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Network Evolution of Transactional Community: A Different Network Closure Mechanism from Social Network

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Abstract: With the Internet changing from era Web1.0 of computers' interaction to era Web2.0 of users' interaction, the development of transactional community has become the key solution to combine economic value with social value in social commerce. Transactional community is different from traditional social community in its relationship establishment because of the unique motivations of their members. Based on network data from Taobao.com, this research analyzed the network closure mechanism in transactional community and the results showed: (1) Because of high cost of social interaction and the risk of inefficiency of relationship, members in transactional community would choose to avoid reciprocity; (2) The evolution of transactional community is mainly driven by informational social influence rather than normative social influence, as a consequence, number of contagion paths has a negative effects on getting relationship embeddedness from the other members; (3) The relationship establishment in transactional community mainly comes from mutual acquaintances or mutual activities.

Keywords: Transactional Community; Network Closure; Reciprocity; Contagion; Selection Effect

1. INTRODUCTION

With the Internet changing from era Web1.0 of computers' interaction to era Web2.0 of users' interaction[1], the traditional e-commerce model is also evolving towards the social commerce model, which presents the enterprises both opportunities and challenges: how to combine economic value with social value in the context of social commerce? There are two basic approaches adopted by enterprises to address this issue: (1) add trading platform to the social networking site (integrate social value into economic value); (2) add social platform to the transaction sites (integrate economic value into social value)[2] .Among them, the first approach is based on the evolution of social networks and the key point is to identify opinion leaders in social networking[3]. In contrast, for the second approach, there is little research about the relationship establishment in transactional community. The question is whether the application of the existing social network evolvement theory could be used to guide building of the transaction-based community? Since the social factors in the establishment of social network is quite different from the economic factors in transactional network, we need to understand how different they are and what is the main mechanism that is driving the establishment of transactional network.

As a matter of fact, the relationship building among transactional communities boasts characteristic of Two-mode Embeddedness[4]. It is because of essential difference between the transactional community and the traditional social communities (see Table 1-1).

This study selected one of the activist online social network communities (7,902 members) in Taobao.com, and used web crawler to collect the information regarding direct social relationships (followers, fans) and indirect two-mode relations (post, reply) among the members of the community, to display the network structure of community members (see Figure 3-1) and analyze the network evolution mechanism.

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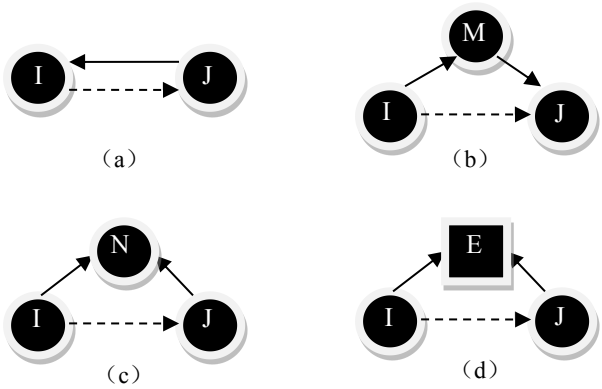
Table 1-1 Differences between transactional community and social community

Dimension		Social Communities	Transactional Communities
Community Factors (member and relationship)	Member's role	Friends, relatives, schoolmate	Businessman, buyer, seller
	Member's need	Mainly emotional communication	Mainly business communication
	Relationship source	Existing social ties + Newly-built social ties	Existing transactional ties Potential transactional ties
Community network structure		Mainly direct interpersonal communication, Social capital[3]	Mainly indirect Functional and Informative ties Two-mode network [4]
Community evolvement dynamics		Normative Influence	Informational Influence

2. LITERATURE REVIEW AND HYPOYHESIS

2.1 General Network Closure and Transactional Community Evolution

In the related studies of general network evolution, scholars often simulate the network relationship embedding process through the closure process. Existing network closure theories considered acceleration effect of the reciprocity, social influence, choice influence on the whole network closure process, related researches include: Stockman and Doreian[5]; Kossinets, Gueorgi and Watts [6]; Crandall etc.[7]; Jun-an Lu, etc.[8]; Lin-yuan Lv, etc.[9]; Ai-xiang Cui etc.[10]. Figure 2-1 illustrates the general community network closure forms, mainly consisting of binary or ternary or multiparty closures.



Note：Circles I,J,M,N denote community members；Square E denote community activities

Figure 2-1 General Network Closure Form

In Figure 2-1, the closure emerged between two community members I and J with the underlying mechanism such as: (a) reciprocal effect; (b) social impact based contagion effect; (c) mutual friends based similarity; (d) mutual activities based similarity. But whether these closure mechanisms in previous social networking communities still exist in transactional communities? This is the question need to be answered in this study.

2.2 Reciprocity, Contagion, Similarity and Transactional Community

Reciprocity (reciprocity) refers to the behavior (good or bad) of people which is based on the behavior of others as a feedback. In some studies, reciprocity is generally considered to be of fundamental features of interpersonal relationships[5]. But some scholars also studied the negative impact of reciprocal relationship from the opposite perspective. As reciprocity is based on a lot of social interaction, reciprocal relationship itself requires higher input[11] , which includes (1) time and duplication of information (repeated interaction); (2) the

relationship inefficiency; (3) relations responsibilities and pressures brought by embedding (obligation)[12]. Based on this, we propose the following hypothesis:

H1: In transactional community, members would pay more attention to the cost of establishing mutually beneficial relationships. That is to say, following from member j to member i have negative impacts on member i building a relationship with j.

Contagion is a major issue in network closure mechanism study. Previous studies on the network infection models are based on social networking platforms[13]. In fact, the difference between trading communities and social networks is very obvious. In trading communities, the informative influence is more prominent than normative influence, and the information itself is more important than the source of information. Based on this, we propose the following hypothesis:

H2: In transactional community, the more contagion paths from member j to member i, the less probability that member i would establish relationship with j.

During the evolution process of transactional community, and social support for social comparison purposes, the community members have a very strong tendency to gather together with those who have similar characteristics with them[14], which is a selective influence based on members' similarity[6]. Selective effects make community members build relationships based on existing similarity, thus promoting the community evolvement. Therefore, as another major driving force behind the evolution of transaction-based community development, we propose another hypothesis:

H3: In the transactional community, (a) shared friends and (b) shared community activities will positively affect relationship establishment between member i and j.

3. METHODOLOGIES AND DATA ANALYSIS

3.1 Data Collecting Based on the Eclipse Platform and Java Program

The transactional community data in this study comes from most active community on Taobao.com. The virtual community was established on June 12th, 2012. The data in this study was collected on an Eclipse-based development platform and all the information was stored in SQL Server databases. Table 3-1 contains the explanation for the data.

Table 3-1 Basic Information for Taobao Communities based on Eclipse Platform

Data title and type		Details	Data Format
Individual Ego-network information	Member's ID	Every member has her own ID	Text
	Member's Follower	Follower's ID	Text
	Following	Following's ID	Text
Personal Information	Joining Time	Date of joining in the community	Number
	Personal Page	Link address for members	Link
	Points	Standards to measure members' experience	Number
	Views	The number of views of personal pages	Number
Activities Information	Post ID	Only ID of post in virtual community	Link
	Poster ID	ID of poster	Text
	Replier ID	ID of replier	Text
	Posting Time	Date of posting	Number
	Replying Time	Date of replying	Number

3.2 Variable Measurement and Network Closure Model Construction

According to the definition of reciprocity in network[5], reciprocity is a interaction relation, which is a binary variable, namely:

$$\mathrm{Re}c_{i,j} = \begin{cases} 0, & link_{j,i} = 0 \\ 1, & link_{j,i} = 1 \end{cases} \quad (1)$$

where, $\mathrm{Re}c_{i,j}$ denotes member i's reciprocity, $link_{j,i}$ denotes whether member jis linked to member i. The contagion j to i is measured as follows:

$$Con_{i,j} = \sum_{p=2}^{m} link_{i,j,A^P} * \left(\frac{1}{p}\right)^p \quad (2)$$

Where, m represents the length of path; $link_{i,j,A^P}$ means the number the path; A^p is matrix algorithm. Among the specific variable calculating similarity among the members is derived from two matrixes, one of which is the original matrix A mentioned before; the other, matrix B, recorded the event of a community members.

$$\begin{aligned} PSim_{i,j} &= link_{i,j,A*A^T} \\ ESim_{i,j} &= link_{i,j,B*B^T} \end{aligned} \quad (3)$$

Where, $PSim_{i,j}$ denotes similarity based on mutual friends; $ESim_{i,j}$ denotes similarity based on mutual activities. In model building, we use the links sent out by virtual community members as the representation of its embeddedness. Specific model is constructed as follows:

$$\begin{aligned} logit(P_{link_{i,j}}) &= \alpha + \beta \mathrm{Re}c_{j,i} + \gamma Con_{j,i} + \varphi Sim_{i,j} + \eta Con_{j,i} * Sim_{i,j} + \theta_1 Exp_i + \theta_2 Tim_i + \varepsilon \quad (4) \\ &= \alpha + \beta link_{j,i} + \sum_{p=2}^{m} \gamma_{p-1} link_{i,j,A^P} * \left(\frac{1}{p}\right)^p + \varphi_1 link_{i,j,A*A^T} + \varphi_2 link_{i,j,B*B^T} \\ &\quad + \eta_1 \left[\sum_{p=2}^{m} link_{i,j,A^P} * \left(\frac{1}{p}\right)^p\right] * link_{i,j,A*A^T} + \eta_2 \left[\sum_{p=2}^{m} link_{i,j,A^P} * \left(\frac{1}{p}\right)^p\right] * link_{i,j,B*B^T} \\ &\quad + \theta_1 Exp_i + \theta_2 Tim_i + \varepsilon \end{aligned}$$

In the model (4), $P_{link_{i,j}}$ denotes that member i is embedded in j's network (i.e. sending out a link or following). For the independent variables, β is the effect of reciprocity on embedded membership; γ_{p-1} is the length of the path via which information is transmitted from j to i; φ_1 is the impact of similarity based on mutual friends; φ_2 is the impact of similarity based on mutual activities; η is a group of interaction effects; θ is a set of control variables; ε is the error term.

3.3 Data analysis and results

According to the data, only 2438 community members of the 7902 have a direct relationship to each other. Figure 3-1 and table 3-2 showed the overall structure and characteristics of the relationship between these members. Outside nodes have sparse community relations while the center nodes have close relations with others. Graph layout algorithm is from Hu[15].

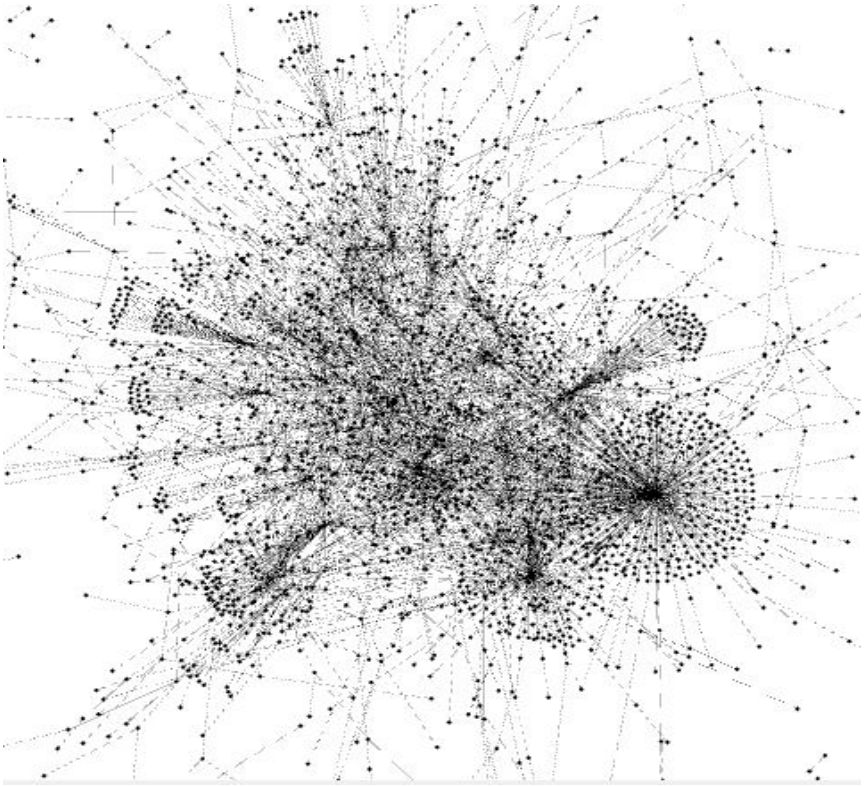


Figure 3-1 Graph Layout Algorithm[15] based Community Relationship Diagram

Table 3-2 Basic Network Characteristics of Community in this Study

Network Indexes	Value	Explanation
No. of nodes	2438	Number of members in the virtual community
No. of edges(directed)	4312	Number of directed links constructed in community
Average degree	1.769	Average following and followers' number
Network diameter	16	The longest path between any two members in the community
Average path length	5.798	The average length it takes for information to diffuse between any two members
Network density	0.001	Existing links/ All possible links
Average cluster coefficient	0.031	The connectivity between the nodes that are linked to the same nodes

When we tested model (4) using SAS 9.2, the sample size is 304233. Table 3-3 lists the correlation matrix for variables in this study.

Table 3-3 Descriptive statistics and correlation of variables（n=304233）

Variable name	Average	SD	（1）	（2）	（3）	（4）	（5）	（6）
（1）Reciprocity	0.01	0.11	1					
（2）$Contagion_1$	0.07	0.28	0.006	1				
（3）$Contagion_2$	0.16	0.19	0.003	0.032	1			
（4）$Contagion_3$	0.31	0.13	0.012	0.004	0.012	1		
（5）$Similarity_a$	0.84	0.44	-0.159	-0.188	-0.016	-0.013	1	
（6）$Similarity_b$	0.26	2.20	0.029	-0.014	0.031	0.004	-0.199	1

Note：$Contagion_1$,$Contagion_2$, and $Contagion_3$ refer to the contagion path with a distance of 2,3,4 respectively;

$Similarity_a$ and $Similarity_b$ refer to similarity based on mutual friends and activities respectively.

As the sample is too large, SPSS is not easy to deal with, so the data in this study is run in SAS 9.2. Table 3-4 is the maximum likelihood estimation results for model (4) with SAS 9.2:

Table 3-4 Maximum Likelihood Estimation Results（n=304233）

Dependent variable：relationship establishment		Result explanation
Interception	3.50	
Reciprocity impact（H_1）		
β： reciprocity	-2.99***	Transactional community members avoid the reciprocal relationship formation
Social influence（H_2）		
γ_1： $Contagion_1$	-0.44***	Less relationship embededness with the contagion path length increasing
γ_2： $Contagion_2$	-0.03**	
γ_3： $Contagion_3$	n.s.	
Selective influence（H_3）		
φ_1： $Similarity_a$	2.44***	More relationship embededness with increasing common friends
φ_2： $Similarity_b$	1.23***	More relationship embededness with increasing common events
Interaction influence		
η_1：（$\sum$contagion）*$Similarity_a$	-1.41***	
η_2：（$\sum$contagion）*$Similarity_b$	-0.13***	
Control variable		
θ_1： member i's community experience	3.38**	
θ_2： member i's time spending	n.s.	
AIC=34458.63； SC=34523.63； -2 Log-likelihood=33116.50 Max-rescaled R^2 =0.31		

Note：*p<0.1;**p<0.05;***p<0.01；"n.s." denotes insignificant

For the overall fit of model (4), the fit with interaction term (-2LL =33116.50) is better than that without interaction term(-2LL=34012.23); for the main effects, reciprocity (H_1) has a significantly negative impact on relationship establishment; Number of contagion path has negative impact on relationship establishment (H_2)（ $\gamma_1 = -0.44$; $\gamma_2 = -0.03$ ）, and with the length of contagion path increased, the effect is reduced (γ_3 is not significant); The major driving force of transactional relationships establishment comes from similarity between the members (H_3), where mutual friend-based similarity has the strongest positive impact on the community relationship establishment($\varphi_1 = 2.44$), mutual activities-based similarity also has a positive influence on the community relationship establishment ($\varphi_1 = 1.23$); There is an interaction effect between similarity and contagion ($\eta_1 = -1.41$; $\eta_2 = -0.13$); In addition, community experiences have a positive effect on relationship establishment ($\theta_1 = 3.38$ ）.

4. CONCLUSIONS

This study analyzed the difference in transactional community's closure mechanism with Taobao's social network data. We concluded that transactional community members will avoid reciprocity. Contagion mechanism, which plays an important role in social network, does not have the same effect in transactional network. The main driver of transactional network evolution is selective mechanism. As reciprocity is avoided by community members, then some members will often backfire when they deliberately send out-links to establish relationships. The opinion leaders of social network identified in previous studies may not be able to enhance embeddedness and this study suggests that when a member has more mutual friends and activities with

other members of the community, the member is more likely to attract other members and become the key node in transactional communities.

The analysis on transactional community's closure mechanism can help managers to better understand the evolution of transaction-based communities. Future research can focus on the formation of transactional network in a dynamic view. Since the formation of transactional network is a dynamic process, the opinion leaders in such network could be stable or instant. Based on the principle that we found in this paper, future research could focus on the reasons of emergent or declining of opinion leaders in such network.

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