoP administrators should spend some time determining the optimal network-cohesion level given the types of members who participate in the off-topic discussion threads in order to maximize domain-specific participation.

5.3 Study Limitations and Future Research

Like all research, our paper has several limitations. First, we studied a single eNoP in a single industry (software development). Although we believe that using a single eNoP avoids potentially confounding website specific differences associated with different norms and cultures across multiple eNoPs, we cannot universally generalize our results to all professional eNoPs in or outside the software development industry without additional empirical data. Software developers are interesting in the sense that they spend most of their time online, so professionals in this industry may be more comfortable socializing in off-topic forums. Lawyers or medical doctors, for example, may have different online social interaction patterns due to the professional differences associated with the different occupational cultures. These differences may influence the network effects that we found using a sample of software developers. As such, an interesting and fruitful area of future research would involve extending our models to an eNoP in a different industry.

Another interesting context extension would involve testing or extending our models to other virtual environments beyond professional oriented eNoPs. With our sampling frame, we can only conjecture about what the off-topic forum dynamics might be in other types of virtual communities such as those that focus on gaming or a particular sports team. Following Lee and Baskerville (2003), we analytically generalized our empirical evidence to argue that the cohesiveness of an off-topic forum and each member's participation rates in it are likely to influence domain-specific forum participation in an interesting manner. These insights will usefully guide further studies in a variety of virtual contexts beyond eNoPs and in other types of eNoPs to further examine limiting and boundary conditions related to these effects. Obviously, we cannot generalize any of our statistical results outside of our sampling frame. However, we assert that future networking research should empirically and theoretically consider qualifying factors such as network cohesion when investigating membership patterns between and in different sections of websites in different types of virtual environments.

Second, we did not test or theorize about different management interventions (i.e., different motivational techniques to encourage domain-specific participation) based on the relational structures of the off-topic forum. However, our results do show that members acted on different network structures differently in terms of domain-specific participation rates, which suggests that it would be reasonable to predict that members embedded in different relational structures would respond differently to similar management interventions. An interesting future research project would involve investigating different management interventions based on network structure, participation rates, and the purpose of the forum to determine if certain interventions work better or worse in terms of promoting domain-specific participation.

Third, with our study design, we could not determine why each member participated in the off-topic forum. For instance, one member may have desired to become a highly embedded member in the TPC café, whereas another may not have cared as much. As such, these differences may weaken or strengthen the network cohesion moderator because being socially excluded may not influence each member in the same manner. Even though our large sample size may mask this potentially confounding factor, we suggest that an interesting future study might survey off-topic forum participants to gain further insights into these types of differences in relation to our theorized network variables.

Finally, we attempted to maximize external validity by investigating objective membership patterns in an unobtrusive manner at a real eNoP. As a result, we cannot make any statements related to causation with this particular study design. Our studied revealed interesting correlations and associative relationships related to off-topic network effects, but a controlled experiment that is high in internal validity is necessary in order to make any type of statement of causation. The longitudinal nature of our study does suggest an element of causation, but we must be cautious in making such a conclusion. Future research can build off our findings in order to further tease out the direction of the effect. Nevertheless, our study does provide strong evidence that an interesting pattern of membership behaviors associated with these two separate but related network structures in an eNoP exists.

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Appendix A: Network Variable Operational Details

All of our network variables required determining relations (ties) between members in the respective (off-topic versus domain-specific) forums. At the time of our study, TPC organized discussion threads (i.e., stream of posts about a specific topic) in forums (i.e., collections of discussion threads). Members participated by starting new discussion threads and/or by posting in existing discussion threads (i.e., posts are made in discussion threads, which are organized in forums). We used digital trace data consistent with the previous literature in order to determine ties between the TPC café's participants and the ties between the domain-specific forums' participants (Ahuja et al. 2003; Howison et al., 2011). We determined ties based on participation in a common thread in the TPC café or in a common thread in the domain-specific forums. We constructed unidirectional binary matrices (one for the domain-specific forums and one for the TPC café forum) whereby, if two members posted in the same common thread, we entered a 1 in the cell in the matrix; otherwise, we entered a 0. We followed this process for each of the 20 discrete periods.

A.1 Network Cohesion of the Off-topic Forum

We calculated the network cohesion of the off-topic (TPC café) forum at each of the 20 discrete periods using the global clustering coefficient that Watts and Strogatz (1998) define. The global clustering coefficient is an average all of the local clustering coefficients for each member of the TPC café. The local clustering coefficient of a vertex u (TPC café participants) was:

$$C_G(u) = \frac{e(N_G(u), N_G(u))}{\frac{|N_G(u)|^2}{2}},$$

where G represented a graph that contained all informal socializing ties between all vertices (individuals) and $N_G(u)$ represented the immediate neighbors of a specific vertex u . The global clustering coefficient was the average of all of the local clustering coefficients. As such, we defined the global clustering coefficient as:

$$C(G) = \frac{\sum_u C_G(u)}{|V|},$$

where $|V|$ was the set of all vertices in the graph. At any point in time, there was a single value between 0 (lowest possible level of cohesion) and 1 (highest possible level of cohesion) for the TPC café as a whole. We calculated the global clustering coefficient for each of the 20 discrete periods (i.e., a total of 20 different values). We then centered the final values on the grand mean (0.8473 was the grand mean across all 20 discrete periods). Therefore, a 0 in the final negative binomial regression models represented an average level of network cohesion of the off-topic forum (0.8473).

A.2 Network Cohesion of the Domain-specific Forums

We calculated this variable in the same manner that we followed to calculate the network cohesion of the off-topic forum. We calculated the local clustering coefficient for each active member in the domain-specific forums in each of the 20 discrete periods using Watts and Strogatz's (1998) cohesion measure. We then took the average of all of the local clustering coefficients to determine the global clustering coefficient for each of the 20 discrete periods. Finally, we grand mean centered (grand mean of 0.6829 for all 20 discrete periods) the final values. Therefore, a 0 in the final negative binomial regression models represented an average level of domain-specific network cohesion (0.6829).

A.3 Betweenness Centrality

The formation of off-topic forums created an opportunity for certain members to act as brokers or bridges between the domain-specific forums and the off-topic forum, which could impact a member's propensity to participate in the domain-specific forums. Following Wasserman and Faust (1994), we calculated a standard betweenness centrality measure to determine the strength of the bridge for each member who participated in both the domain-specific and the off-topic forums in each of the 20 discrete periods. For each active vertex (u), we defined betweenness centrality as:

$$g(v) = \sum_{s \neq v \neq t} \frac{\sigma_{st}(v)}{\sigma_{st}}$$

where σ_{st} was the sum of the total number of shortest paths from node s to node t and $\sigma_{st}(v)$ was the count of the number of paths that pass through u . We then mean centered these values on the average for each of the 20 discrete periods.

A.4 Centralization of the TPC Café and the Domain-specific Forums

Centralization measures how central the most central node is in relation to all of the other nodes (Wasserman & Faust, 1994). To determine this value for the domain-specific and the off-topic forums, we first calculated the sum of the differences in the degree centrality between the most central node and all of the other nodes in each forum. Then, we divided that quantity by the theoretically largest sum of the differences in any network of the same size. Therefore, we defined centralization as:

$$C_x = \frac{\sum_{i=1}^N C_x(p_*) - C_x(p_i)}{\max \sum_{i=1}^N C_x(p_*) - C_x(p_i)}$$

where $C_x(p_i)$ was the degree centrality of node i and $C_x(p_*)$ was the largest degree centrality in the network. We calculated this value for each of the 20 discrete periods for the off-topic and the domain-specific forums. We then grand mean centered the final values using their respective grand means.

A.5 Density of the TPC Café and the Domain-specific Forums

Researchers often use density as a proxy for a network's cohesiveness, but the global clustering coefficient (cohesion) differs conceptually from network density. Network density is based on direct relationships and not indirect third party relationships, which the global clustering coefficient is based on. The common formula for density is simply the number of actual connections between all nodes in the network divided by the number of possible connections for each vertex in the network (Wasserman & Faust, 1994). We used this formula for both the off-topic forum and the domain-specific forums in each of the 20 discrete periods. We grand mean centered the final values using their respective grand means.

A.6 Local Clustering Coefficient of an Individual's Network across the Entire eNoP

To control for the effect of an individual's network's cohesiveness across the entire eNoP, we calculated each member's local clustering coefficient (Watts & Strogatz, 1998) using a unidirectional matrix of ties across the entire eNoP (i.e., both domain-specific and off-topic forums). This variable did not factor in the cohesiveness of the entire social structure but rather each individual's triadic closure. We then centered these values on the average for each period.

About the Authors

Tom Mattson has a PhD in International Management and is an Assistant Professor in the Robins School of Business at the University of Richmond. His research focuses on a variety of managerial and technological issues facing modern organizations.

Elizabeth Davidson is a Professor of Information Technology Management at the Shidler College of Business, University of Hawai'i Manoa and the Editor in Chief of *Information and Organization*. She has formerly served as Senior Editor for *J AIS*, Senior Associate Editor for *EJIS*, and as AE of *MIS Quarterly*.

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