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Relationships and Evolving Networks of Rural Manufacturing Clusters: A Case Study in Yucheng County, Henan Province of China

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Abstract: The evolution of networks in rural industrial clusters, in particular in the context of China has been paid more attention to in the world. Applying the theory and techniques of social network analysis (SNA), this study is with particular regard to the business network relationships and their evolutionary dynamics of steel measuring tape manufacturing clustered in Nanzhuang Village, Yucheng County of Henan Province, China, which is important for better understanding the industrial and regional development in less developed rural areas. From data collected by comprehensive questionnaire survey in 2002 and mass interviews with 60 enterprises and assembling families and several government authorities in 2002, 2003, 2004, 2005 and 2008, four types of networks are identified: spin-off, consulting, communication and cooperative. The characteristic of these networks is outlined in detail. Compared with the high-tech clusters of typical developed areas, the networks that have evolved in traditional manufacturing clusters are more affected by emotive linkages. The cluster networks are shown to exhibit a polycentric hierarchical structure. The family relationships are the dominate spin-off channels of enterprises, while the supply and demand relationships and the mobility of the skilled workers are also important paths of network learning, and the cooperation relationships are comparatively stable. Besides the root enterprises, the middle-sized enterprises are comparatively more active than small-sized enterprises, and the intermediary agencies and the service institutions act as bridges of the inter-enterprises cooperation. By analysis of the structure of networks and the interactions between the networks, the four stages of network evolution are also identified. The four stages are dominated by the family networks, the internal division production networks, the local innovation networks and the global supply networks respectively, and they play different roles in cluster development.

Keywords: evolution dynamics; cluster network; less developed rural area; steel measuring tape manufacturing cluster; social network analysis

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1 Introduction

Industrial cluster has long been known to bestow advantages such as reduction in transaction costs, innovation-sharing, and ultimately, improved economic welfare (Piore and Sable, 1984; Porter, 1990; Saxenian, 1994; Sun *et al*., 2003; Wei and Leung, 2005; Scott, 2007; Morrison and Rabellotti, 2009). Industrial clusters in rural areas have not only increased employment and incomes for the peasant, but also facilitated training skilled labours and nourished new industries, which in turn augment multiplier effects in rural economies (Wei-

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jland, 1999; Rosenfeld, 2001; Zhu and Ding, 2006). The advantages of industrial clustering come, more importantly, from the greater scope for expanding the network of inter-relationships in ways that increase the scope for generating innovation (Porter, 1990; Gordon and McCann 2000).

Early studies mainly focused on the potential for the networks to influence regional competitiveness and innovation capability. But all existing empirical studies on networks in clusters take a static perspective, depicting the network at a certain point in time, and often ignore the fact that networks are not inherent but co-evolved with the emerging clusters (Giuliani and Bell, 2005; Ter Wal and Boschma, 2009). Some scholars call for an evolutionary research on how the structure of networks evolves over time and space and, particularly, how the evolution of networks is related to the evolution of clusters, based on evolutionary concepts of selection, retention (continuity) and variation of any economic systems (Nelson and Winter, 1982; Schamp, 2005; Iammarino and McCann, 2006; Boschma and Martin, 2007; Ter Wal and Boschma, 2009).

However, previous research results provide very few empirical outcomes. By US patent data in 1975–2002 and surveys, Lee and Frenken (2006) emphasized the importance of the technical connection and pervasion among enterprises on the evolution of inventor networks in the Silicon Valley and Boston. But, to a certain extent, they ignored the influence of historically rooted and place-based environment on network formation and evolution. In reality, the formation and evolution of cluster networks are closely related to the historical origins and the cultural background networks operate. What should be noted firstly is the differences between the network formation of rural clusters and that of high-tech clusters, since the former is influenced largely by the family number in rural community and associated culture, while the latter is influenced mainly by technology-based linkages. Some special background of rural clusters also can be listed: less openness to the outside, infrastructural inconvenience to connection with the outside, lower level of marketization, and relatively closed social environment. These also influence the nature and trajectory of cluster networks in less developed rural areas. Consequently, during the formation of industrial clusters in rural areas, the local economic units change from rural households to industrial workshops. Further development brings an expansion of the connection network from local range to global. The core relationships between enterprises and their partners vary in different development stages of clusters.

For many traditional manufacturing clusters in rural areas, the steel measuring tape industry cluster in Nanzhuang Village, Yucheng County of China, is typical and representative in the development context and network formation process. By the analysis on the recent experiences of small-and medium-sized steel measuring tape manufactures in Nanzhuang Village, employing social network analysis (SNA) to track the formation process, this paper studied the relationship characteristics and spatial evolution of the networks in this manufacturing cluster in less developed rural areas in China through following questions. 1) What relationships are at the core of the cluster networks in the different stages of the cluster development? 2) Which nodes or organizations are crucial for the network formation? And 3) how do networks co-evolve and with what rural community environment?

2 Study Area, Data and Methods

2.1 Study area

Nanzhuang Village is located in Shaogang Township, Yucheng County, Henan Province, linked to other places by National Highway G301 in its north and the Longhai (Lanzhou–Lianyungang) Railway in its south. Since the establishment of the first enterprises in 1993, the steel measuring tape industry in the village has been developing rapidly, spreading to nearby villages and towns within a radius of about 10 km, such as Fengzhuang, Fanzhuang and Xiaolizhuang villages. By the end of 2007, the number of manufacturing enterprises in the steel measuring tape cluster had increased to 275, and more than 170 assembly families were involved in the contract production with these enterprise, and more than 12 000 migrant workers worked for the enterprises. The annual production of steel measuring tapes had reached 5×10^8. The products were sold to more than 20 countries, such as Russia, South Korea and Turkey and so on. Steel measuring tapes produced in Nanzhuang′s enterprises accounted for more than 80% of the domestic market share. The value of production was 1.8×10^8 yuan in 2007. The industry provided the dominant source of peasants′ income. About 80% of permanently registered

residents (918) in this village were involved in the production. Per capita income in Nanzhuang Village rose to 12 000 yuan in 2007, 3.1 and 4.8 times of that of Henan Province and Yucheng County respectively. Its high income has effectively made the Yucheng County jump from the national list of poverty-stricken counties. This dynamic rural industrial cluster has outperformed 29 state-owned enterprises in this industry and become one of the biggest manufacturing bases of steel measuring tapes in China.

Nanzhuang Village was a typical rural area in Henan Province before developing steel measuring tape industry, and its economy primarily depended on traditional farming. It offered no advantages in location and access to resources associated with industrial development. A farmer took the opportunity of steel measuring tape shortage in the rural market during the late 1970s to ignite an emergence of a steel measuring tape industry in this village (Li and Li, 2007). Later, many rural households entered this industry because of its low entrance thresholds, which promoted Nanzhuang complete transition in the late 1980s.

During the 1990s, the steel measuring tape industry in Nanzhuang Village experienced a dramatic improvement and realized mechanization, and a few larger enterprises also appeared. Steady expansion and increasing scale of production among the enterprises made steel measuring tape industry become specialized and interlinked, starting from the late 1990s. Meanwhile, the production technologies of steel measuring tapes were gradually diffusing to the surrounding villages and towns. Currently, the local industrial system including production, supply, marketing and service is tend to mature status, and a vigorous SME (Small and Medium Enterprise) cluster has formed.

2.2 Data collection

This study had a survey by the questionnaire and interview. Some comprehensive questionnaires were given out in 2002, and mass fieldwork-based interviews with enterprises, assembling families and government authorities were conducted in Nanzhuang Village in November 2002, December 2003, May 2004, March 2005 and April 2008, and after that, several telephone interviews were completed. In total, 43 enterprises and 17 families engaging in assembling steel measuring tapes (assembly families) were investigated (by questionnaire and personal interview) and a database with 298 data fields was created. The selection of the sample enterprises was based on two criteria: 1) the number of the samples exceeding 10% of total producers, and 2) the types of samples representing different scales (large, medium and small) and production divisions (integrated enterprises, intermediate input producers, and assembly families) (Table 1). By the interview with the enterprise owner or manager as well as several government authorities of Yucheng County, some data including census data on SMEs in this industry were attained. We also interviewed the trade association of the steel measuring tape industry and other related enterprises in Shaogang Township to supplement and contextualize the related data.

The interaction among enterprises is jointly coordinated by formal business exchanges and informal social linkages such as the delivery of goods and services, the diffusion of information and knowledge, and the development of trust and friendship. Considering that the formation of the network is affected by political, economic, social, technological and psychological factors, the questionnaire was designed to seek information not only about the cooperative networks (depicting the formal linkages among agents, such as the production linkages, the sub-contract linkages, the service linkages, the technological linkages, the supply chain linkages and the financial linkages), but also the spin-off networks (relevant to the enterprise establishment motive), the consulting networks (mirroring the direction of the information and knowledge flows), and the communication networks (reflecting the fellowship linkages).

2.3 Methods

SNA and the software UCINET 6.9, developed by Borgatti *et al*. (2002), were selected to analyze the structure

Table 1 Sample enterprises and assembly families in Nanzhuang Village

	Integrated enterprise		Intermediate input producer					Assembly families	Related enterprises
	Large scale	Small scale	Bar	Box	Spring	Hook and nail	Accessory		Pack box and electroplate
Number	3	3	6	12	6	3	7	17	3
Average employee	342	86	57	33	30	22	16	12	20
Fixed asset ($\times 10^5$ yuan)	100	50	10	6	3	4	5	0	3

and characteristics of the four types of networks. In the analysis, four indicators were employed including degree centrality, centralization, betweenness and density. Degree centrality is a measure of centrality that considers the number of direct connections of a node (Scott, 2000). The position of a node in the network can be illustrated by comparing its value of the degree centrality with other nodes. Centralization describes the degree of concentration in the whole network, which expresses the degree of inequality or variance in the network as a percentage of that of a perfect star network of the same size (Scott, 2000). As for as the centralization is concerned, the first step is to calculate the disparity of the centrality scores between the strongest central nodes and all others. Centralization is the ratio of the sum of their actual disparities and the sum of the greatest possible disparities. Betweenness views the extent of an actor as being in a ″bridge″ position. It measures the potential capability of a node to control other nodes, and the more nodes depend on it to make connections with other nodes, the greater power it has. Density describes the general level of cohesion in a network. It is defined as the ratio of the relationship number between the actual existence and the greatest possible existence in the network. Its value is between 0 and 1, and the closer 1 it is, the denser the network is, whereas the sparser. SNA is designed to map the networks and it offers useful tools to describe the core relationship types by penetrating into the implicit social relatonships among nodes from the interview with the interviewees.

In order to collect high quality attribute data and relational data, a structured questionnaire was designed carefully. Firstly, we listed all the sample enterprises, intermediary agents and service institutes with identifiers. Secondly, we asked the owner or manager of the surveyed enterprise to fill in the relationship items with 1, representing having relationship with his enterprise, or 0 otherwise. Finally, we acquired four 64×64 relational matrixes, which were analyzed using the UCINET 6.9 software tools.

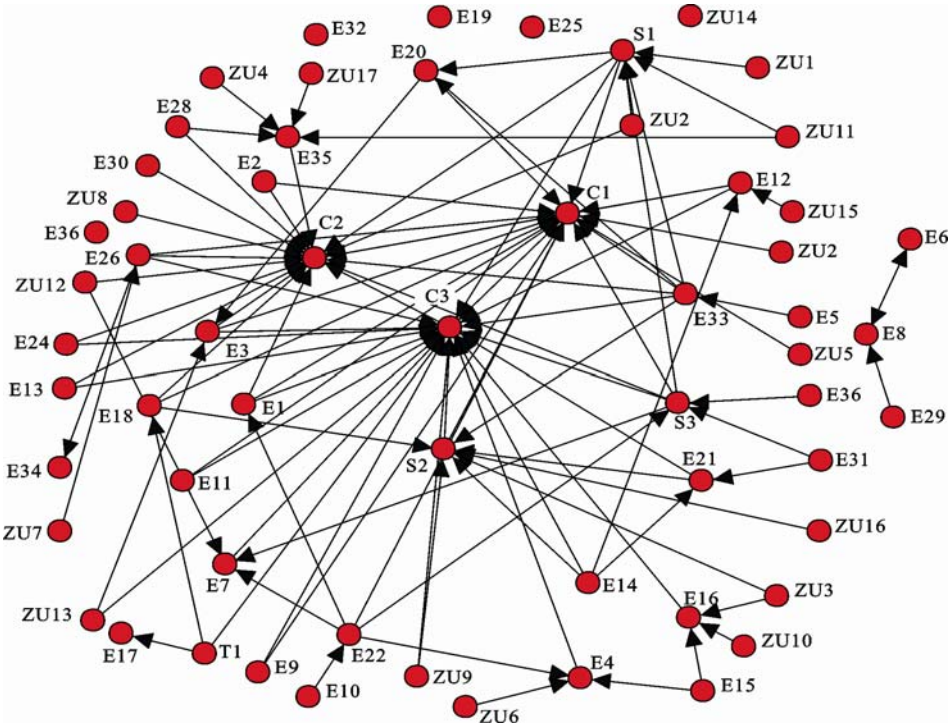
3 Network Relationships and Structure Characteristics in Nanzhuang Cluster

According to the survey results, four types of network relationships and Eigen values were shown in Figures 1–5 and Table 2. The network relationship displays several clear characteristics:

(1) Polycentric hierarchical structure. During cluster growth and network evolution, a few farmers took the lead in breaking with peasant tradition, and in initiating or joining the enterprisers. These root enterprises have set the direction of the cluster and network evolution, which made the four networks take on ″the polycentric nuclear structure″. As Fig. 1 illustrates, enterprise spin-offs were mostly accomplished by the three big core enterprises C1, C2 and C3. The degree centralities of the three nodes are 18.0, 19.0 and 22.0, respectively; the standard deviation of the degree of centrality in the networks is 4.313; the centralization of the network attains 32.67%. Some of their spin-off enterprises (e.g. S1, S2, S3) have already grown to the hypo-level root enterprise status (their degree centralities respectively are 9.0, 9.0 and 8.0). Meanwhile, the three root enterprises (C1, C2 and C3, with the degree centralities of 19.0, 21.0 and 25.0 respectively in the consulting networks, being the centers of technical innovation and diffusion (Fig. 2).

(2) The family relationships are the main channel of spin-offs. According to the links that one node has with the other nodes of the network shown in Fig. 1, tracing their social relationships based on the survey data, we could find that the spin-off path of enterprises is mainly extending along the family relationships. The reason is that Nanzhuang villagers are located in a poverty-stricken county, Yucheng County. Lack of start-up funds marked the initial stage of development. Accessories were generally purchased on credit from relatives already engaged in the steel measuring tape production. The borrower then started assembling steel measuring tapes at home, and selling steel measuring tapes to other places. After accumulating the necessary funds, they could buy the special machinery and equipment to produce certain intermediate inputs to other assembly members of the cluster. The first three leading enterprises produce the measuring tape, which is the more expensive accessory in the production process. Coupled with imitation effect from successful business models, most small enterprises have been supported or affected by the three leading enterprises. This kinship network is to be discussed in detail in section 4.1.

(3) The supply and demand relationships and the mobilization of the skilled workers are important paths of network learning. According to the consulting networks (Fig. 2), tracing the social relationships among nodes ba-



To keep secret for actors, three core enterprises are named as C1, C2 and C3, respectively, assembly family as ZU, transportation brigade as T1, trading company as T2, financial institution as *F*, industrial association as *A*, university as *U* and rest enterprises as E1, E2 and so on; arrow means executors of actions; following figures are similar

Fig. 1 Spin-off network

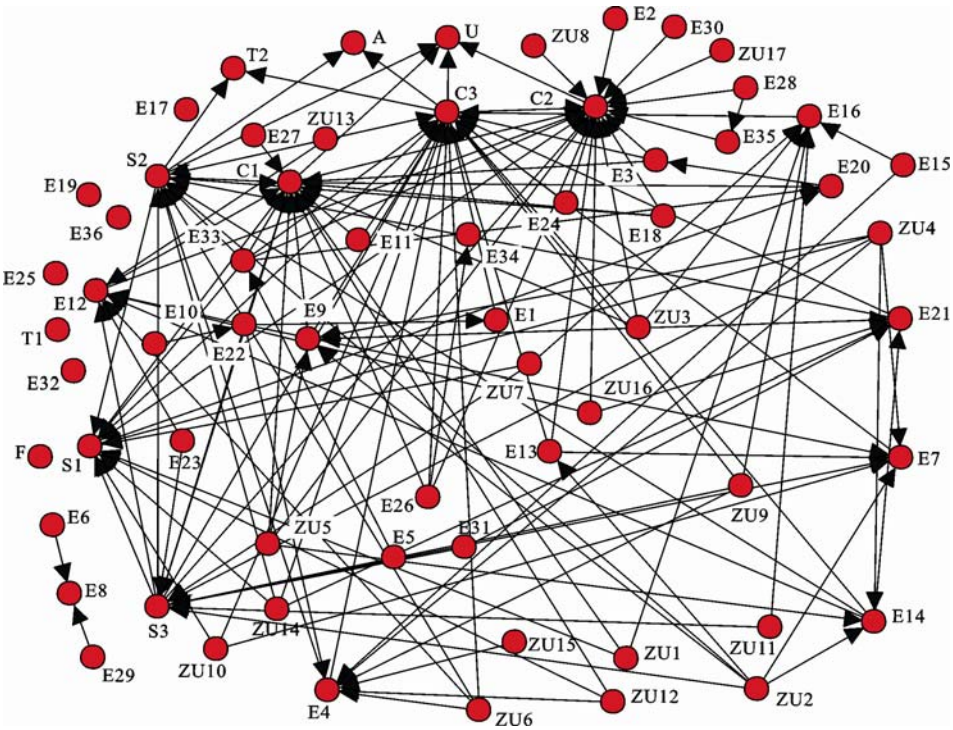


Fig. 2 Consulting network

sed on the survey data, we can find that the technical consultation mainly occurs among the up-downstream enterprises. In general, enterprises consult about technical problems to their upstream enterprises and, in turn, help their downstream enterprises to deal with their technical problems. In this way, the inter-enterprise mobilization of the skilled workers is also an important path of the technical learning, especially among similar enterprises.

(4) The medium-scale enterprises are more active than the small-scale ones. In the four networks, both the root enterprises, and the medium-scale enterprises are active. In the communication networks (Fig. 3): for instance the normalized degree centrality of S1 (15.25), a medium-scale enterprise, ranks third, only following C3 (25.4) and C2 (25.4), and in the cooperative networks, it is 24.0, exceeding that of the original root enterprise C1. Accordingly, S1 has been the hypo-level leading enterprise in the cluster and has the potential to supplant the first level root enterprise. While, the small-sized enterprises seldom contact with other enterprises: in the four networks, the average value of degree centralities of the three root enterprises amount to 20.1, while that of 10 smallest enterprises is only 1.5. Being both manufacturers and supervisors, the owners of the small-sized enterprises have no time to communicate informally with others. However, the owners of large or middle-sized enterprise may have separated from the production activity to discuss issues of mutual concern.

(5) The intermediary agencies and the service institutions act as bridges for the enterprise cooperations. In the cooperative networks, the degree centrality (11.1) and the betweenness (0.25) of the financial institutions (F) are low, while the degree centralities of the transportation brigade (T1), the trading company (S1) and the industrial association (A) are 68.3, 23.8 and 17.5 respectively, higher than the average degree centrality (15.3) (Fig. 4). For the betweenness, the transportation brigade (25.6), the trading company (7.5) and the industrial association (1.7) would be in the first, the third and the 17th place respectively in all nodes.

(6) The cooperative relationships derived from a long intensive interaction are comparatively stable. Compared with the linkage characteristics of nodes in the four networks, the communication networks, consulting networks and cooperative networks consist with the spin-off networks, which show that the networks formed by a long interaction and based on the family or the supply-demand relationships are comparatively stable.

The communication network almost contains the spin-

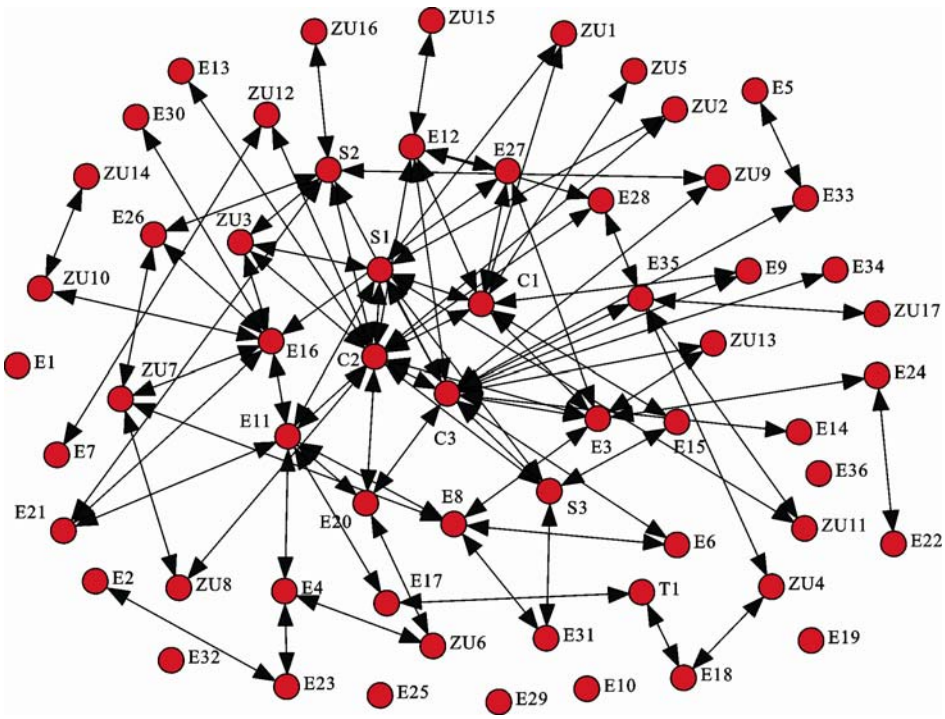


Fig. 3 Communication network

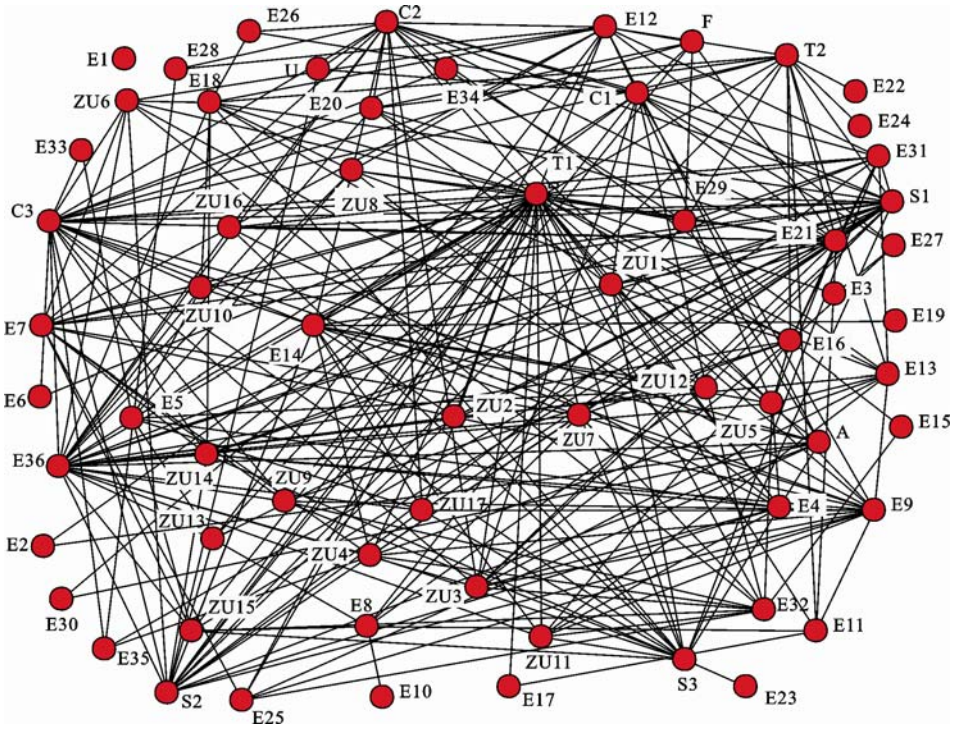


Fig. 4 Cooperative network

off network, which shows that the dissemination of know ledge and technology among enterprises is mostly through informal intercommunion and has a character of strong path dependence. Although the density of the cooperative networks can reach 0.1533, their cooperative relations mostly come from input-output linkages among up-downstream enterprises (such as the supply and demand relationships). Removing the nodes of assembly families with a function of organizing production, the transportation brigade, accessory producer, industrial associations, and financial institutions, the simple cooperative networks are shown in Fig. 5. The whole density of the cooperative networks reduces to 0.0927. It can be shown that the technological linkages and joint developments among enterprises are few, while only a few big enterprises keep the technological contact with universities, playing a role of ′the technological gatekeeper′ in the cluster. Meanwhile, the relation characteristics shown in Fig. 5 overlap with the spin-off networks, indicating that enterprises easily retain consistent psychological contracts with their spin-off partners, while the cooperation relation formed by a long interaction on the basis of the value chain can strengthen the stabilization of business networks.

(7) There are some isolated points in each network, which revealing that not each local actor joins into the regional networks. Some local enterprises are geographically adjacent but they do not participate in the local production networking basically because of lacking the pre-requisite abilities, confidence, or being in crisis of some kind or another.

Table 2 Eigenvalues of networks in Nanzhuang village

Type of network	Density	Centralization (%)	Standard deviation of degree centrality	Standard deviation of betweenness
Spin-off network	0.0288	32.67	4.313	0.139
Consulting network	0.0360	33.64	5.145	0.730
Communication network	0.0508	21.04	3.168	5.212
Cooperative network	0.1533	54.63	7.571	3.543

4 Stage Characteristics of Network Evolution

By the analysis on the selection and change of partners in cooperation, the change of the core relationships in the cluster networks can be distinguished by: 1) tracing the development history of enterprises and the participation time into the network; 2) observing the social relationships between an enterprise and its partners based on the survey data, and comparing the four networks of the

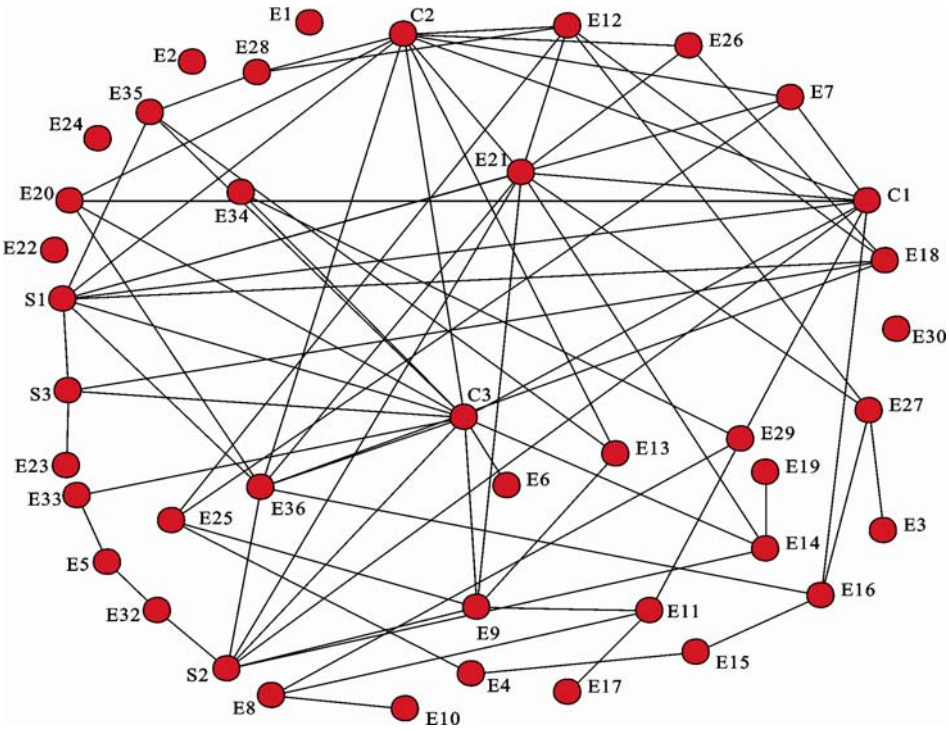


Fig. 5 Cooperative networks without service institutions and assembly families in cluster

same enterprise and the same networks of different enterprises which was established at different time; and 3) documenting the partner changes of an enterprise between initial stage (spin-off networks) and present stage (consulting networks, communication networks, and cooperative networks) based on the progress of the cluster development (Table 3).

Naming each evolutionary stage according to the core relationship in its cluster network, the evolution of SMEs networks in Nanzhuang cluster, a traditional manufacturing cluster in less developed rural areas have evolved through four stages of network development: the family networks, the internal division production networks, the local innovation networks and the global supply networks. The four networks′ evolution is basically along the same direction, which reflects the changes of socialization, the degree of enterprise network organization, and the spatial trends that the SMEs network-organization extends from the local to the global. Different network types play different roles in different stages of cluster development, and the networking behaviors of enterprises match the relative significance of endogenetic capabilities and the significance and types of external contracts. In this process of evolution, the number of the nodes in the network will be growing, the types of actor becoming more diverse and different, the linkages between actors more close and effective, the cluster focus enterprises adapting smoothly, such that the enterprise networks upgrade naturally.

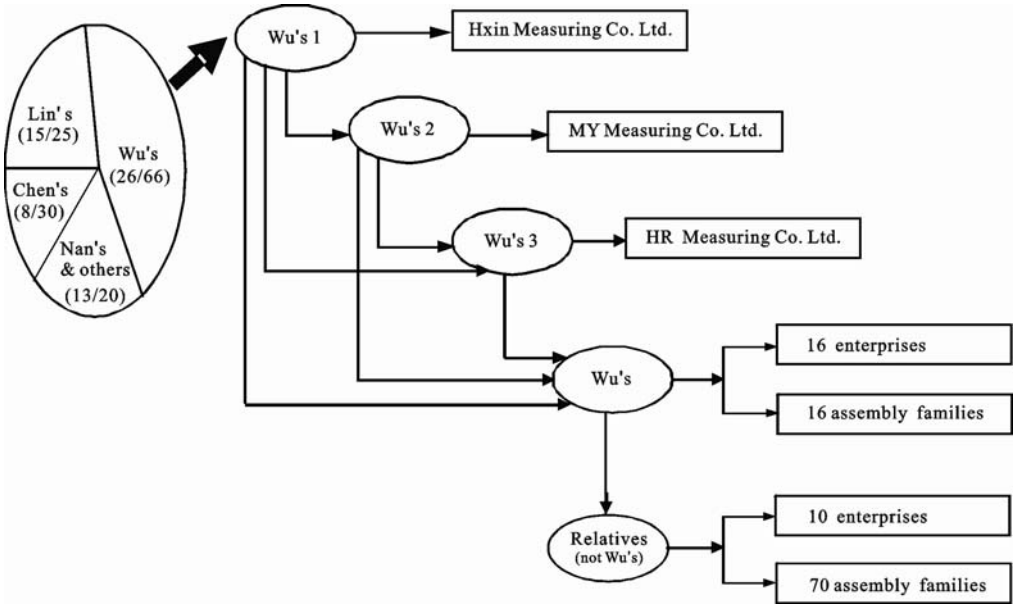
4.1 Family networks expediting formation of cluster

Cluster networks are organized and diffused based on blood-affinity linkages, that is, the family relationships are the core connections, while the geographical proximity is the secondary factor in the initial stage of cluster formation. According to our survey, in a village or town further away from the Nanzhuang Village, enterprises and assembly families engaging in steel measuring tape industry are mostly spread through this kind of channel. Before 1995, the Nanzhuang cluster only contained three enterprises, but 70 households were soon to enter the assembly industry, most of whom (about two-thirds) derived from the family relationships. In the 60 sample enterprises, 38 were derived from this kind of kinship. At this stage, the three root enterprises only jointed business with households in family ties or spread their enterprising spirit, ideas or relevant technology to their partners, but no division, subcontract and cooperation actions among enterprises.

In order to test and verify the role of family relations

Table 3 Changes of core relationships in enterprise networks in different stages of cluster development

Stage	Approximately time	Spin-off network		Consulting network	Cooperative network	Communication network	Core relationship
		Relationships	Section to entry				
First stage	1978–1995	Family	Assembling	Dominated by family relationship	Family relationship (co-purchasing, co-selling, no division)	Dominated by family relationship	Family networks
Second stage	1995–2000	Family, colleAgue at same enterprise	Intermediate inputs production	Up-down stream relationship	Up-down stream relationship; family relationship	Up-down stream relationship	Internal division-production networks
Third stage	2001–2005	Colleague at same enterprise	Upgrade to integrated enterprises or service sector	Up-down stream relationship; universities; research institutions	Intermediate service institutions; research institutions; up-down stream relationship	Up-down stream relationship	Local innovation networks
Fourth stage	2005–	Colleague relationship	Upgrade; intermediate inputs production; trade agents;	Overseas trade enterprises; research institutions; up-down stream relationship	Subcontracting between enterprises in up-down stream; trade companies; OEM (Original Equipment Manufactures)	Dominated by up-down stream relationship	Global supply networks



In left figure, each fan-shaped area presents proportion of persons with a surname in total population of Nanzhuang Village, and first figure in parenthesis represents for number of enterprises, and second is number of assembly families

Fig. 6 Kinship network and enterprise expansion in Nanzhuang cluster

in spin-off networks, we trace and check out the diffusion process of Wu′s family networks in Nanzhuang Village (Fig. 6). According to the survey, 16 enterprises and 16 assembly families are derived from them. Approximately 80 non-Wu′s relatives are attached to the Wu′s enterprises to engage in steel measuring tape production industry. The persons with the surname Wu are not the most numerous in Nanzhuang Village, but they have the largest number of enterprises (Fig. 6). While those with the family name Lin are the most popular, fewer enterprises engaged in the production of steel measuring tape employ them, owing to the absence of the leading Lin′s enterprises. It shows that the derived enterprises are mainly started by the family network. Thus, it

is the family networks to promote the rapid expansion of the steel measuring tape industry and the formation of manufacturing cluster in Nanzhuang Village.

4.2 Internal division production networks accelerating growth of cluster

With the expansion of the cluster scale, the division of labor and the specialization of production have become more distinctive within it. Many specialized intermediate input producers and servicing entities emerged. For example, as early as 1998, 16 measuring-box plants, 3 measuring-belt plants, 8 measuring-spring plants and 2 measuring-hook plants were established in the cluster. Generally, the specialized enterprises are derived by two pathways: one is the upgrading of the assembly households by purchasing specialized equipment, and other refers to the initiatives of the skilled workers separated from the parent enterprises.

The Nanzhuang cluster is notable for the frequency of cooperative activity among the complementary enterprises and the intense competition between the enterprises in the same phase of the production chain, which lead to closer and more direct linkages in the economic networks. The enterprises network by the following ways: 1) the horizontal cooperation (such as joint purchase and sell and so on) among the competitive enterprises; 2) subcontracting non-core parts of production to the surrounding households or plants for the larger enterprises in cluster; 3) local traders organizing the relevant enterprises to be a production chain or do OEM production; 4) the assembly households organizing a network by purchasing all parts from various specialized enterprises, and linking with the trademark design, printing, packaging, transportation teams and other enterprises.

At the stage of internal division production networks, the enterprise mainly cooperates in dollars-and-cents terms with its up-downstream enterprises such as the suppliers, customers and agents in the production or marketing. Accordingly, besides geographical proximity, the network linkages are mainly as economic or industrial ties, while, the kinship ties take second place. Through a long period of exchanges between enterprises, the original family networks evolve forward two directions, one is to build more stable economic co-operation based on the unique trust among enterprises built by family members, while the other is to the other extreme, to destroy the networks by breaching of psychological contracts between the family members in the course of interaction. The latter often results from family loans being in arrears or bad trust among family members. Nevertheless, in the cooperative networks which are stabilized by a long interaction among enterprises, the family relationships still play an important role. The enterprises derived from family members can rapidly find and enter their own suitable value chain phases. Especially, the spin-off network of the root enterprises can accelerate the formation of the division production networks.

4.3 Local innovation networks boosting cluster competitiveness

The flexibility that comes with expansion and specialization brings diversity and a more definable hierarchy to the cluster. This serves well the individulised demands of consumers. The initial low-level production saturates the market and they are easily imitated during phases of vicious competition which eventually cause profits greatly shrinking. Enterprises in such a position can develop a strong sense of innovation and realize the advantages by cooperation with various actors in local networks. They develop close interactions with their up-downstream enterprises, customers, the trading agents, technical service centers, universities, research institutions, money corporations and even with their direct competitors to expand innovation channels. Local government and industrial associations also actively construct networks aiming at increasing innovation competitiveness, and eagerly improving the hardware and software environment of cluster production. For example, in 1997, the local government of Shaogang Township repaired the circular village road, set up a cable network and established a large-scale wholesale market in the cluster. In 1998, the industrial association, the quality check center and SMEs′ service centre were set up in succession. Product variety in the cluster increased fastest in this stage: from 60 kinds in 1998 to 195 kinds in 2004. The SME local innovation networks took form during this time.

It is at this stage that enterprises construct business networks to enhance their technological innovation abilities and the trade efficiency: value-oriented, formal or informal ways are pursued. As stated above, the technical consulting mainly occurred among the up-downstr-

eam enterprises, while, because of the maintenance of stable friendship, the entrepreneurs of similar companies also often get together to discuss technical issues, which can lead rapidly to the creation and diffusion of cluster-focused innovation. In the survey, we found that the technological innovations of enterprises were mainly imitative innovations, which came mainly from external markets or, for the large enterprises, from joint development with universities or research institutions. In contrast, the small businesses were inspired from within the cluster. We also found that it only took three months for a new kind of steel measuring tape sample to be imitated diffusely or its innovative aspects to be incorporated by other enterprises (Li and Li, 2007).

During this stage of cluster development, the drived enterprise mostly comes from the fission of the large enterprises: new enterprises or service sectors are established by workers with crucial techniques in the large enterprises. In the cluster, the inter-enterprises networks based on kinship, together with interlocked nature of the value chain, constitute strong ties, while the linkages of enterprise with government, intermediary organizations and research institutions are weaker ones. With the aid of both the strong and weak ties, the SMEs successfully extended beyond their own resources, space and capacity constraints by forming reciprocal (formal or informal) contract arrangement. However, the interaction among entrepreneurs who have been in the same family, town, industry or in the same school continues to play a role in the stability of inter-enterprises cooperation.

4.4 Global supply networks driving upgrading of cluster

When the rural SMEs construct their innovation networks and extend them to the outside, they also pay attention to the global market. The rapid pace of economic globalization increases the trades between developing countries and developed countries, and enterprises become more dependent on the coordination of global buyers. The producers in developing countries who can be integrated into the commodity supply chains driven by global buyers will have access to rapid upgrading of production. After the first three stages (spin-off networks, consulting networks, communication networks), the large enterprises can rely on their technological advantages to develop middle-level and high-level products and gradually integrate into an international market so as to capture more profits. Recently, more and more enterprises have taken out import/export licenses. As a result, the number of companies exporting steel measuring tapes grew from 1 in 2000, to 3 in 2003, to 19 in 2007. However, after 2003, most companies began to follow the ′indirect globalization′ path: they export their products through the Wenzhou agents, foreign trade companies, or agree to an OEM for the trade companies, further embedding themselves into the global commodity supply chain. Thus trading agents located in the coastal areas become important to them, although a few enterprises succeed in establishing direct import and/or export.

At this stage, the derivative of enterprises decreases and the degree of vertical division of labor stablizes. Enterprise networking focuses on the global market, integrating into the global commodity chain and upgrading to capture as much value as possible. Unlike those in the coastal areas of China, inland enterprises are less likely to have a direct overseas relationship, so formal economic linkages with foreign enterprises are their main networking priority. The hierarchical gradation among enterprises has clarified by this final stage of development, while the community-based social network has become less relevant. However, after the long-term contacts, enterprises have formed stable cooperative relationships with foreign customers.

5 Discussion and Conclusions

The worldwide research on network evolution has just begun. Because the historical relational data are difficult to acquire, the research on SNA has placed by far the most emphasis on static analysis of existing networks, thereby taking comparatively little concern for the evolution of cluster networks. However, by contrasting the initial stage cluster spin-off networks with the communication networks, consulting networks and cooperative networks of the mature stage of rural area manufacturing cluster development, and tracing the enterprise and network development history, this paper analyzed the cluster evolution with special reference to the maturing of enterprise networking, and had a new trial dynamic research on the SNA. Thus it can be summarized how the core relationships in cluster networks and the crucial organizations in network structure change. It is found that, compared with the traditional Chinese coastal areas

or the high-tech manufacturing clusters with their direct access into the global value chain, which emphasize technical linkages in developed countries, the evolution of networks in traditional manufacturing clusters in close, lagging and less developed rural areas have more endogenous features and follow an auto-organizational principle. The following evolutionary characteristics can be summarized as follows:

(1) One or a few farmers with entrepreneurship takes/ take the lead in breaking with the traditions of peasant agriculture to become owners of industrial enterprises and diffuse their advanced ideas along the channel of the family networks. Those pioneers, then become the owners of the root enterprises, and thereby acted themselves as a technological gatekeeper in a developing manufacturing cluster, which evolves into a polycentric hierarchically structured cluster of production facilities and associated communication and other enabling networks. The family relationships are the main channels in forming derived enterprises, while the supply-demand relationships and the mobility of the skilled workers develop as important paths of network learning, and the cooperative relationships formed by the enduring interactions become comparatively stable. Besides the root enterprises, the middle-sized enterprises become comparatively more active than small-sized enterprises, and the intermediary agencies and the service institutions act as bridges for the inter-enterprise cooperation.

(2) In the process of cluster growth, networks evolvement, the core relationships of which respond to the changing enterprise sizes, status, capabilities, are still much affected by the cluster position in a rural community environment. With the further development of clusters, the level of trust among enterprises sometimes can begin to deteriorate due to breach of psychological contracts and vicious competition. At the same time, it can be expected that the competition will force network extention to take in contacts outside the region. However, enterprises in those clusters located in less developed rural areas, are most likely to do this by following the ′indirect globalization′ way. The trading agents play a crucial role in integrating the rural enterprises into global networks.

(3) In the view of the nature of the core relationships linking rural area manufacturing members of the cluster, the evolution of networks can be divided into four stages, that is, the family networks, the internal division production networks, the local innovation networks and the global supply networks. Each type plays a different role in different stages of cluster development. In this process of evolution, the number of the nodes in the network will be growing, the types of actor becoming more diverse and different, the linkages between actors more close and effective, the cluster focus enterprises adapting smoothly, such that the enterprise networks upgrade naturally.

(4) With the evolution of cluster networks, the nature of endogenetic capabilities and the types of external contracts made by enterprise owners will also be changing constantly, but with phased characteristics. This study found that not every local participant is involved in the local networks. Some local small business, although in geographic proximity to others, do not participate in the local network activities because they lacking of the pre-requisite abilities, confidence, or are in crisis of some kind or another. Thus the networking behaviors of enterprises match the relative significance of endogenetic capabilities and the significance and types of external contracts. Future research may further explore the evolutionary styles of networks in rural clusters from these two complementary and comparable perspectives.

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