The ties that bind: Social network principles in online communities

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ABSTRACT

In a Web 2.0 environment, the online community is fundamental to the business model, and participants in the online community are often motivated and rewarded by abstract concepts of social capital. How networks of relationships in online communities are structured has important implications for how social capital may be generated, which is critical to both attract and govern the necessary user base to sustain the site. We examine a popular website, Slashdot, which uses a system by which users can declare relationships with other users, and also has an embedded reputation system to rank users called 'Karma'. We test the relationship between user's Karma level and the social network structure, measured by structural holes, to evaluate the brokerage and closure theories of social capital development. We find that Slashdot users develop deep networks at lower levels of participation indicating value from closure and that participation intensity helps increase the returns. We conclude with some comments on mechanism design which would exploit these findings to optimize the social networks and potentially increase the opportunities for monetization.

1. Introduction

Since the opening of the Internet to commercial organizations, there have been many experiments with business models to capitalize on the features and capabilities of the World Wide Web. Some have become main-stream, like online storefronts and auctions, and some seem to be fading, like subscription based newspapers. Several of the newest sets of online business opportunities involve "Web 2.0" concepts, especially those centered on virtual communities. We use the term Web 2.0 to refer to websites which provide content that gets richer as more people use the website, harnessing "the power of user contribution, collective intelligence, and network effects" [24,25]. The most prominent of these sites include YouTube, MySpace, Wikipedia, Facebook and Orkut, which together encompass a sizable share of the world's most popular sites (#3, 6, 7, 8 and 11 respectively by ranking of global traffic (Alexa.com July 2008). Clearly, this form of online organization is creating a large impact in the business community. However, the business principles behind websites based around social networks are not well-understood. This paper seeks to illuminate a part of this area of study.

Online organizations face unique challenges managing their organizational interests given their customer base is physically distant, psychologically unknown and literally faceless. This becomes more critical as businesses move from a model of simple transactional online functionality to one in which customer input and integration with the business is part of the product. At its most preliminary, this trend can be membership specials (Lego.com), or one where the user commentary is a valued subset of participation (Salon.com's Tabletalk). At its most extreme, the user-generated content is the primary focus of the business model (Flickr.com, Youtube.com). Therefore, the question arises: how can a website interested in exploring the possibilities of Web 2.0 features encourage and manage high quality participation to the benefit of its online presence. The answer includes strategically implementing mechanisms to encourage and support desired types of participant behavior and attitudes towards the community.

Web 2.0 collaborative sites provide a fundamentally different environment for managers than a traditional business. The website users and visitors provide such a great portion of the value of the site that they are critical "members" of the organization, yet their efforts are completely voluntary and the normal tools of organizational control are often not applicable. Instead, the social network — a structure that works more behind the scenes in traditional networks — jumps to the fore in virtual organizations. Social networks provide an immediate incentive for participation and transactional rewards for cooperative behavior. They can be used to manage the community [4] in lieu of traditional tools, establish credibility in an anonymous environment, and provide structure to the problem of balancing thousands of cooks in a single kitchen. By providing a framework to build trust, social networks can help make the website more flexible and enduring by building loyalty, cooperation and teamwork [12]. Online social networks have become a parallel community for many, satisfying in the virtual world the "impulse to sociability in man[.]" [33] Finally, it brings an opportunity for other business to develop from the additional information about the network participants and their interests.

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It is clear that if deployed and utilized to the benefit of both participants and owners, a social network is critical to the smooth and optimal design and management of a virtual organization. However, the question of what is the optimal structure of a social network to both participants and managers of online communities is still open. While research into social networks in traditional organizations is rapidly forming a solid body of results, there is currently little to guide interested parties in the online environment. In this study we examine some of the dominant theories and concepts in social network theory to test their application to Web 2.0 organizations. This paper has major implications on the literature of social networks by demonstrating the significance of their characteristics in an environment where the main rewards to forming relationships are primarily intangible and may never cross into the "real" world. Managers and developers of online social networks will be provided an important guide to creating powerful social networks for both participants and the community.

In this paper we present an exploratory study of the extent to which traditional organizational theories of social networks apply to online social networks, specifically addressing the question of whether the social network theories informing management principles in traditional organizations can also apply to Web 2.0 organizations. The fundamental premise underlying our approach is that the structure of a network can create opportunities for the generation of rewards to its members. We specifically focus on the brokerage and closure concepts in social network theory to determine whether the social capital benefits of networks are also relevant to participants in virtual organizations. We examine a specific case website — the for-profit online community Slashdot (http://slashdot.org) — in which the role of social networks is critical to the efficient running of the site and provides important returns to both participants and the site operators. We believe that our analysis of Slashdot can reasonably be extended to the more general case of virtual communities and that this research will provide an important first step in exploring how to optimally manipulate the social network and manage the online organization.

2. Background

The application of network theory to virtual communities presupposes a vision of the websites as organizations. Can a community which is not much more than a social network be considered an organization? We believe so. As Granovetter discussed, social relations are a series of social exchanges which inherently encompass market based relations. In other words, these social exchanges are a series of market transactions [11]. Therefore, it follows that the transaction cost approach [38,39] is applicable to analysis of social relations, to social networks, and most modernly, to virtual communities. Ouchi [27] describes the closest parallel to a virtual community organization when he describes a clan organizational structure. The clan provides an alternative to corporate authority in situations where a hierarchy is ineffective due to weak pre-definition of roles and where a market is ineffective because performance and presentation is difficult to verify and valuate. A clan structure specifically forms its strength on the social relations of the organization; it can compensate for vague roles and indefinite outcomes. Not only does this vision of virtual communities as an organization provide a ready body of organizational work to examine the issue facing website stakeholders, but it also emphasizes the importance of social networks to creating the backbone of the organization, just like it does with offline clan organizations.

However, there are some significant differences between traditional and online communities. Virtual communities may not have a predefined structure guiding the relationships, so they can be much more open and in flux. There may also be much less at stake to participants. There is less information guiding the relationships and actions on the community and less transparency. Many of the organizing schemes and authority is based on more on informal agreement than a strict hierarchy.

These differences eliminate or minimize many of the motivation and control mechanisms that would be available in traditional organizations. The network perspective augments our understanding of traditional organizations, but in the online world it is of central importance. As Burt [6] describes, network theory focuses on outcomes based on a matter of relations, not player attributes. In virtual communities, the relations are most commonly the only trustworthy information that researchers have to examine the organization; this is certainly true to participants. Therefore, understanding the relationship between the structure of the social network and positive outcomes for online communities is critical to optimizing the experience for all stakeholders.

2.1. Network theory and social capital

Social networks are the structure of the direct and indirect relationships people create which offer socioeconomic resources to the individual [20]; the value of social networks manifests to participants as social capital. Social capital is "a person's social characteristics — including social skills, charisma, and the size of his Rolodex — which enables him to reap market and non-market returns from interactions with others." [1,10] One metric of social capital is status ranking or reputation. High status rankings in online communities often align with increased privileges to the user or with a higher assumption by other participants of veracity and authority in the user's contributions.

Social capital is both an outcome gained by individuals in an online community and a tool for facilitating the governance of such spaces. The value from a social network to the organization includes the indirect benefits from having participants with more buy-in to the site and also the direct benefits of being released from the need to vet participant contributions and having implied paths connecting participants for the purpose of control and information dissemination [13,34]. As stated in Jones et al. [13,34], "Large-scale, pseudonymous participation is typical of many online communities, making them difficult to govern for designers, to make sense of for participants, and to form social capital in for all stakeholders." Further, researchers are beginning to recognize that online communities have characteristics that not only help form traditional ties between participants, but may form new types of relationships as well [32,37]. Thus, a tool like a social network, if properly structured, can be a primary component of a successful Web 2.0 business model.

We follow closely the efforts of Burt [5,6] who builds a theory of social capital in networks by focusing on the presence or absence of structural holes. Structural holes are defined as a lightly connected bridge between denser sub-network elements. If, in their collection of networks, an individual has bridged one or more structural holes they are "brokers" between the sub-networks; at the other extreme they are participating in "closed" networks. Also, It is possible for personal connections to develop with both attributes. These concepts are illustrated in Fig. 1.

Burt organizes these ideas into two complementary theories for the creation of social capital from structural holes — brokerage vs. closure. If the structural hole is large with very few actors crossing it, *brokerage* allows the entry of new ideas across a "bridge" or "brokerage" across sub-communities in a way that can facilitate information flow in the larger network. The brokerage principle provides the argument that, in a business setting, an individual with a personal network high in structural holes can reap the benefits of high social capital by providing the indirect connection that resources need to flow around an organization. A few research studies stand out in the large body of relevant literature, much of which is summed up in Lin [20] and Burt [6]. Tsai and Ghoshal [36] found that network between-ness — a centrality measure that captures the presence of structural holes — was positively associated with the ability of an organizational unit to exchange and combine resources in ways that add value through product innovation. In his study of middle managers at 10 operating companies of a Fortune 100 firm, Burt [7] offers an interesting extension of his foundational work where he compares the networks of American and French managers and finds that, despite the
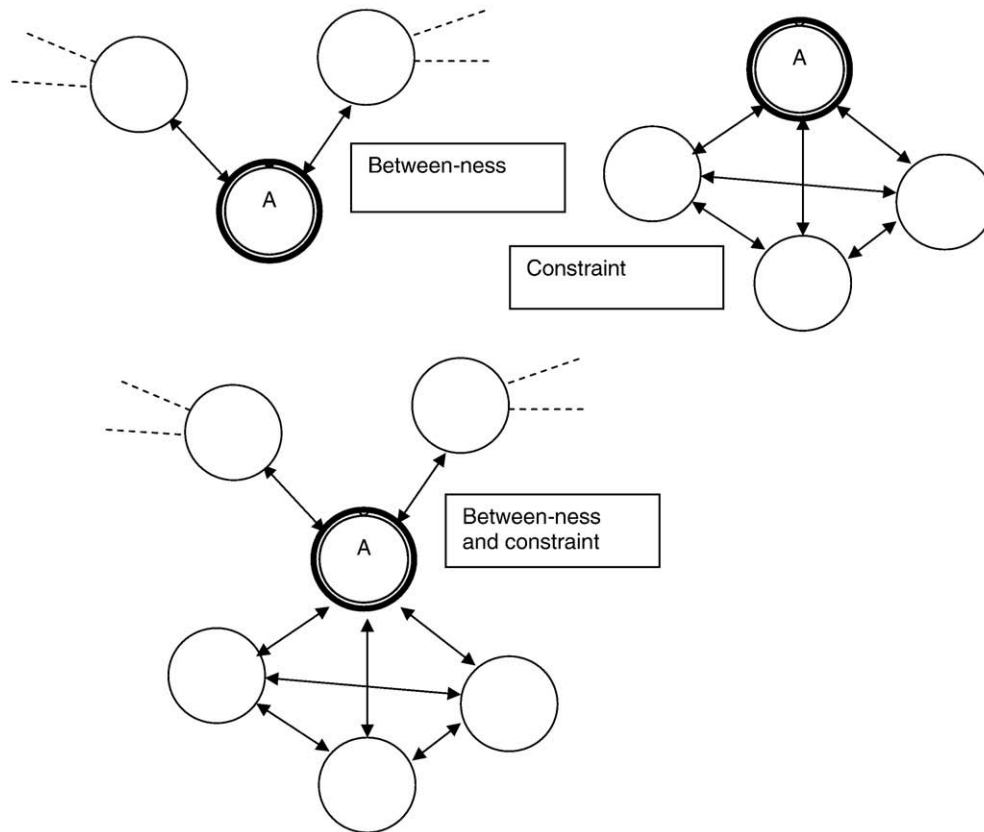
Fig. 1.

differences in bureaucracy, successful managers in both countries tend to have networks rich in structural holes. Zaheer and Bell [40] examine the network structure of the 77 mutual fund companies listed in the Investment Funds Institute of Canada are embedded and the connection with their performance and show that network structure construed as access to structural holes boosts firm performance.

Further, individuals in the denser sub-networks on either side of structural holes may gain social capital through the mechanism of *closure*. The principle of closure supports the concept that individuals with a personal network that is highly interconnected with few structural holes may gain social capital with the intense support of their strong relationships. For example, Ashleigh and Nandhakumar [3] showed that feelings of trust in terms of confidence, respect, commitment and teamwork were significantly higher within teams than between teams. Moran [23] found, in a study of 120 product and sales managers, that structural embeddedness, a measure of closure, has a more significant impact on managerial performance than relational embeddedness, a measure of brokerage.

While most of the literature concerning brokerage and closure examine traditional organizations, smaller streams of work in computer-mediated communications and in electronic markets are examining the issues of trust and innovation that are relevant to any social network. For example, Gargiulo and Benassi [9] examine data on 19 managers involved in project teams in an Italian multinational computer firm subsidiary. They find that the cohesion gained by closed networks may curtail the autonomy to develop cooperation beyond the network necessary to perform complex organizational tasks. In other words, closure can stifle the ability to achieve outcomes. Powell, Piccoli and Ives [9,31,36] conduct a review of the literature on virtual teams and point out that while the literature shows that socio-economic processes can have a considerable impact on the outcome, there are unique difficulties in meeting these needs, but that social communication through online tools can help overcome them.

In the study of electronic markets and control mechanisms, recommender and reputation systems are valuable by helping to create a history of interactions and by providing explicit feedback about users based on the experiences and opinions of others [35]. This will aid in building trust, since they can be used anytime when the past is predictive of the future [8], and help provide social cues, or signals, that are lost due to the high volume, text-mediated, pseudonymous environment of most online communities [41]. Directly relevant to this study, Jøsang, Ismail and Boyd [14] tie in a survey of existing and proposed reputation systems with online communities including Slashdot and help to support our point that social networks also must positively deal with the information asymmetries in transactions in order to have positive outcomes.

To summarize the theory, brokerage is useful for broadening the network contributions to the wider circle without overloading it with too much information. Conversely, if the structural hole is minimal with many connections between sub-networks, closure allows the tight alignment of ideas. Burt [5] suggests that closure is useful in small groups and teams to focus efforts on specific targets or goals, while brokerage helps to stimulate innovation. Thus, both situations create positive environments in rich networks and they often exist in duality. This is supported by research findings. Oh, Chung and Labianca [26] studied 77 work groups from 11 Korean organizations and found that a moderate level of closure internal to a group and a high level of brokerage to other groups leads to the optimal level of group effectiveness. Liao and Welsch [19] examine a sample of over 400 nascent entrepreneurs using the Panel Study of Entrepreneurial Dynamics (PSED) through a series of hypotheses related to structural, relational, and cognitive aspects of entrepreneurial networks. Significantly, they compare the impacts of structural and relational capital on growth aspiration for both technology-based and non-technology-based nascent entrepreneurs, and conclude that brokerage is a beneficial factor for technology entrepreneurs, while closure is important for their non-technology-based counterparts. Thus, the context of the network is important to the path to generating social capital.
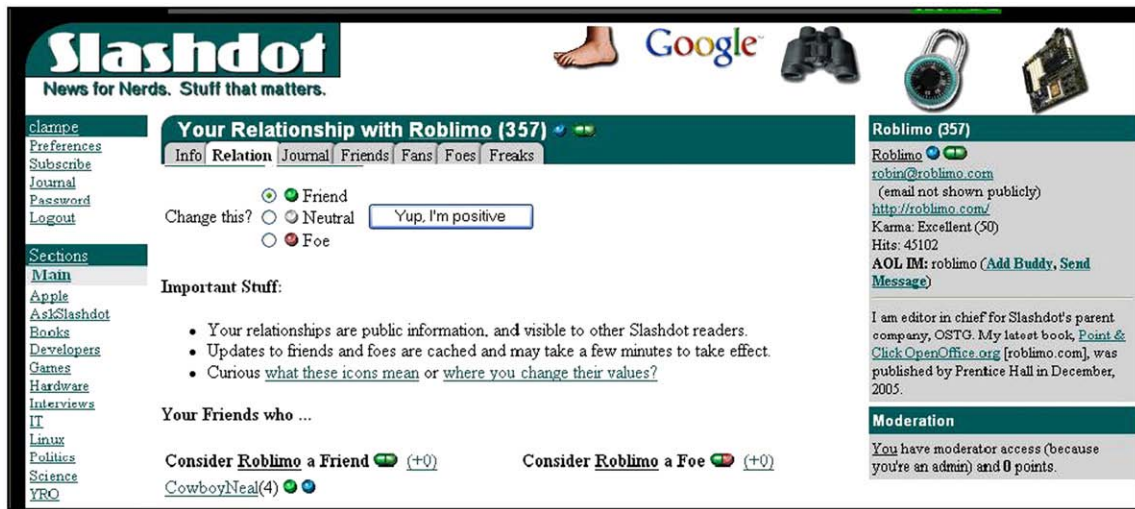
Fig. 2. The Slashdot interface for declaring relationships with other users.

2.2. Slashdot

In this paper we use a specific website — Slashdot.com — as a case study of the theoretical principles behind Web 2.0 organization management.

Slashdot is a news and commentary site founded in 1997 which is dedicated to technology issues, especially those focused on open source software. It attracts over 600,000 unique visitors a day, as measured by unique IP addresses requesting pages from the site. Paid editors select about two dozen news stories each day to appear on the site, providing a one paragraph summary for each and a link to an external site where the story originated. Each story becomes the topic for a threaded discussion among the site's users. Most of the commentary occurs in the first few hours after a story is posted, in part because the story loses its prominence on the front page of the site as other stories are posted. Around 75,000 comments are posted each day to the site.

To organize conversation and provide feedback, Slashdot has implemented a recommender and reputation system by which users rate comments on the site, which affects the reputation of those who wrote the comments. Slashdot calls their comment rating system "moderation" and their user reputation system "Karma." [17] Comments are eligible for moderation for two weeks, though most moderation happens in the first 4 h of a story's life. A comment may receive any number of individual moderations, but will only display a score between -1 and $+5$. Registered Slashdot users have Karma ranging from -50 to $+50$ based on their posting behavior, and to a lesser extent on their reading activity on the site. A user with high

reputation will be able to post comments at a higher starting score than other users, and will be eligible for moderation more often.

In 2002 Slashdot incorporated an online social network by which registered users could explicitly list "friends" and "foes". When a user examines the profile of another, they have the option to select a tab called "Relation" by which they can set the status of that user if they so desire.

Fig. 2 above shows the interface for setting relations on Slashdot. The default setting is neutral, with the option to declare either a "Friend" or a "Foe". The user setting the relationship has their ties listed publicly in their profile, as shown in Fig. 3.

Besides tabs for "Friends" and "Foes" shown in Fig. 3, there are also tabs that list "Fans" and "Freaks". A friend or a foe can be a one- or two-sided relationship from the user with the listing, but a fan or a freak is a one-sided relationship stemming from someone else. Fans are other users who have set you as a friend, and Freaks are users who have set you as a foe. One effect of the social network is the aggregation of other users in personal profiles, which helps provide social awareness in a system in which there are nearly a million registered users. The other effect is that the scores of comments (comments may gain or lose points by users granted moderator status) can be personalized based on the social network, such that comments written by friends display higher scores, and comments written by foes display lower scores.

3. Model and hypotheses

We can construct a model for the relationship between network structure and social capital in the context of Slashdot. As illustrated in Fig. 4, social capital is represented by karma and is the outcome from
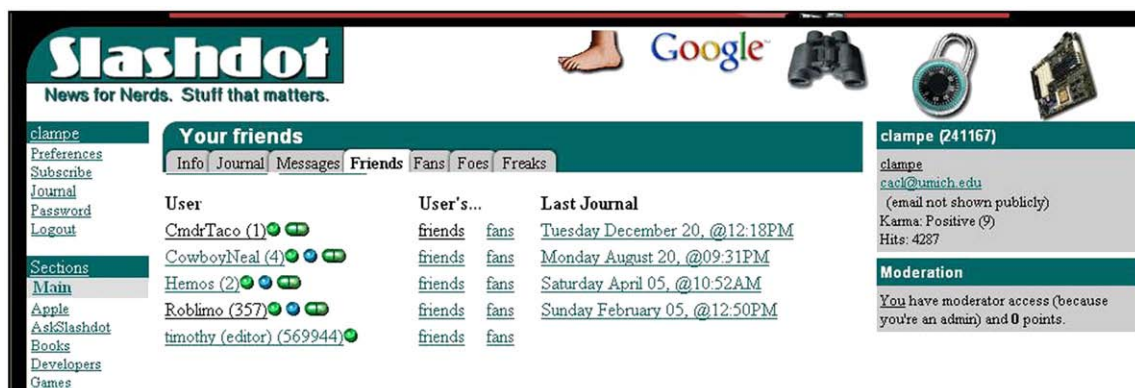

Fig. 3. An example of the list of relationships that a user sees in their profile.

participation in the site. Direct user characteristics are unobserved or unreliable; however individual behavior is reflected in the shape of each user's network, the number of relationships they invest and the intensity of their participation.

In this study we observe only the network not the individual motivations. However, as our model indicates, we believe that networking behavior is a direct reflection of the individual's satisfaction of their unique set of incentives for participating in the site. This is supported by the findings of [16] who assert that usage processes and technology choices of different users are driven by users' individual or social needs.

Consistent with transaction cost analysis, we assume that individuals prefer to spend their resources only in ways that provide benefits. Since building and maintaining a network requires resources (at a minimum, time) we believe that the more carefully formed networks reflect, on average, more purposeful allocations of effort. Therefore, the fundamental assumption of our analysis is that networks that have closure or brokerage attributes are the result of individuals investing in relationships that have value to them and that the motivations for that value can be generalized to be in common across the network structures.

Assumption 1. Individuals motivations for participating in the site are revealed in their networking behavior.

Theories of social networks have provided motivations to develop analytical tools [18,22,30] designed to analyze a network and identify the relationships of major players or nodes in non-biased ways. There are several metrics in the concept of centrality, known to positively influence knowledge sharing and knowledge transfer process, that are relevant to the theories we examine. Under its umbrella are the metrics of between-ness, constraint and degree. *Between-ness* measures the count or the percent of the relationships of a node that are not directly connected to each other i.e. it is directly related to the bridges between sub-networks. *Constraint* measures the inverse; it evaluates the interconnectivity, or relationship redundancy, of the sub-network immediately surrounding a node. Between-ness and Constraint tend to be substitutes for each other. *Degree* is the simple count of the number of relationships a node has to other nodes. These metrics are not exclusive of each other, but combine in different ways to form the theoretical constructs that describe a network structure.

Assumption 2. Brokerage and Closure opportunities are characterized generally by high between-ness/low constraint and low between-ness/high constraint respectively.

Because of these assumptions, we can draw a hypothesis about the relative size of groups of individuals with similar network characteristics. Individuals with constrained networks are likely to be motivated by a high degree of interest in topic-specific sharing, learning and networking. These individuals will often have a specific professional or topical focus. While a site like Slashdot already targets a specific type of user (i.e. Slashdot offers "News for Nerds"), once on the site, the threads and conversations overlap in content a great deal. Therefore we assert it will be unusual for participants to have narrow interests within the site, and there will only be a minority of participants who will develop and sustain the correlated constrained network.

Individuals with a high measure of between-ness are likely to have broad interests or a focus that spans many topics. Efforts to build relationships between disjoint networks require the ability to contribute to focus areas that have little overlap — this is often the stimulus for innovation and creativity for the participant and the relationship partners [5]. However, it can also be difficult to maintain since as time passes it will become more likely that other relationships form that connect the structural holes. Between-ness is the most unusual network structure because of the challenges to its creation and maintenance.

Finally, most individuals in social networks choose to participate out of fun and general collegiality [21]. Even in a professional setting, there can be a sizeable portion of users motivated by a general sense that it is worthwhile to "give back" to the knowledge base of the community [2]. These individuals are not primarily using the network for "investment" and will thus allow their network to develop organically. The relationship structure will quickly appear random.

From this discussion, we present our first hypothesis as follows:

Hypothesis 1

(a) Most participants of the site will exhibit both low between-ness and low constraint.
(b) There will be more participants with high constraint measures than with high between-ness measures.
(c) There will be few individuals who score highly in both constraint and between-ness.

Previous work has indicated that business managers with high social capital from interpersonal networks rich in brokerage across structural holes receive more positive evaluations, earlier promotions and higher compensation [7]. Additionally, research has extended this theory to demonstrate the benefits of closure [19,23]. Further, Burt [5,6] explicates that individuals who are balanced in both rank more highly. As between-ness and constraint are metrics of brokerage and closure respectively, this body of research leads to the following hypotheses:

Hypothesis 2

(a) High between-ness and high constraint are individually associated with high social capital.
(b) High between-ness and high constraint are jointly associated with high social capital.
(c) High constraint is more associated with high social capital than is high between-ness.
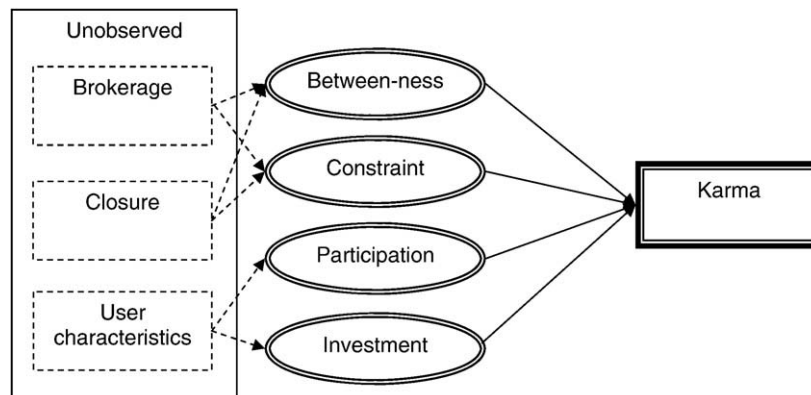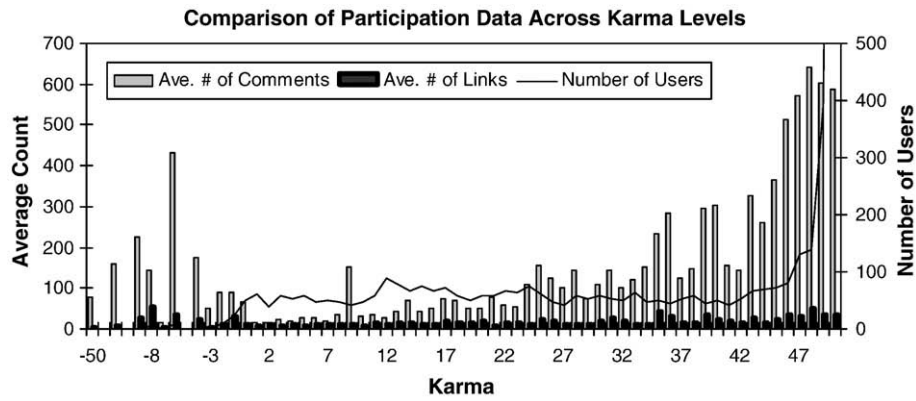

Fig. 4.

Fig. 5. Graphical representation of Slashdot user characteristics.

Gaining social capital through between-ness is more difficult than from constraint. While the value to the sub-networks involved might be high from an effective broker, the broker has to share time and effort, and thus the direct results will incur slower. Further, time decreases the likelihood of between-ness and increases the likelihood of constraint since it increases the likelihood of relationships forming across the structural hole between other participants. Because success tends to engender copycats, one would expect this effect is more pronounced in those with high participation intensity and network investment. From this discussion we propose the following:

Hypothesis 3

(a) Between-ness is inversely related to participation intensity.
(b) Constraint is directly related to participation intensity.
(c) Network investment moderates the relationship between both between-ness and constraint and social capital.

Between-ness brings rewards to network participants by enabling the flow of new information and expanding the reach of ideas. This requires that individuals on the sides of structural holes to be bridged are open to the relationship and the concomitant exchanges. Since network participants are not bound to reward brokers for participation, they tend to reward only high-value exchanges. These are naturally more likely with highly rated individuals; therefore, one would expect that those with high social capital are also those who get the most benefits from the relationship. Similarly, the value of closure as a network structure lies in its connection to trust. Networks with high closure permit greater social sanctions between individuals through common relationships which increasing incentives for cooperation and reciprocal benefits [3]. Cooperation and active reciprocity are particularly important to building trust. This implies that individuals who are active in closed networks receive more intense reciprocity while they are building trust than when it has been established. From this we propose the following:

Hypothesis 4

(a) Positive outcomes from between-ness are more significant to those with high social capital.
(b) Positive outcomes from constraint are more significant to those with low social capital.

4. Research design and data

To evaluate the effect of network configuration on social capital, we will estimate equations of the form

$$\text{outcome} = \alpha + \beta \cdot \text{network characteristics} + \gamma \cdot \text{controls} + \varepsilon$$

where β measures the causal effect of the network characteristics, between-ness and constraint, on the social capital outcome, ε captures

unobserved variation and measurement error, and the controls refer to other factors that are hypothesized to influence the outcome. One important control variable is the intensity of participation in the network, which we measure by the number of comments divided by the degree of each network member. This corrects the measure for time related aspects that lead to correlation and biased results. Another is the network investment, a trust metric, which we measure number of the ratio of friends to total contacts.

Our outcome measure of social capital is taken from the karma rankings of each individual on the Slashdot site. This is an overt measure of status where the perceived quality of the body of work is ranked from -50 to $+50$ by moderators. Our network characteristics, between-ness centrality and constraint are calculated by analysis of the network graph using UCINET, a software tool. Constraint is a type of closeness centrality metric that measures the extent to which the contacts of an individual i are directly or indirectly connected to a contact j, corrected for the size of the network:

$$\text{CI} = \Sigma_i \left(p_{ij} + \Sigma_q p_{iq} p_{qj} \right)^2,$$

for $q \neq I.j$, where p_{ij} if the proportion of $i's$ relations invested in contact j

The constraint index shows the extent to which these structural holes exist in a network. Between-ness then, is the absence of constraint, and measures the extent to which the contacts of an individual, by percent, are not connected. See Burt 1992, pp. 50–71, for further discussion of these measures.

We have gathered information on the social network of Slashdot consisting of almost 6000 current active users with over 200,000 relationships. This is defined as users posting at least one comment within the last year, receiving at least one feedback rating and participating in the social network. Several extremely connected participants, for example users 1 and 666, were omitted from the final analysis to focus the results on the more typical participant. The final data set included 5591 individuals, all with at least 2 relationship connections, encompassing 150,912 network ties in total.

To assess the relationship we first conduct a standard regression analysis of the dependent variables, CI, Comments, Friend Ratio and Foe Ratio, on the independent variable, Karma. Karma is standardized to compensate for the upper and lower limits of the values, and the Comment variable is logged to correct for the exponential growth pattern. The standard regressions were tested for multi-colinearity (all values below .5) and have been corrected for heteroskedasticity using White's heteroskedasticity-consistent error terms. Then we follow with a quantile regression technique (see [15] at various intermediate quantiles of Karma levels. This allows us to assess the impacts of the dependent variables as the Karma levels increase, thus allowing comparison of the potentially different network dynamics at different stages of Karma accumulation (Fig. 5).

Table 1
Summary statistics.

	Mean	Std. dev	Max	Min
Karma	30.7	20.3	50	− 47
Between-ness	.0029	.0186	.379	0
Constraint	.6823	.3436	1	.006
Comments (#)	304.3	545.2	11,076	2
Friends (#)	2.5	3.5	35	1
Degree	3.15	6.57	225	1

	Between-ness	Constraint	Intensity[a]	Friend ratio[b]	Degree
Between-ness	1				
Constraint	− 0.2654	1			
Intensity[a]	0.2119	− 0.3357	1		
Friend Ratio[b]	− 0.0124	0.0190	− 0.3728	1	
Degree	0.6273	− 0.4654	0.2642	− 0.0472	1

[a] As used in regression, intensity = comments/degree.
[b] As used in regression, friend ration = friends/degree.

Table 1 presents summary statistics of the data series used in this analysis and correlation coefficients between the variables in the analysis. Additional control variables, like the degree and the time on the site, were also implemented but did not have a statistically significant impact on karma. Thus, they were deleted for the sake of parsimony.

5. Results

To respond to Hypothesis 1 we present a count table of high and low between-ness and constraint measures in Table 2. Although we cannot analyze the results using statistical tools since we cannot make assumptions about the distribution of the measures, it is clear that there is some merit to the assertions of H1. High levels of Constraint and Between-ness are both unusual network characteristics, jointly even more so, and between-ness is a particularly rare configuration. If our assumptions about the connection with between-ness, constraint, brokerage and closure are correct, this can be interpreted to indicate that of the two power sources for social capital in the network, closure is the more dominant force at work in Slashdot.

In Table 3 we present the results of the regressions. All of the hypothesized effects are significant, however the sign on some of the variables is surprising. The coefficient value between constraint and Karma is positive, which supports our Hypothesis 2b that constraint has a positive impact on social capital. However, the coefficient value between between-ness and Karma is negative, which is the inverse of our Hypothesis 2a. However, since between-ness and constraint are inversely related, this adds more support to the benefits of closure to Karma accrual. Further, these relationships exist beyond the significance of the moderating variables.

The number of connections, representing participation intensity, also has a positive and significant relationship with Karma, which indicates that there is a complementary relationship between Karma-building and network participation. The Friend ratio, representing network investment, exhibits significant but negative behavior. Hypothesis 3c is supported, but only partially since the sign of investment is negative. We believe that this is because Degree is interacting with Karma in the opposite manner that we expected. This also impacts H3a and H3b as you can see from the correlation matrix; the sign on these relationships is the inverse of what is hypothesized. Between-ness increases with the degree and constraint decreases. However, since constraint appears to have a stronger relationship with karma than between-ness, this result leads us to observe that a large network size has an overall detrimental effect on social capital that participation intensity and strong ties cannot overcome.

The substance of the results are consistent across the range of values for Karma but not the scale. As the quantile regressions show in Table 3, while the signs of the coefficients remain the same for most of the equations, the scale of both the between-ness and the constraint coefficient varies as the value for Karma increases. Between-ness begins in the 15th quantile as significant and negative and then the absolute value reduces steadily until becoming very small by the 65th quantile. Thus, the bridging of structural holes are strongly related to the status of participants in the beginning and middle part of their Karma-building experience, but less so at the end which is contrary to H4a. Similarly, constraint begins in the 15th quantile as significant and positive and then the absolute value reduces steadily until becoming insignificant at the median. This supports H4b. where the number of connections actually has a negative impact by the 70th quantile. This strongly implies that a network containing fewer structural holes (low brokerage/high closure) is strongly correlated with the early stages of a Karma rating. Thus, H4a is partially supported (since the relationship is significant but not positive), and H4b is fully supported (Table 4).

We can speculate on the network dynamics of these patterns that these results are reflecting, even though we cannot use these results to definitively comment on causality. If we assume that network participants are acting rationally within the bounds of their goals and information, it follows that the benefits to individuals at lower Karma levels of establishing a deep (closed) network are higher than for a broad (brokered) network, and that these benefits are less important at higher Karma levels. This suggests a pattern of users expanding their network of contacts early on in an effort to make connections and establish a reputation and a group of supporters for mutual benefit. Later, with the foundation of a social network established, network participants may indulge more in nurturing a wider group of contacts. In an analogy with a business environment, first the emphasis is on building the Rolodex and later its on joining networking clubs.

6. Conclusion

The target of our inquiry is the Web 2.0 organization, of which the most prominent type is based around social network capabilities. Research on the business implications of Web 2.0 sites is just beginning [28,29]; our paper is one of the first to venture into this new research stream. We demonstrate that the structure of the network can have a direct impact on the perceived benefits and costs and is thus of consequence to examine. Viewed through the eyes of potential participants, a formalized social network can provide a major incentive for participation, easier adaptation (i.e. less costly learning) to the norms and rules of the site, and provide opportunities for new experiences. If the shape of the social network has an impact on participant's behavior and the resulting success of the organization, then it is a critical tool for organizational management in an environment without many of the traditional tools available.

Our results show that there is an important role for structural holes in forming a powerful social network, just as previous studies in

Table 2
The number of individuals in the upper third absolute values of the metrics.
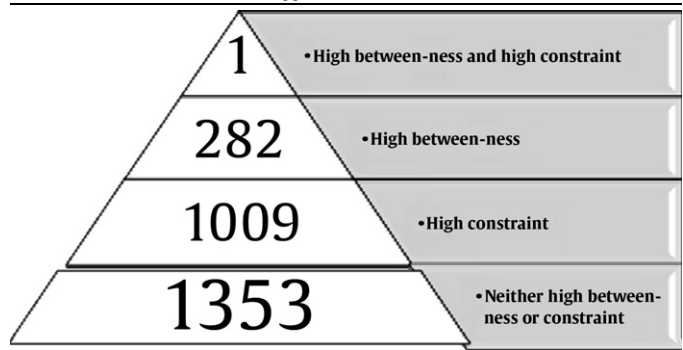
Total sample size is 2639 records.

Table 3
Regression results 2639 records.

	Between-ness	Constraint	Joint	Comments	Friend Ratio	
Karma	−0.0045*** (.0012)			0.4409*** (.0137)	−0.3666*** (.0918)	$F=.0000$ $R^2=0.4575$
		0.1230*** (.0410)		0.4381*** (.0142)	−0.3704*** (.1212)	$F=.0000$ $R^2=0.4515$
			−0.0745*** (.0143)	0.4458*** (.0139)	−0.3409*** (.0924)	$F=.0000$ $R^2=0.4581$
Quantile regression						
Karma (15th)	−0.2078***			0.6150***	1.2903*	Pseudo R^2 0.2871
		0.2706***		0.5489***	−05389***	0.3280
			−0.1061***	0.5558***	−0.5203***	0.3348
Karma (35th)	−0.1001***			0.3598***	0.3430	Pseudo R^2 0.1913
		0.0891*		0.4064***	−04943***	0.3023
			−0.0621***	0.4102***	−0.4815***	0.3067
Karma (50th)	−0.0670***			0.2406***	0.2730	Pseudo R^2 0.09861
		0.0588*		0.3146***	−0.5466***	0.2409
			−0.0455***	0.3267***	−0.4960***	0.2442
Karma (65th)	−0.0179***			0.0642***	0.0795	Pseudo R^2 0.0170
		0.0368		0.2597***	−0.3771***	0.1361
			−0.0377***	0.2648***	−0.3580***	0.1387
Karma (75th)	−0.0032***			0.0142***	0.0076	Pseudo R^2 0.0007
		0.0294		0.1784***	−0.2523	0.0601
			−0.0199***	0.1877***	0.2376***	0.0619

Constant terms are omitted; standard error in parentheses.
*** Significant at the 1% level ($p<0.01$).
* Significant at the 10% level ($p<0.1$).

business organizations have demonstrated. More specifically, we reveal a higher correlation between structural holes and a large number of contacts, what can be termed a *broad network*, and determine this has a negative relationship with karma building especially early in status building, and a strong, positive relationship with a *deep network* at building social capital. Our test of the relationship between the structure of a participant's social network and the power of social capital as indicated by their status in the organization has revealed interesting patterns in the functioning of networking on this online community.

In terms of the drivers of social capital, our results indicate that brokerage is associated with individuals at lower levels of Karma, and closure is associated with individuals at higher levels of Karma. People newer to the site (we may assume from the Karma levels) find more personal benefit from connecting to individuals in different circles, while people fully involved in the site tend to connect to tight networks of individuals. It is less of a surprise that people with high Karma levels associate with tight networks — one assumes that over time one's group of contacts become less diverse and more concentrated. However, it is interesting that newer individuals are bridging the holes between existing groups of contacts even with relatively few connections instead of building relationships with a couple individuals already in a single group. Because our data does not follow individuals over time, we cannot say that reducing brokerage and increasing closure leads to high Karma rankings, or that only those who have high closure will continue on to reach high Karma and those with high brokerage drop out. But this pattern leads to a user profile that may help Slashdot build features to encourage behavior that will help the goals of the site.

Since the business model of Slashdot (and many other Web 2.0 sites like it) is based on advertising, a critical determinant of revenue potential is the amount of activity on the site which is best tracked by the amount and quality of membership. Online communities depend on a strong core of very active and experienced users, which in Slashdot's case are users with high Karma rankings. Because social groups may have a tendency to become very tight knit or cliquish, or in other words as demonstrated with Slashdot's core group have high closure, these communities also need steady streams of new membership to refresh interest in the site. Thus, nurturing the users with lower Karma rankings is important as well. It is important to considering creating features for a site like Slashdot that

would serve the interests of each of these groups without detracting from the positive benefits of brokerage and closure to those who are reaping them.

For example, a concept that might interest those with lower Karma levels and a higher brokerage identity (someone newer to the site with more diverse interests) would be a page of "What Friends Are Saying". The page would randomly generate a collection of recent comments of friends and friends of friends. Individuals might be teased by an interesting comment to follow it to a thread they hadn't read, thus encouraging them to explore more of the site. They might also be encouraged to follow up on some of the friends of friends and become more invested in the site. By being random, yet customized for every user according to their particular network, it would continue

Table 4

		Support
H1a	Most participants of the site will exhibit both low between-ness and low constraint.	Partial
H1b	There will be more participants with high constraint measures than with high between-ness measures.	Supported
H1c	There will be few individuals who score highly in both constraint and between-ness.	Supported
H2a	Between-ness and constraint are individually positively associated with social capital	Partial — Between-ness is significant but negative
H2b	Between-ness and high constraint are jointly positively associated with social capital	Not supported — significant but negative
H2c	Constraint is more associated with social capital than is between-ness	Supported
H3a	Between-ness is inversely related to participation intensity	Not supported
H3b	Constraint is directly related to participation intensity	Not supported
H3c	Network investment moderates the relationship between both between-ness and constraint and social capital	Partial — significant but negative
H4a	Positive outcomes from between-ness are more significant to those with high social capital	Not supported — negative relationship, however absolute value is smaller.
H4b	Positive outcomes from constraint are more significant to those with low social capital	Supported

to be new and interesting. From the point of view of the social network management, it would encourage the longevity of these newer users.

The users with high Karma rankings and high closure levels might be well served by emphasizing the tightness of the networks in which they relate. If a few of the sub-networks with larger numbers of members with high Karma rankings can be associated with common participation in specific thread topics, then an invitation-only roundtable discussion of this topic for these "power users" might provide them with a focused opportunity for socializing that they would find rewarding. It may also help the site management to identify areas of site expertise that might translate to other business opportunities. In terms of managing the social network, a feature like this would emphasize the value of the "power users" to the site and help retain them.

"Power user" dynamics may have negative implications for the management of the site however. An overly deep network by too many participants is indicative of network power becoming concentrated in sub-groups of privileged participants instead of being dispersed throughout the membership. This can lead to clique behavior which reduces the egalitarian spirit valued by many of these sites and increases the potential for abusive peer pressure. It can also lead to a power struggle between the site participants and the leadership that can seriously disrupt the management and future of the organization. Since many of these sites have become for-profit organizations, as is the case with Slashdot, these negative forces need to be guarded against in order to maintain business viability. A policy response that may be considered is an expiration-date on relationships that would need to be renewed periodically for the connection to remain active. This might more effectively mimic the reality of social networking in the offline world where connections are not open indefinitely, and better support a network structure in which connections truly reflect active and valued interpersonal relationships.

Like many social network studies, our effort has a number of weaknesses that can be addressed in later work. We are limited in the data we have to a single cross-sectional look at the relationships, and we are missing information that would add value to our whole-network approach. More extensive data collection efforts are helping to provide deeper analyses in the future. We also would like to explore qualitative surveys to augment the network data and thread analysis to build a topical examination of relationships. Future work will continue to explore the basic characteristics of the organization as they can be perceived transplanted to electronic forms and help to guide managers on the best ways to build an environment that is effective in the Web 2.0 context.

Acknowledgments

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