

## Key Nodes Identify in the Peasants' Social Network Based on Structural Hole Theory

Chen Zhongtai, Ma Ning\*, Wang Xiaohuan and Shi Xiuqing

Beijing Forestry University, China  
[maning@bjfu.edu.cn](mailto:maning@bjfu.edu.cn)\*

### Abstract

*In rural area, it is very important for peasants to get the information efficiently. In this essay, peasant's interpersonal communication is studied. Using data of 98 rural households from 3 villages in Fujian Province, their social networks are painted, with the application of Burt's structural hole theory. The structure of peasant's social networks is analyzed and the key nodes in the network are identified. According to the results, we sum up some general characteristics of the key node of peasants in their social networks, and put forward suggestions to improve the communication of information among peasants.*

**Keywords:** Social Network; Structural Hole; Identification of key nodes

### 1. Introduction

Currently, most of the forestry information is spread through the mass media, which has poor targeting effect and inefficient feedback. Compared with the mass media, how people communicate with each other is point to point in fact, such as talk face to face or over phone calls. In this way, peasants with similar background can get better understanding of the information they will get. However, with limited time and vigor, it is unrealistic for people to convey messages to all peasants one by one. So identifying key peasants in the village and communicating with them is significant to spread the information among peasants effectively.

#### 1.1. Social Network

Social Network refers to the set of relationship between social actors. A social network is a collection, which is made up of nodes (social actors) and connections between each node (the relationship between the social actors) [1].

In previous researches, numerous scholars have pointed out that social networks played an important role in information dissemination among Chinese peasants [2]. It is nearly 70 years since researchers began to research social network. Meanwhile, Mark Granovetter put forward Embeddedness theory in 1985, it concerns the extent to which economic action is embedded in structures of social relations, in modern industrial society [3]. And then his Weak Ties theory tells us that weak ties play a more important role than strong ties in a person's work and career [4]. But Yanjie Bian's "The Strength of Strong Ties" hypothesis, which is under the perspective of localization, gives out an opposite conclusion with Granovetter. It shows the difference between Chinese society and American society [5].

And the speed and efficient of information dissemination in different network has become a hot topic [6-8]. Mobile service has played an important role in dissemination of knowledge in science and technology, and what's behind it is the strength of trust [9, 10]. Structural holes theory was put forward by American sociologist Ronald Burt in at 1992 [8]. According to the theory of structural holes, the social network structure of peasants is analyzed and their key nodes are identified in this essay.

## 1.2. Structural Holes

**1.2.1. An Overview of Structural Holes:** Structural holes theory refers to the non-redundant ties between two actors. A structural hole is a gap between two individuals with complementary resources or information. When the two are connected through a third individual as entrepreneur, the gap is filled, creating important advantages for the entrepreneur [8]. From top view of social network, it seems that holes emerge in the network structure [11].

For example, here is the personal network of A, formed by four actors named A, B, C, D. As shown in Figure 1, there is no direct tie between B, C, D in structure a and they can only connect with each other through A. Then A has a competitive advantage because A is at the center position with three structural holes (BC, BD, CD). The structure b is a closed network structure, in which each actor can mainly get equivalent and repetitive information. As a result, there isn't structural hole in structure b [12].

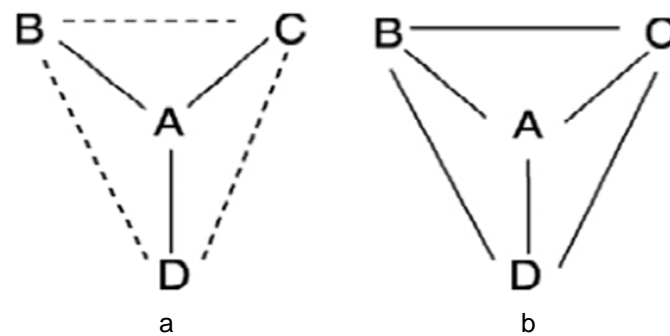


Figure 1. The Example of Structural Hole

**1.2.2. Advantage of Structure Hole:** Structural Holes Theory, compared with other theories, emphasizes that researchers should analyze from the structural and take advantage of interpersonal relationship. The theory is much clearer, easier to grasp and operate in practice [13]. Burt believes that Structural Holes can provide its occupants "information of interest" and "control interest" with better opportunities and as a result of which, the occupants have more competitive advantage than other members.

Finding key nodes in complex networks is one of important researches of complex network. Burt proposed evaluation method based on the importance of local information to find "structural holes" in the network. Burt indicated that nodes in the network can take advantages of structural holes to get competitive advantage. Currently, there are several methods have been proposed to evaluate the importance of nodes in the network. A number of important evaluation parameters are including degree, betweenness, cohesive, feature vectors, sub- charts and so on. These assessment methods will measure the importance of nodes in two different perspectives, global or local. Because the size of network in real world is rather huge and the structure is fairly intricate, it seems impossible to traverse the whole network in order to evaluate the significance of the key nodes from global perspective. Exploring one method to evaluate the significance of the key nodes which based on local perspective is more realistic and practical. Since the publication of "Structural Holes: The Social Structure of Competition" in 1992, Structural Hole Theory was verified, complemented, and became matured. It is practical and effective in the study of complex network and key node. So, here we chose structural holes theory to find out key nodes in peasants' network, and then help transmit information in rural area.

**1.2.3. Measure of Structural Holes:** Structural holes can be measured by two types of indicators, one is a series indicators put forward by Burt, the other is betweenness centrality [14].

The indicators put forward by Burt include four indicators: effective size, efficiency, constraint and hierarchy.

Effective size refers to the difference between the network is its actual size and its redundancy.

$$\text{EffSize} = \sum_j \left( 1 - \sum_q p_{iq} m_{jq} \right), q \neq i, j$$

In equation 1, j represents all nodes which connected with i, q represents node which does not equal node i or j.  $p_{iq} m_{jq}$  represent the redundancy of node i and j.

Efficiency refers the ratio of the effective size of node to its actual size.

$$\text{Efficiency} = \frac{\text{EffSize}}{\text{Degree}}$$

Constraint refers the degree of restriction of the node in the network. It is used to show the capacity of taking advantage of structural holes. The higher the coefficient of constraint one node has, the fewer structural holes it can utilize. When considering in local perspective, the equation of constraint is

$$C_i = \sum_j \left( p_{ij} + \sum_q p_{iq} p_{qj} \right)^2, q \neq i, j$$

In equation 3,  $p_{ij}$  represents the proportion of cost spent on j by i to the total cost of i. When j is the only node connected to i,  $p_{ij}$  will get its maximum value which equals 1. When considering in global perspective, the restriction from nodes which have a distance more than 2 to node i should be taken into consideration and we will not discuss this in this essay.

Hierarchy refers to that to which extend constraint should put on one node.

$$H = \frac{\sum_j \left( \frac{C_{ij}}{C/N} \right) \ln \left( \frac{C_{ij}}{C/N} \right)}{N \cdot \ln N}$$

In equation 4,  $C = \sum_i C_i$ ,  $N$  is the number of nodes in the network and  $C/N$  is the average of constraint of each node. When the constraint of each node which connected to the node to that node is equaled, the hierarchy will get its minimum value which equals 0.

Betweenness centrality was put forward by Freeman. It describes to which extend one node locates in the center of other nodes. To  $G = (V, E)$ , the Betweenness of x is

$$C_B(x) = \sum_{i,j \in V} \frac{\sigma_{ij}(x)}{\sigma_{ij}}, i \neq j$$

In equation 5,  $\sigma_{ij}$  represents the number of the shortest path between i and j, and  $\sigma_{ij}(x)$  represents the number of the shortest path between i and j which goes through x [14].

With Indicators put forward by Burt, structural holes are usually measured by constraint, which reflects how much does one node depended on others. The bigger value and the stronger dependence, the structural holes is less. Betweenness is a measurement based on the ability of resource control. The actors which locate on the shortest paths of communication node and have low dependence on others will always have strong ability to own and control resources [14].

In this essay, we attempt to judge the importance of the actor based on its power (the number of structural holes) in the network. So, we use betweenness centrality, which reveals the ability to control resources, as the indicator.

## 2. Identification of Key Nodes with Structural Holes

### 2.1. Variable Selection

Base on the design of egocentric social network questionnaire, the group used snowball sampling to do the research and investigation. The primary data utilized in this essay is acquired through the questionnaire handed out by the group at Sanming city, Fujian province at August 2013 [15]. The survey takes a household as a unit, involving their natural information and social information. Natural information refers to their age, position, gender, education, and social information refers to whom they often communicate with in the village. 102 questionnaires were handed out and 98 of them were returned. Then the recovery rate is for 96.08%.

### 2.2. Identification of Structural Holes

Processed by UCINET using network adjacent matrix of three village, we get indicators of each nodes (households) in three villages. Then according to their Betweenness, put them in descending order [14, 16]. Because of Chang Kou's loose structure, and in order to cover its whole network more efficiently, we choose top two nodes from the largest subnet and top node from others. The results are shown in Table 1.

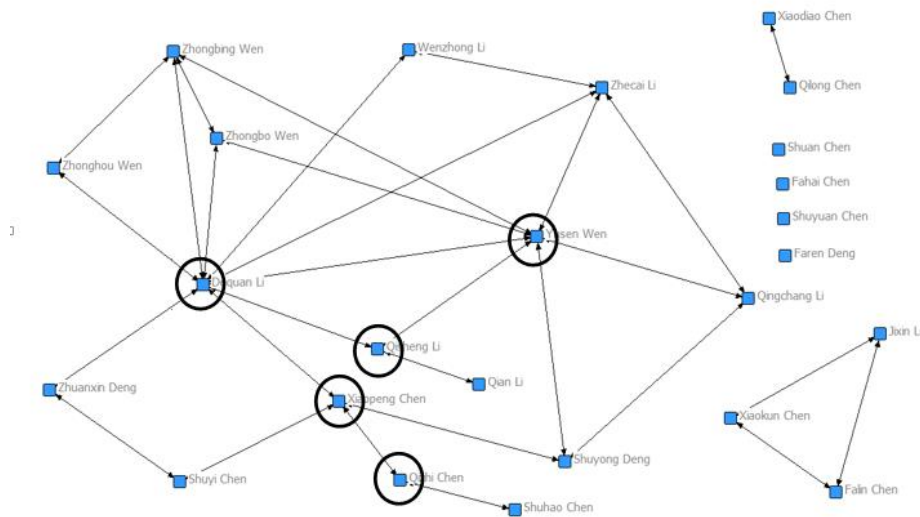
**Table 1. Gauges of Structural Holes**

<i>Village</i>	<i>Name</i>	<i>Betweenness</i>	<i>EffSize</i>	<i>Efficie</i>	<i>Constra</i>	<i>hierarc</i>	<i>Degree</i>
Jingping	Dequan Li	56.667	7.444	0.827	0.243	0.067	9
	Xiaopeng Chen	34.417	4	1	0.25	0	4
	Yusen Wen	16.167	5	0.714	0.331	0.044	7
	Qisheng Li	14	2.333	0.778	0.393	0.006	3
	Qizhi Chen	14	2	1	0.5	0	2
Shekeng	Derong Yu	465	12.538	0.964	0.106	0.026	13
	Xianlu Tong	169	3.5	0.875	0.309	0.023	4
	Yuan Li	124	3	1	0.333	0	3
	Zuhua Yu	107.5	3	1	0.333	0	3
	Dexing Yu	93	3	0.75	0.465	0.022	4
Changkou	Huowang Yang	54	4	0.667	0.343	0.043	6
	Dingfu Yu	52	4.429	0.633	0.382	0.051	7
	Yuzhang Chen	11	3	1	0.333	0	3
	Jun Yang	8	2.333	0.778	0.482	0.025	3
	Bingyan Yang	5	3	1	0.333	0	3

Compare Indicators put forward by Burt which measured by constraint with Betweenness in the Table 1, the orders of structural holes are almost the same.

### 2.3. Data Analysis

Due to the different reality and structural holes in each village, we analyze these results separately.

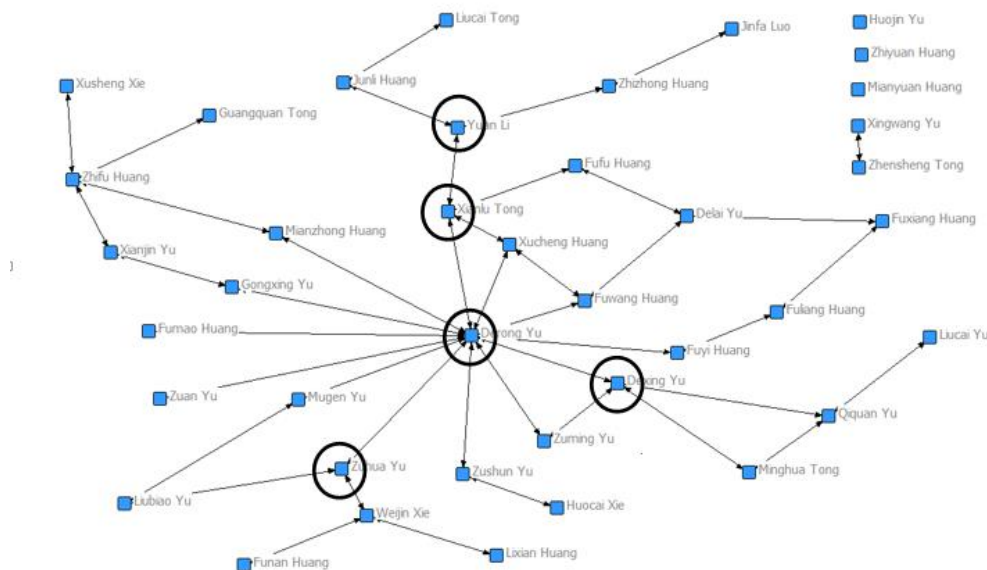


**Figure 2. Social Network of Jingping and its Structural Holes**

**2.3.1. Jing Ping:** Jingping’s social network is shown as Figure 2, households with circles are top five structural holes holders. And the center household of the social network is Dequan Li, which is an ordinary villager.

The household named Dequan Li, an ordinary family in the village, has the largest number of structural holes. For other four households, Yusen Wen is wealthier than most households in Jing Ping village, Xiaopeng Chen, Qisheng Li, Qizhi Chen are all ordinary households with no special. In the Jingping’s social network, village cadres do not play roles as key nodes.

**2.3.2. Shekeng:** Shekeng’s social network is shown as Figure 3, households with circles are top five structural holes holders. Its network centralization index is 0.5922, it means Shekeng’s network has a high trend of concentration, and in the center of the network is the household named Derong Yu. Also this household has the largest number of structural holes in Shekeng.

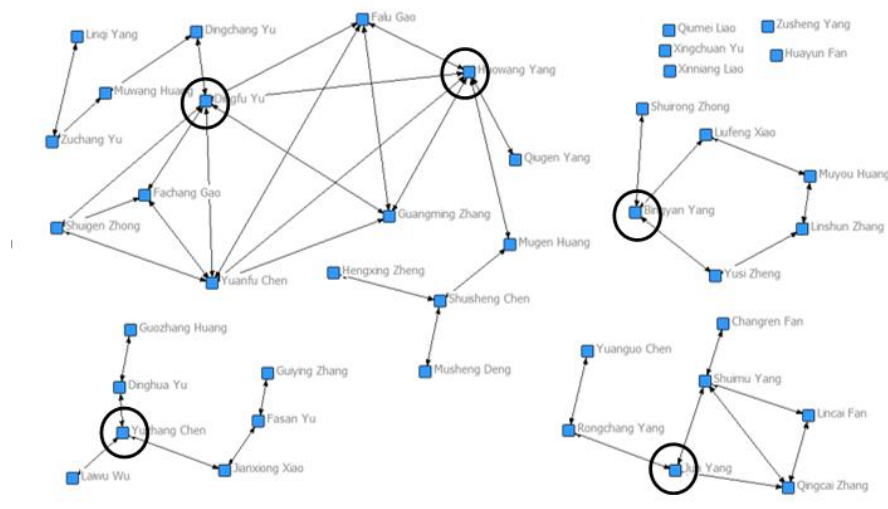


**Figure 3. Social Network of Shekeng and its Structural Hole**

Derong Yu, secretary of the Party committee, runs a small store which is located in the center of the village and close to the village committee in the village. In the store there's a TV, a number of tables, chairs and something else for villagers' entertainment. Therefore, there are always a large number of villagers gathering in the store. As a result, the store plays an important role for exchange and transmission of information in their social network.

The other four households have close relationship with Derong Yu. And among them, Dexing Yu, Zuhua Yu, Yuan Li, are all village cadres. It shows that cadres in Shekeng plays very important roles in Shekeng's social network.

**2.3.3. Changkou:** Changkou's social network is shown as Figure 4, households with circles are top five structural holes holders.



**Figure 4. Social Network of Changkou and its Structural Hole**

Different from Shekeng's high network centralization index, Changkou's network centralization index is only 0.0609. Its structure is loose because of its terrain. Chang Kou is located at the foot of a mountain, one part of the village is on the side of the mountain, and the other part is at downside. People in two parts have few communications with each other. Although the village committee often organize activities (such as square dance), but the result is not obvious.

The subnet on the right of the Figure 4 is the largest subnet in Chang Kou, and in the center of this subnet is the household named Dingfeng Yu. Huowang Yang is one high-income household in the village. Among other three, Bingyan Yang serves as a Correspondent, Yuzhang Chen and Jun Yang are ordinary households.

### 3. Discussion and Conclusion

In order to develop agriculture, reformat the rural area and increase the income of peasants, the implement of policy and high technology are seriously needed. To improve the quality and the efficiency of information transmission, mass media, like radio and television, is essential but not enough. Meanwhile interpersonal communication should be take good use of. Here are some advises.

First, to ensure information spread throughout a village smoothly, advancing relationship of villagers and increasing their communication are of great necessity. The survey find that each village has isolated actors, and some village even has isolated subgroup (as Changkou shows), which means that information cannot be spread

throughout the network and reach every nodes in the network. On the contrary, in Shekeng village, the villagers set up space for activities in the village. And the result shows this method does not only activate the atmosphere of the village, but also increase the income of the owner of the store and the exchange of information. Different provinces, cities, villages have different customs, therefore there should not be a general decision of public activities. To achieve a good environment for peasants communicating with each just like Shekeng, a lot of things should be done. However, how to select appropriate methods and public activities, it needs villages in different area to discuss and put their thoughts into practice.

Second, taking good use of key nodes in peasants' social network is able to improve the efficiency of information transmission. It is significant to select the initial node to transmit information when transmitting the information throughout the social network of peasants. The initial node plays a key role to transmit the information. It guarantees the information can be spread efficiently to all nodes in the network in a short time. Selecting a right initial node can not only reduce labor force to communicate face to face with villagers, but also ensure the efficiency of information transmission. On the contrary, if an inappropriate initial node is selected or an isolated node is selected, the information will transmit in a limited area or even cannot transmit. So, it is important to identify key nodes. According to the result, key nodes of peasants' social networks often have following characteristics:

(1) Serve as a village cadre which frequently need to communicate with other households directly.

(2) Have upper-income in the village, but the difference with other households is not too large.

(3) Like communicating with other villagers, spend more times living and running business in the village than outside.

After identifying key nodes, one should focus on explain new information to them. It will be helpful for information transmission and policy implement in the village.

Final, enhancing relationship between cadres and peasants is necessary. Village cadres are the main force of rural works, are practitioners and propagandists of our party's line, principles and policies. If village cadres are closely related with peasants, they will trust cadres and like to communicate with cadres. As a result, peasants will accept information quickly and easily. On the contrary, cadres can hardly get into touch with peasants, and everything seems difficult at this time.

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