An Empirical Study of Investment Bank Syndicate Networks in China's Capital Market

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***Abstract*—I analyzed the IPO syndicate networks in China's capital market tracked over a period of 5 years from the perspective of social network. The syndicate networks were among 89 investment banks in China's capital market and included 905 ties. With the help of UCINET 6.0, I found that these inter-organizational networks showed clear pattern of small-world which was characterized by high degree of local clustering and short paths between banks. I also found that the connectivity of the syndicate networks was highly skewed. I examined evolution over time in the network's properties of small-worldliness and skewness, and demonstrated their theoretical and practical implications for Chinese investment bank networks by linking these properties to the network's information transmission speed and resilience.**

Keywords-syndicate network; inter-organizational network; small-world; skewed topology

I. INTRODUCTION

China has seen vigorous development in recent years in its capital market. The market capitalization of A-share market at the end of 2009 is nearly eight times as large as that at the beginning of 2005. With the help of domestic investment banks, averagely 60 companies launched their initial public offerings (IPOs) every year since 2005. Through these IPOs, investment banks formed extensive cooperative networks.

Investment banking industry is a relationship-oriented rather than transaction-oriented industry. In underwriting deals investment banks often collaborate to share risk, reach a wider market of investors and utilize the expertise of each other in some specific deals [1]-[4]. However, few papers have focused on the investment bank syndicate networks in China's capital market despite its rapid development and numerous papers contributed to syndicate networks of United States, United Kingdom and Canada.

This paper uses data of IPOs in China's capital market from 2005 to 2009, which include 89 banks and 905 ties, to analyze the statistical properties of Chinese investment bank syndicate networks and demonstrate their theoretical and practical implications for the China's capital market.

II. THEORETICAL BACKGROUNDS

A. *Properties of Network Structure.*

Network analysis stands currently in the epicenter of new economic sociology and is gaining popularity in other fields of social science, even in biology and informatics, because network structure has important implications for the spread of information and ideas, as well as social influence and inequality [5][6]. Through empirical and theoretical studies of social networks, two families of network structures have been identified and brought into attention: small-world network structures and skewed structures.

1) *Small-world network structures*

Small-world networks are characterized by coexistence of high degree of clustering, meaning that two actors are very likely to be acquainted if they have one or more other acquaintances in common, and short characteristic path length, meaning that most pairs of actors can reach each other through a rather short path in the network [7].

Stanley Milgram first proposed the concept of small-world in his famous experiment involving letters passed from acquaintance to acquaintance. Watts and Strogatz used the description of combination of short paths and high network clustering to formalize the concept of small-world. They suggested the empirical detection of small-world structure by analyzing two basic properties of networks: clustering coefficient, C, and characteristic path length, L [7]. Clustering coefficient C measures the average probability that two actors, which are both connected to a third actors, will be connected. C is a measure of local network structure pattern. It shows how cliquey the local network is. In contrast to C, characteristic path length L is a measure of global structure of network. It is determined by the average length of shortest path between any two actors in the network. By comparing the values of C and L of the network in question and a random network with the same number of actors and ties, the small-worldliness of the network can be assessed. For small-world network, the value of C should be much larger than that for random network, while the value of L should be close to that for random network.

The reason for which small-world effect draws so much attention lies in that small-world network structure is capable of rapid communication and information processing, and has great tolerance for errors. The closely knitted local networks or cliques, indicated by great value of clustering coefficient, are advantageous in the processing and digestion of information, while the short paths between actors through prominent intermediate actors facilitate the rapid transmission of information from actors at one end to that at the other end throughout the entire network. Because of these advantages, small-world networks seem result of natural selection and empirical studies have found small-world structure in a range of economic, social, technological and biological networks [7]-[9].

2) Skewed topology of networks

Although the feature of skewed degree distribution commonly coexists with small-world networks, it is not included in the Watts-Strogatz models. The degree distribution is the distribution of numbers of ties of actors. In contrast with random networks, in which the numbers of ties of actors are of the same order of magnitude, resulting in normal distribution, the skewness and kurtosis of degree distribution of networks with highly skewed connectivity are very large, indicating that some prominent actors are in possession of disproportionately large numbers of ties while the majority of actors holds only few ties.

Albert and Barabási demonstrated that the Internet and the World Wide Web are networks of skewed connectivity [10]. They proposed that the numbers of new ties gained by actors are in proportion to the numbers of old ties possessed by actors. This dynamic that the rich gets richer and the poor gets poorer is often referred to as the Matthew Effect in sociology.

The networks with skewed degree distribution are resilient to outside shocks. When a network faces random failure of actors or ties, it is most likely the actors with a small number of ties, or peripheral actors, that fail, because the majority of the actors in the skewed network are peripheral actors. Central actors often remain intact and the majority of the network is stable. The skewed network structure is therefore particularly robust to the random removal of actors or ties. Cohen, Erez, ben-Avraham, and Havlin, illustrated the resilience of the Internet to random failures of routers [11], and Watts showed the robustness of the power grid in the western U.S. to the random failure of power transmission lines [12]. However, the failure of central actors in networks with skewed degree distribution is catastrophic. This kind of failures can cause the whole network to break apart into isolated sub networks or even to collapse altogether.

B. Investment Bank Syndicate Networks

The investment bank industry is relationship-oriented rather than transaction-oriented. Relationships are a vital resource, as ties provide investment banks with underwriting opportunities and contribute to banks' reputations [8]. Because banks usually have to purchase all the unsold issues themselves and underpriced issues mean low profits, effective pricing and placing of issues are of vital importance and banks often collaborate to share risks and to reach a wider market of investors in underwriting deals. In underwriting deals, the decision makers of an investment bank, called lead managers, invite co-lead managers to form underwriting syndicates based on the lead managers' understanding of the relationships with co-lead managers.

Except for some huge deals, the primary reason for forming syndicates in most underwriting deals in China's primary market is compliance with regulations rather than sharing risks, because the demand for securities is much higher than the supply. According to the regulations of China Securities Regulatory Commission, underwriting deal involving more than 50 million shares, which is fairly small capitalization and considered risk-free in a primary market with huge demand, must be underwritten by a syndicate.

Interviews with experts in the industry reveal that Chinese investment banks do not choose their partners randomly to comply with the regulations. These banks form underwriting syndicates based on past cooperation of banks and in some cases personal relationship between decision makers of banks. Li and Rowley showed that investment banks favor past partners because of reciprocity, experience, prior performance, and network inertia [3].

However, company-specific information acquired by co-lead managers through participating in a syndicated deal can be later used to attract that company's business away from the lead manager bank, since many companies issue securities more than once, e.g. corporate bonds and follow-on offerings after IPO. Lead manager usually implicitly guarantee its co-lead managers a future stream of revenues from participating in other syndicates to make the cooperation more profitable than stealing customers. Thus, cliques of cooperative banks develop in this industry, resulting in the low information distribution of deal-specific information in the inter-organizational network, but high commonality of distributed knowledge within cliques of regularly interacting lead and co-lead banks [8].

III. Data and Methods

To study the structure of investment bank syndicate networks in China's capital market, I collected data on all IPOs in China's primary market from 2005 to 2009. The data come from Prospectus published by stock issuing companies before their IPOs and are collected from the databases of Shanghai Stock Exchange and Shenzhen Stock Exchange. In the five-year time period, there are altogether 383 IPO events and 89 investment banks. I considered the coexistence of a pair investment banks in an underwriting syndicate a tie between the two banks and constructed networks from adjacency matrices capturing the number of times each bank participated in a syndicate with each other bank for two-year moving periods. I used two-year event windows because syndicate ties are only observable evidence of relationship between investment banks, and banks forming syndicates in any given year were very likely to interact with each other before the underwriting deals. The other reason is that two-year window makes the measure of the relationships between banks more accurate by including repeated cooperation.

In order to assess the small-worldliness of networks, the values of clustering coefficient C and characteristic path length L need to be determined. If an actor has k ties, the clustering coefficient of the actor is calculated by the number of links among the actor's k neighbors, N, dividing the maximum number of ties they might have, $k(k-1)/2$. Numerically it can be presented as

$$C = N/[k(k-1)/2]. \quad (1)$$

The average of clustering coefficients of all actors in the network C_{Actual} was then calculated. L is the shortest path length between any two actors. The value of characteristic path length L_{Actual} was determined by calculating the average of minimum path lengths between all pairs of actors in the networks. High values of L_{Actual} indicate that information transmit throughout the entire network rapidly.

The small-worldliness of a network can be assessed by comparing the values of C_{Actual} and L_{Actual} for the network in question with the values of the parameters for a random network with the same number of actors, n, and ties, k. The values of C and L for a random network are k/n and $ln(n)/ln(k)$ respectively [12]. For small-world network, the clustering coefficient should be much larger than that for random network, while the characteristic path length should be close to that for random network. Following Baum, Rowley and Shipilov, I used following summary statistic to indicate the presence or absence of small world:

$$SW = (C_{Actual}/C_{Random})/(L_{Actual}/L_{Random}), \quad (2)$$

where C_{Random} and L_{Random} are clustering coefficient and characteristic path length for a random network respectively. A network is considered a small world when the value of SW is greater than 1 [8].

I dichotomized and symmetrized the adjacency matrices of syndicate networks to form binary and undirected adjacency matrices for the application of UCINET 6.0, which can be used to calculate the average clustering coefficients and characteristic path lengths, as well as the degrees of each actor. The values of skewness and kurtosis of degree distributions were then calculated for the assessment of skewed topology of network, and Shapiro-Wilk test was performed to evaluate the departure of degree distributions of syndicate networks from normal distribution. Higher values of skewness and kurtosis signify skewed and fat-tailed distribution, while lower values of Shapiro-Wilk statistic indicate departure from normality.

IV. Analysis and Results

Table I summarizes the evolution of small-world property of investment syndicate networks in China's capital market. As demonstrated in Table I, the clustering coefficients for the actual networks are about four times larger than those for random networks in all four periods, indicating clear pattern of clustering. This pattern of high degree of clustering is also illustrated by Fig. 1 and Fig. 2, which show graphically the syndicate network in period 2007-2008 and 2008-2009 respectively. Both figures show dense local clusters in networks. Comparing Fig. 1 and Fig. 2, I found that the network of 2008-2009 is much sparser than that of 2007-2008, indicating lower degree of clustering, which is consistent with the clustering coefficients in Table I, as period 2007-2008 has the smallest clustering coefficient, 0.131, and smallest ties per bank, 1.738. This is because the volume of individual IPOs in 2009 decreases dramatically. After almost all the large qualified companies in China successfully completed their IPOs before 2008, investment banks turned to small- and medium-sized qualified companies. The decrease of volume of individual IPOs reduced the incentive for banks to form underwriting syndicate, and reduced the clustering.

The characteristic path lengths of four periods are all around 2.5, and very close to those of random networks, except for the last period, in which the characteristic path length for random network with 61 actors and 106 ties is 7.44, indicating information from one actor to another going averagely through 6 to 7 intermediate actors. However the characteristic path length for syndicate network remains low, signifying a mechanism of rapid information transmission.

The small-world statistics of all four periods are significantly greater than 1, indicating the existence of strong small-world effect. Even when the degree of clustering reduced during the period 2008-2009, the characteristic path length remained short. Due to the comparatively short path length, the syndicate network of the last period shows even stronger small-world effect, with SW statistic up to 14.5. The Chinese investment bank syndicate networks thus form small worlds, and are capable of rapid communication and information processing with great tolerance for errors.

Table II demonstrates the values of skewness and kurtosis for degree distributions of syndicate networks, as well as the Shapiro-Wilk test results. For all four periods, the values of skewness and kurtosis are much higher than zero, indicating the degree distributions are highly positively skewed and fat-tailed. The results are supported by Shapiro-Wilk test. The values of the statistic for four periods are all significant ($p<0.001$), signifying serious departure from normal distribution. The highest values of skewness and kurtosis appear in the period of 2008-2009, implying stronger Mathew Effect in face of dramatic decrease of volume of individual IPOs.

TABLE I. Small-World Characteristics for Investment Bank Syndicate networks, 2005-2009

Year	Ties	Banks	Ties/Banks	C_{Actual}	C_{Random}	C_A/C_R	L_{Actual}	L_{Random}	L_A/L_R	SW
2005-2006	220	78	2.821	0.190	0.036	5.278	2.619	4.202	0.623	8.468
2006-2007	349	73	4.781	0.321	0.065	4.938	2.146	2.742	0.783	6.310
2007-2008	230	65	3.538	0.286	0.054	5.296	2.228	3.303	0.675	7.852
2008-2009	106	61	1.738	0.131	0.028	4.679	2.397	7.440	0.322	14.522

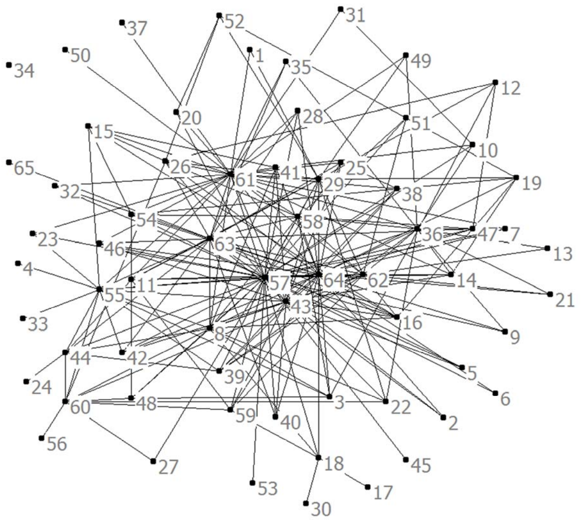

Figure 1. Investment bank syndicate network, 2007-2008.

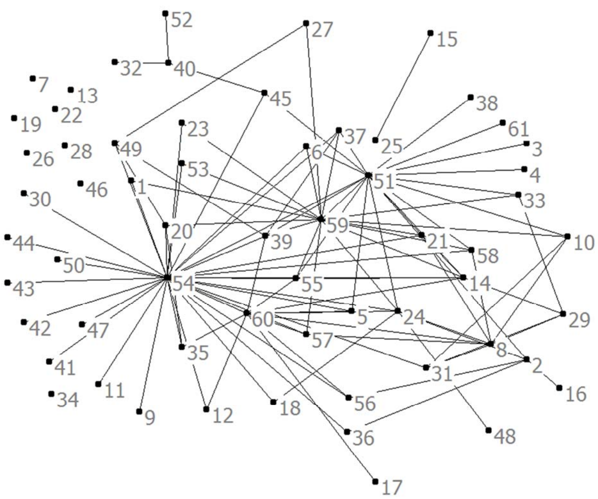

Figure 2. Investment bank syndicate network, 2008-2009.

TABLE II. THE SKEWED DEGREE DISTRIBUTIONS OF SYNDICATE NETWORKS, 2005-2009

Year	Skewness	Kurtosis	Shapiro-Wilk Statistic
2005-2006	2.074	4.859	0.767[a]
2006-2007	1.917	4.250	0.804[a]
2007-2008	2.416	6.454	0.714[a]
2008-2009	3.764	17.207	0.571[a]

a. $p<0.001$

The skewed topology can also be identified by examining the graphics of the network. Fig. 1 and Fig. 2 both showed that a small number of investment banks are in possession of a disproportionately large number of ties, e.g. bank 43, 57, 61, 64 in Fig.1 and bank 51, 54, 59 in Fig. 2, while other banks have a very limited number of ties. The connectivity of Chinese investment syndicate networks is therefore highly skewed and the networks are especially resilient against failure of peripheral banks, but vulnerable in the situations of failed core banks.

V. CONCLUSION

In this paper, I investigated the investment bank syndicate networks in China's capital market during the period from 2005 to 2009. I found that the syndicate networks were highly clustered and the typical distances between pairs of banks were short, with, on average, only two steps needed to get from one bank to another in the network. The networks therefore formed small worlds. I also found that the degree distributions of the networks were highly skewed and are significantly different from normal distribution, with a small number of banks having a disproportionately large number of ties.

These features suggest that the Chinese investment bank syndicate networks were capable of rapid information transmission and processing and have great tolerance for errors. The networks are also resilient against random failure of banks or relationships between banks, but very sensitive to the failure of the most-connected banks.

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