China Journal of Accounting Research 7 (2014) 101–118

Contents lists available at ScienceDirect

China Journal of Accounting Research

journal homepage: www.elsevier.com/locate/cjar

Independent directors' board networks and controlling shareholders' tunneling behavior☆

Yunsen Chen [a,*], Yutao Wang [a], Le Lin [b]

[a] School of Accountancy, Central University of Finance and Economics, China
[b] School of Economics and Management, Tsinghua University, China

ARTICLE INFO

Article history:
Received 23 February 2012
Accepted 6 September 2013
Available online 4 January 2014

JEL classification:
G30
L14
M00

Keywords:
Network
Independent director
Tunneling
Social network analysis

ABSTRACT

As one of the channels by which board directors build important relationships, board networks can affect the governance role of independent directors. Defining director board networks as their connections based on direct ties they establish when serving on at least one common board, this paper explores the role of the network centrality of independent directors in restraining tunneling behavior by controlling shareholders in the Chinese capital market. Our empirical evidence shows that tunneling behavior by controlling shareholders is negatively related to the network centrality of independent directors and that this relationship is stronger when non-operating fund occupation is used as the measure of tunneling. The results of our study show that board networks can help independent directors to restrain tunneling behavior by large shareholders, which plays a positive role in corporate governance.

* Corresponding author. Address: School of Accountancy, Central University of Finance and Economics, No. 19, Haidian South District, Beijing 100081, China.
E-mail addresses: chenyunsen@vip.sina.com, yschen@cufe.edu.cn (Y. Chen), wangyt.05@sem.tsinghua.edu.cn (Y. Wang), linl.09@sem.tsinghua.edu.cn (L. Lin).

☆ The authors thank the executive editor and the anonymous referees for their helpful suggestions. Chen especially thanks his supervisor, Professor Xie Deren from Tsinghua University. This study was supported by the National Natural Science Foundation of China (Project No. 71202126; 71102124), the MOE (Ministry of Education in China) Youth Fund of Humanities and Social Sciences (Project No. 12YJC630021) grants from the Beijing Municipal Commission of Education "Pilot Reform of Accounting Discipline Clustering", grants from the Beijing Municipal Commission of Education "Joint Construction Project" and the "Project 211" fund of the Central University of Finance and Economics, China.

1755-3091/$ - see front matter © 2013 Production and hosting by Elsevier B.V. on behalf of China Journal of Accounting Research. Founded by Sun Yat-sen University and City University of Hong Kong.
http://dx.doi.org/10.1016/j.cjar.2013.09.002

1. Introduction

In the corporate governance field, relations among directors are one kind of social network that cannot be ignored (Conyon and Muldoon, 2006; Engelberg et al., 2012; Fracassi and Tate, 2012). The behavior of directors depends simply not only on their own contacts, but also on the influence of other people's contacts within social networks (Granovetter, 1985). Independent directors not only play a role in monitoring the company, but also play many other social roles, such as serving as company executives, industry association leaders, government officials, university professors and members of a variety of associations. Directors with many social roles naturally have a variety of social network connections, such as through their membership of professional associations, alumni networks and clubs, fellowships, in-law relationships and kinship networks. This paper focuses on one of the unique forms of social networks – interconnections forged among directors of listed companies by serving on at least one common board at the same time – to investigate the governance role of independent directors in China.[1]

Specifically, this paper examines the role of independent director board networks in mitigating agency problems between large shareholders and minority shareholders. That is, whether the network centrality of independent directors pushes them to deter tunneling by controlling shareholders. In comparison with the U.S. and a few countries with characteristics of dispersed ownership, most countries have more concentrated equity ownership (La Porta et al., 1999), and most firms are controlled by one or a few large shareholders. The existence of controlling shareholders gives prominence to agency problems with minority shareholders and tunneling[2] is the most direct form of evidence of controlling shareholders' agency problems that seriously damage the interests of minority shareholders.[3] The tunneling behavior of controlling shareholders in China's capital market hinders its healthy development (Chen and Wang, 2005; Jiang et al., 2010). A series of policies have been issued to restrain tunneling behavior by controlling shareholders. However, these policies have not achieved their goals in practice (see Section 3 for more details). Many tunneling events have occurred in China's capital market to date. Moreover, these events are becoming increasingly serious.[4]

This paper does not examine all types of network relations among directors and is limited to an investigation of the network centrality and governance role of independent directors. There are three reasons for this approach: first, the weak tie and structural hole theories hold that independent directors play the key role in board networks, whereas most inside directors are isolated and their network characteristics are not obvious. Second, most inside directors are also executives, which reduces their monitoring role (Fama and Jensen, 1983). This is especially in China, where the chairman of the board plays a role somewhat similar to that of the CEO in the U.S. (Firth et al., 2007; Ye et al., 2011). Third, due to the mandatory policies on independent directors implemented in China's capital market from 2003 to date, many prior studies find that the average proportion of independent directors is one third, just meeting the CSRC requirement, and that they have no obvious governance role in China. Hence, given this institutional background, this paper only investigates independent director networks and their economic consequences.

Among the various mechanisms designed to prevent controlling shareholders from tunneling in China, governance by independent directors has been one of the key measures since it was introduced for A-shares in

[1] For example, I1, I2 and I3 are three independent directors. I1 and I2 do not serve on the same board, so there is no direct connection between them; however, when I1 and I3 both serve on the board of Company B, and I2 and I3 both serve on the board of Company C, then I1 and I2 are indirectly connected by I3.

[2] The word "tunneling" was proposed by Johnson et al. (2000) to describe the behavior of company controllers transferring the company's assets and profits to further their own interests.

[3] Under certain circumstances, controlling shareholders prop up listed companies. For example, Jian and Wong (2010) find that controlling shareholders prop up listed companies through abnormal related party transactions to reach refinancing standards or avoid delisting. However, they also point out that such propping behavior is accompanied by controlling shareholders transferring listed company funds in the next period.

[4] Based on CSRC data on penalties imposed on controlling shareholders for using listed company funds from 2007 to the end of 2010, we find that such penalties were imposed in relation to 30 listed companies (involving 80 year-observations). During this period, the number of penalty observations for the use of company funds by large shareholders was still 38 in years after 2007, accounting for 23% of all such observations between 2000 and 2010.

2001. Independent directors of companies listed on the Chinese capital market have special powers in the supervision of "significant related party transactions and related financial problems," one of six regulatory requirements. Thus, independent directors must monitor and issue independent opinions on significant related party transactions and the use of related funds. While no clear conclusion can be drawn from existing empirical evidence on the governance role of independent directors (Gao et al., 2006; Ye et al., 2007), this paper adopts a board network perspective to provide detailed new evidence on the role of independent directors in curbing tunneling behavior by controlling shareholders. Using various measures for the use of controlling shareholders' funds, the empirical results show that the higher the degree of network centrality among independent directors, the smaller the extent to which controlling shareholders use shareholders' funds, especially when the use of non-operating funds is used as the tunneling measure. These empirical results imply that the network centrality of independent directors promotes their governance role in deterring tunneling by controlling shareholders. In other words, board networks can contribute to the governance practices of independent directors and reduce Type II agency problems (problems between large shareholders and minority shareholders). This paper differs from studies focusing on the role of director networks in the United States. For example, Hwang and Kim (2009) find that independent directors who have social networks with the firm lose their independence. Fracassi and Tate (2012) find that internally prompted earnings restatements and value-decreasing M&A activities occur in firms with more extensive relations among their directors.

The remainder of this paper is organized as follows. Following a review of the literature in Sections 2 and 3 analyzes the institutional background and develops our hypothesis. Section 4 describes the research design. Section 5 provides the empirical analysis and Section 6 concludes the paper.

2. Literature review

As the first researchers to use the word "tunneling" to describe the misuse of company funds by controlling shareholders, Johnson et al. (2000) list several methods by which it is achieved: transferring growth opportunities belonging to listed company to themselves or their subsidiaries; transferring profits via intra-group transactions from listed companies to other subsidiaries they own or control; using assets or capital belonging to the listed company or using them as collateral or guarantees for their financing activities; and capital operations aimed at diluting the interests of other shareholders. Friedman et al. (2003) propose a model showing how large shareholders tunnel or prop listed companies in different financial positions. Meanwhile, companies with a pyramid ownership structure are more likely to be tunneled, but are more likely to be propped when facing adverse shocks.

In the Chinese capital market, Yu and Xia (2004) find that related party transactions are significantly more prevalent in companies with controlling shareholders. Li et al. (2004) finds that the use of listed company funds by controlling shareholders exhibits an inverted U-shaped nonlinear relationship with the proportion of equity held by the largest shareholders. Wang and Xiao (2005) find that the use of funds by the 10 largest shareholders for related party transactions is significantly less common in listed companies with institutional investors and that an increase in the stake held by institutional investors is significantly negatively related to the extent of funds used by related parties in listed companies. Chen and Wang (2005) find that the value of related party transactions is significantly positively related to ownership concentration and that increasing the number of controlling shareholders holding more than 10% reduces both the probability of related party transactions occurring and the value of such transactions. Jiang and Yue (2005) find a negative relationship between the use of funds by large shareholders and future profitability in listed companies, and show that the use of funds by large shareholders has a negative effect on the company. Gao et al. (2006) conclude that tunneling by controlling shareholders is exacerbated by ownership concentration and business group control, but is inhibited by managerial ownership and fund holdings, information disclosure transparency, investor protection and product market competition. Luo and Tang (2007) observe that the less the regional government intervenes in the market and the more developed are financial markets, the lower the probability of tunneling by controlling shareholders in listed companies in the region. Ju and Pan (2010) find that listed firms that are smaller, have higher leverage or lower operating margins, or in which non-operating profit accounts for a larger proportion of total profit are more likely to engage in related party transactions. Du et al. (2010) find that high-quality auditing can significantly inhibit the use of company funds by large shareholders of listed companies, but that

companies with more serious cases of funds being used by large shareholders may not choose to have high-quality audits performed. Jiang et al. (2010) examine other receivables in Chinese listed companies to examine the nature, content and economic consequences of controlling shareholder behavior. Jian and Wong (2010) point out that abnormal related sales are one means of propping used by the controlling shareholders of listed companies, and that it is more prevalent in state-owned listed companies and regions with a poor institutional environment. They also show that abnormal related party transactions take place in conjunction with the next phase of associated lending for cash transfers among controlling shareholders. Using Chinese data to verify the model of Friedman et al. (2003), Peng et al. (2010) find that in financially healthy (financially distressed) listed firms, controlling shareholders are more likely to tunnel (prop) the firm through related party transactions, and that the market reacts negatively (positively) to such transactions. They also find that all types of related party transactions can be used as a means of tunneling or propping. Wang and Xiao (2011) investigate the relationship between the tunneling behavior of listed company controlling shareholders and executive compensation incentives in China, and find that tunneling by controlling shareholders reduces executives' pay-for-performance sensitivity. This implies that controlling shareholders lower the incentives in the relationship between managerial pay and performance for their own interests.

Prior studies have examined the relationship between the supervision of independent directors and related party transactions or company fund use by listed company controlling shareholders. Among these studies, Tang et al. (2005) find that independent directors play a governance role in suppressing channel excavation by large shareholders through related party transactions, such as the use of company funds, asset sales and security and cash dividends, but that these effects are not obvious. In contrast, Gao et al. (2006) find that independent directors have no monitoring effect on tunneling behavior by controlling shareholders. After controlling for the endogeneity of independent directors, Ye et al. (2007) find that increasing the number and proportion of independent directors may deter controlling shareholders from using company funds. Huang and Pan (2010) find that the professionalism of independent directors has a significant monitoring effect on related party transactions between controlling shareholders and listed companies. They also demonstrate that independent director compensation is significantly positively related to the frequency of related party transactions between controlling shareholders and listed companies, but that the proportion of independent directors has no significant effect on such transactions.

Although the literature has yet to explore the relationship between social networking among corporate boards and the tunneling behavior of controlling shareholders, some recent studies examine the nexus between board social networks and corporate finance. Hochberg et al. (2007) find that venture capital companies with more network relationships perform better in the follow-up financing and exit stages. Kuhnen (2009) shows that mutual fund directors and fund administration consulting firms prioritize appointing each other based on the degree of contact they have had in the past, but that such strong director-consultant links do not lead to better or worse consequences. Based on a sample of 29,637 firm observations in the United States from 2000 to 2007, Larcker et al. (2013) find that firms with more central director positions earn higher stock returns. They measure centrality by the number of directors common to two companies. If a portfolio is constructed by buying stocks of firms with a central position in a board network and selling stocks of those without, an average annual excess return of 4.68% can be obtained. Their results show that the board of director network is a signal of economic benefits not immediately reflected in stock prices. In the Chinese capital market, Chen and Xie (2011, 2012) investigate the relationship between the board network of independent directors of listed companies and investment efficiency or executive incentives.

In sum, findings on the effect of independent director governance on the tunneling behavior of controlling shareholders are not conclusive. This paper provides further empirical evidence on this question from the board network perspective.

3. Background and hypothesis development

3.1. Independent directors and tunneling by controlling shareholders

In firms with concentrated ownership, controlling shareholders can rely on their controlling capacity to gain private benefits via various types of transactions with the firm (e.g., selling assets, commodities or services

to the firm at a high price or acquiring assets at a low price). This can occur more frequently in countries with an inefficient legal environment and weak corporate governance (Shleifer and Vishny, 1997). In the emerging and transitional market of China, most firms are controlled by large shareholders. The concentration of ownership among Chinese firms means that Type II agency problems (between controlling and minority shareholders) are more prevalent and tunneling is one of the most direct ways in which controlling shareholders misuse company assets at the expense of minority shareholders. Controlling shareholders use various methods to tunnel listed firms, such as related party transactions and the use of company funds, the latter of which is the most visible and serious means of tunneling in the Chinese capital market (Jiang et al., 2010; Wang and Xiao, 2011).

Because the primary objective of the Chinese capital market is to broaden the financing channels of SOEs, most of the listed companies are SOEs controlled by the government and its affiliated bodies. The non-tradable shares problem these shareholders face further strengthens their tunneling motivation (Jiang and Yue, 2005).[5] Moreover, weak investor protection and penalties for violations provide additional impetus for tunneling behavior. From 2003 to 2006, regulators implemented penalties for tunneling behavior by controlling shareholders. For example, on August 28, 2003, the CSRC and the State-Owned Assets Supervision and Administration Commission of the State Council (SASAC) jointly announced the "normalization of external guarantees between listed companies and related parties," and specified the method by which tunneling would be prevented among related shareholders. On July 27, 2004, the CSRC and the SASAC issued a policy relating to debt-equity swaps involving controlling shareholders to use this method to solve the tunneling problem. In June 2005, the CSRC required listed companies to resolve their cash occupation problems by the end of the year. On November 7, 2006, eight councils of the Chinese government jointly issued the "announcement on cleaning up the use of listed company cash by controlling shareholders," and also required that a continuing policy be established. Though regulators have issued various policies to prohibit tunneling behavior, the governance effect of these measures is not clear. An interesting phenomenon is that while the CSRC has penalized many firms, firms' controlling shareholders act in their own way through more implicit methods. From 2007 to 2010, 38 firms were sanctioned for the illegal use of cash. Tunneling by controlling shareholders remains a major problem in the Chinese capital market (Jiang et al., 2010).

Among various corporate government mechanisms, the independent director policy is aimed at monitoring controlling shareholders and protecting investors' interests. On August 16, 2001, the CSRC issued the "announcement on implementing the independent director policy in listed companies" and endowed independent directors with six special powers, the first one being that major related party transactions must be approved by independent directors before being submitted to the board for discussion. In addition, independent directors were required to express their own views on whether loans or cash transferred to listed companies' shareholders, ultimate controllers and related parties amount to more than 5% of total assets. On August 28, 2003, the announcement on the normalization of external guarantees between listed companies and related parties required independent directors to express their own views on the firm's guarantees. All of the foregoing policies provide independent directors with more powers to prevent tunneling behavior by controlling shareholders in China. The 2004 Annual Report of the Shanghai Stock Exchange shows that nearly 80% of independent directors considered their role were limited to related party transactions and the use of company funds.[6] However, evidence on their success in fulfilling this role is mixed. Gao et al. (2006) and Huang and Pan (2010) find that independent directors have no effect on tunneling behavior by controlling shareholders, whereas Tang et al. (2005) and Ye et al. (2007) find that they have a positive effect. As the proportion of independent directors in most firms is about 33%, which just meets the CSRC requirement, their monitoring role could not be distinguished because of the small degree of variance in the data. Thus, research on the network characteristics of independent directors is more important in China.

[5] Xu (2009) finds that although the non-tradable share reform has reduced this problem, Type II agency problems haven't been entirely resolved.

[6] For details, see the 2004 Corporate Governance Report on Chinese Companies: Independence and Efficiency of Board Directors, Research Centre of Shanghai Stock Exchange, Fudan University Press.

3.2. Board networks, governance role of independent directors and tunneling

We follow Xie and Chen (2012) by defining a board network as directors' connection sets based on direct ties established when serving on at least one common board. From the sociology perspective, network relationships can be expressed as a structure comprising nodes and connections. Thus, in a board network, the nodes can be seen as the directors and the connections can be seen as the relationships among the directors. If two directors serve on at least one common board, they are jointly related and directly connected. The set of direct and indirect connections forms a board network (Larcker et al., 2013). Based on this definition of a network and on the measurable characteristics of networks, their nature and network data, we define a board network as the relationships among board members, which is different from other social relations such as school ties, club relations and kinship. We consider that this type of network is more suitable for empirical study than others, because weak tie theory and structural hole theory in the social network field imply that independent directors, rather than inside directors, play the key role in board networks. Thus, we focus on networks among independent directors in this paper.

Fig. 1 illustrates the board network of three listed firms (Xie and Chen, 2012). The figure shows that independent director O1 will certainly be influenced by his own attributes when making corporate governance decisions. For example, as an accounting professor, he will be an expert in the financial disclosure field. Meanwhile, because independent director O2 has the same background as O1, they may have the same corporate governance effect according to prior research (assuming their other attributes are the same). Independent director I11 in firm A has a legal background, and inside director I33 in firm C is an industry expert (we assume that firms B and C are in the same industry). Therefore, O1 can gain information and professional knowledge about the law and the industry when communicating with I11 and I33 respectively. However, O2 cannot obtain similar information and knowledge because he serves on the board of firm B. Hence, in firm B, O1 has a more significant effect on corporate governance than O2 because of the embeddedness of the board network. This is the logic of board networks.

We consider that the governance role of directors can be influenced by their board network and that the embeddedness of networks can mediate both over-socialization and under-socialization (Granovetter, 1985). On the one hand, network embeddedness can maintain individual directors' independence and help them make decisions based on their professional background and preferences. On the other hand, the network view shows that directors' governance and decision behavior can evolve into a dynamic and interactive process. Directors in a network can exchange information and obtain specific knowledge from each other to improve the efficiency of governance. Therefore, director behavior is embedded in their social networks.

People's positions in the social structure and social connections can influence their ability to gain information and resources, which in turn influences their economic actions (Luo, 2010). The network centrality of independent directors means that they play an active and important role in the overall board network, through which they can gain more information and broaden their knowledge. Differences in network positions can influence independent directors' reputational incentives and ability to exercise independence. First, the network positions of directors are an important channel by which they can build a reputation (Freeman, 1979). Sitting in the middle of the entire board network, independent directors can obtain more governance information and knowledge, strengthen their influence on the board, and gradually accumulate a reputation for corporate governance, and may eventually be more likely to secure additional board seats.[7] All of these can be described as the expert reputation the board network provides.[8] Second, Lin (2002) considers that network-based prestige has a "symbolic effect"; even if actors cannot gain the resources embedded in the social

[7] Cashman et al. (2010) find that if board network centrality increases, the probability of securing additional board seats in the future is greater.

[8] Although Fich and Shivdasani (2006) and Andres and Lehman (2010) find that interlocking relationships among directors may reduce their corporate governance effect, Fama (1980) and Fama and Jensen (1983) demonstrate that the external market for directors is the channel by which independent directors build their reputation (we refer to this as the reputation capital perspective). In addition, more academic evidence shows that interlocking directorships can increase the corporate governance effect. Many studies use the number of seats a director has as an indicator of their reputation in the external labor market (Tan et al., 2010; Ye et al., 2011).

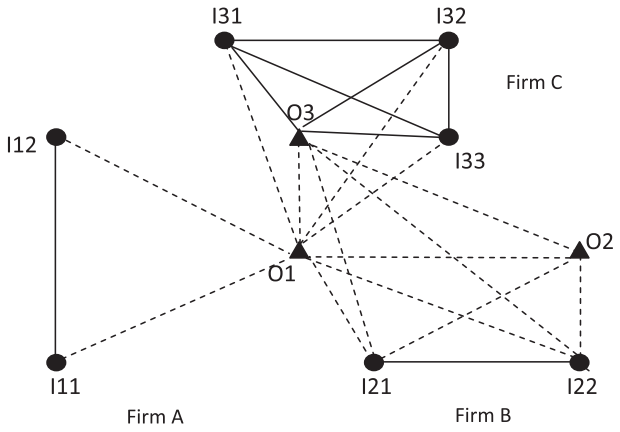

Figure 1. Sample board network.

network, they can be seen as having these resources, which other people view as a symbol. Hence, the more central the independent director's network position, the more prestige he gains. Third, if an independent director's position is central, a virtual group can be formed around him, and most members of this group are elite members of society, which is called an elite circle (Davis et al., 2003; Nguyen, 2009). Wang (2007) finds that there is mutual recognition among members of the elite group.[9] The greater the network centrality of independent directors, the more attention they will pay to others' recognition and the more time they will spend making corporate governance decisions. In contrast, if directors with central positions in the network cannot prevent tunneling behavior, the "outrage cost" from media and the public could be extremely large and their reputation within the network will be damaged, a possibility that independent directors should take seriously. In sum, the expert reputation, social prestige and recognition of the elite group can make independent directors who attain a central position in the network more sensitive to their reputation, and can give them more of an incentive and greater pressure to make decisions to prevent tunneling behavior by controlling shareholders.

Moreover, as independent directors with a more central position do not worry about their future board seats (Cashman et al., 2010), they have greater bargaining power with controlling shareholders, and have more opportunities to make independent decisions to restrict the tunneling behavior of controlling shareholders, such as related party transactions or the use of company funds. Furthermore, public pressure may force controlling shareholders to change their tunneling methods in a more implicit way. Because the ability of directors to collect information can be differentiated by the different network positions they occupy, independent directors in a central network position can gain more specific knowledge of how to detect implicit tunneling behavior than those in non-central positions. Hence, the "learning effect" indicates that independent directors with more central positions are more likely to become aware of and prevent tunneling by controlling shareholders. We thus hypothesize as follows:

Where the network centrality of independent directors in the firm is greater, tunneling by controlling shareholders is less likely to occur and is likely to be less prevalent.

4. Research design

4.1. Measurement of board network centrality

In sociology, network centrality is used to measure different degrees of involvement in a social network (Freeman, 1979; Wasserman and Faust, 1994). We follow the sociology literature by using network centrality

[9] Zhou (2010) finds that in China, relationships between people have changed from those based on traditional relation-based trust represented by "differential patterns" to those characterized by relation-based recognition as represented by "colleagues, friends and 'friends of friends'".

as a measure representing independent directors' network positions and connections in the whole board network.[10] There are four basic network centrality measures: degree centrality, betweenness centrality, closeness centrality and eigenvector centrality (see Appendix A for more details). Wasserman and Faust (1994) point out that as each specific centrality measure has its own advantages and disadvantages, researchers should not use only one measure and ignore the others. For the degree of network centrality, if a director's degree of centrality is small, his position isolates him from other directors in the board network and weakens his participation in ongoing communication. Betweenness centrality gauges the ability of a director to gain information from the network with initiative, speed and accuracy. Closeness centrality represents how independently and accurately a director obtains information. That is, if the director does not occupy a central position in the network, then he must rely on others to obtain information, which reduces its timeliness and accuracy. Eigenvector centrality, a recursive measure of degree centrality, represents the quality of connections. In sum, degree centrality focuses on participation in communication, betweenness centrality on control and initiative in communication, closeness centrality on independence and effectiveness of communication, and eigenvector centrality on quality of communication. We draw on these concepts to construct a new and more comprehensive integrated measure of network centrality (Wasserman and Faust, 1994; Larcker et al., 2013).

Specifically, we collect information on all directors of A-share listed firms and arrange them in matrix form. We first calculate the four network centrality measures for each director for completeness of measurement, then focus exclusively on independent director networks. To construct a firm-level network measure, we compute the median and mean values of the network centrality of a firm's independent directors to estimate the firm's network centrality. In robustness tests, we also use the maximum and minimum values (Schonlau and Singh, 2009; Larcker et al., 2013). We have two reasons for doing so: first, the median value represents the typical centrality of the independent directors' network; and second, one independent director's influence is more representative than that of others. In line with Larcker et al. (2013), to reduce the influence of different dimensions and outliers, we rank the network centrality measures in 10 groups (labeled 0–9) for every year, then take the mean value as the measure of the firm's network centrality (score_median, score_max).

4.2. Measurement of tunneling by controlling shareholders

We use the amount of funds used by controlling shareholders for related party transactions as a proxy for tunneling behavior. Controlling shareholders make two types of loans to listed companies. Operating loans generated by normal related party transactions such as accounts receivable and other receivables beyond normal transactions, such as the use of non-operating funds. The latter type is the key supervisory target of CSRC regulations (Ye et al., 2007; Zeng and Chen, 2009). Thus, we use other receivables held by the largest shareholder and its affiliated firms as a proxy for tunneling behavior (TUN). Peng et al. (2010) find that controlling shareholders use all types of related party transactions for tunneling, two of which are used in this paper: the use of operating funds (ABNTUN) and the use of non-operating funds (NMTUN). However, the use of non-operating funds by controlling shareholders is adopted as the main measure in this paper. Gao et al. (2006) and Zeng and Chen (2009) find that listed firms also use funds from their controlling shareholders. Hence, we also use the net use of funds in robustness tests (ΔTUN, ΔABNTUN, ΔNMTUN). The specific definitions of the variables are listed in Table 1.

4.3. Model and variables

The model used to test the relationship between the network centrality of independent directors and tunneling by controlling shareholders is as follows:

$$Tunnel_t = \alpha_0 + \alpha_1 CEN_t + \sum Controls + \sum IND + \sum Year + \varepsilon \quad (1)$$

[10] Hochberg et al. (2007), Crespi and Fuster (2009), Barnea and Guedj (2009), Horton et al. (2009), Schonlau and Singh (2009), Farina (2009), Andres and Lehman (2010), Chuluun et al. (2010), Cashman et al. (2010), Liu (2010) and Larcker et al. (2013) use similar network measures in the finance and accounting literature. However, most of them use one or several specific measures; only Larcker et al. (2013) use a comprehensive measure.

Table 1
Variable definitions.

Name	Symbol	Definition
Controlling shareholders' tunneling	TUN	Sum of accounts receivable, account prepayments and other receivables held by controlling shareholders, scaled by total assets
	ABNTUN	Other receivables held by controlling shareholders, scaled by total assets
	NMTUN	Sum of accounts receivable and account prepayments held by controlling shareholders, scaled by total assets; equals (TUN − ABNTUN)
	ΔTUN	(accounts receivable + accounts prepayments + other receivables − accounts payable − receivables in advance − other payables) held by controlling shareholders, scaled by total assets
	ΔABNTUN	Other receivables held by controlling shareholders minus other payables held by the listed firm, scaled by total assets
	ΔNMTUN	ΔTUN − ΔABNTUN
Network centrality of independent directors	CEN	The integrated network centrality of independent directors at the firm level (score_median and score _max)
Ultimate controller's ownership	SOE	An indicator variable that takes the value of 1 if the firm is state-owned and 0 otherwise
Concentration of ownership	FSHR	The ratio of shares held by the largest shareholder divided by the total number of shares outstanding at the end of the year
Equity restriction	HFD	The proportion representing the combined ownership stakes of the second to fifth largest shareholders at the end of the year
Separation of ownership and control	CO	The proportion of control rights and cash flow rights held by the ultimate controller. See Claessens et al. (2000) for the calculation process
Firm group	GROUP	An indicator variable that takes the value of 0 if the firm's ultimate controller is an individual, the SASAC, a university, a social organization, a research institution, an ESOP association or an investment corporation, and 1 otherwise (Li et al., 2004; Tang et al., 2005)
Performance	ROE	Net income scaled by equity at the end of the year
Size	SIZE	The natural logarithm of total assets at the end of the year
Leverage	LEV	Total liabilities divided by total assets
Market environment	MKT	A dummy variable equal to 1 if the index of the market environment is above the median and 0 otherwise. See Fan et al. (2010) for index details
Non-tradable shares reform	GG	An indicator variable that takes the value of 1 if the firm's non-tradable reform process is successful and 0 otherwise
Board size	BOARD	The number of board directors
Duality	DUAL	An indicator variable that takes the value of 1 if the board chairman and CEO are the same person and 0 otherwise
Proportion of independent directors	OUT	The proportion of independent directors on the board in the current year
Industry/year	IND/YEAR	The industry dummies are based on CSRC benchmarks (2001) and six year dummies

Table 1 defines all of the variables in our model. $Tunnel_t$ is the dependent variable, which is represented by the fund use measures: TUN, ABNTUN and NMTUN. In robustness tests, we also use ΔTUN, ΔABNTUN and ΔNMTUN as additional measures. CEN_t is the explanatory variable. We predict that α_1 is negative, that is, the greater the network centrality of the independent directors, the greater their monitoring effect and the less prevalent tunneling is by controlling shareholders. We run a Tobit regression for TUN/ABNTUN/NMTUN/ΔTUN/ΔABNTUN/ΔNMTUN to account for the significant number of zero observations.

Similar to those of Jiang et al. (2010), Jian and Wong (2010) and Ye et al. (2007), our control variables include the ultimate controller's ownership (SOE), the proportion of the firm's equity owned by the largest shareholder (FSHR), the sum of the ownership stakes of the second to fifth largest shareholders (HFD), separation of the ownership and control rights of the ultimate controlling shareholder (CO), whether the listed firm is part of a group (GROUP), firm performance (ROE) and the market environment (MKT). Given the finding of Zhang et al. (2010) that the largest shareholder's role changed after the non-tradable share reform was implemented, we control for this phenomenon (GG). As there was a focus on cleaning up the misuse of funds at about the same time as the non-tradable share reform, the GG variable also controls for regulatory policy. We also control for variables influencing the governance role of independent directors such as

Table 2
Descriptive statistics.

Variables	Obs.	Mean	Median	Max	Min	STD
TUN	7572	0.0213	0.0008	0.5138	0.0000	0.0659
ABNTUN	6714	0.0115	0.0000	0.4347	0.0000	0.0517
NMTUN	6714	0.0102	0.0001	0.2077	0.0000	0.0295
score_median	9757	3.4861	3.0000	9.0000	0.0000	2.7506
score_max	9757	4.0323	4.0000	9.0000	0.0000	2.8066
SOE	9757	0.6141	1.0000	1.0000	0.0000	0.4868
FSHR	9757	0.3830	0.3608	0.7584	0.0923	0.1603
HFD	9757	0.0193	0.0073	0.1160	0.0000	0.0259
CO	9757	1.5013	1.0000	6.6051	1.0000	0.9819
GROUP	9757	0.1698	0.0000	1.0000	0.0000	0.3755
ROE	9434	0.0520	0.0694	0.4325	−1.2033	0.2019
SIZE	9754	21.3576	21.2416	25.0182	18.7185	1.1797
LEV	9754	0.5303	0.5132	1.9083	0.0728	0.2773
MKT	9757	0.7483	1.0000	1.0000	0.0000	0.4340
GG	8247	0.4422	0.0000	1.0000	0.0000	0.4967
BOARD	9642	9.4105	9.0000	17.0000	5.0000	2.0450
DUAL	9757	0.1444	0.0000	1.0000	0.0000	0.3515
OUT	9639	0.3522	0.3333	0.5000	0.0000	0.0495

board size (BOARD), duality (DUAL) and the proportion of independent directors (OUT). We also adopt other common control variables such as firm size (SIZE), leverage (LEV) and industry (IND) and year (YEAR) dummy variables.

4.4. Sample and data

We start with observations for all Chinese A-share listed firms from 2003 to 2009. Financial industries are removed from the original dataset. The removal of items with missing data substantially reduces the number of observations, yielding a final sample comprising 9757 firm-year observations. All of the data are from the CSMAR database, among which the data on controlling shareholders' use of funds for related party transactions are from the "cash transfers for related party transactions" CSMAR sub-database. All observations in the top and bottom 1% for continuous variables are winsorized to control for outliers, and *t*-values are clustered at the firm level. The Matlab and Pajek software applications (the most widely recognized software for analyzing large amounts of social network data) are used to calculate directors' network centrality.

5. Empirical analysis

5.1. Descriptive statistics and correlation analysis

Table 2 lists the descriptive statistics of all variables. The results show that controlling shareholders' tunneling of operating funds (TUN) has a mean of 2.13% and a maximum of 51.38%. The mean and maximum for tunneling of non-operating funds (ABNTUN) are 1.15% and 43.47%, respectively. These results imply that tunneling is a serious problem among controlling shareholders in China. The means of score_median and score_max are 3.49 and 4.03, respectively. The mean of FSHR is 38% and the median is 36.08%, indicating a need to improve the monitoring incentives and tunneling suppression capacity of independent directors in Chinese firms with highly concentrated ownership. The mean and median of OUT are 35.22% and 33.33%, respectively, implying that the proportion of independent directors in most listed firms meets or just exceeds the CSRC requirement.

Table 3 lists the correlations among the main variables.[11] There are negative correlations between score_median, score_max and all proxies for tunneling by controlling shareholders, especially TUN and ABNTUN.

[11] Due to the length of this paper, the correlation values of the control variables are not reported.

Table 3
Correlation matrix.

	score_median	score_max	TUN	ΔTUN	ABNTUN	ΔABNTUN	NMTUN	ΔNMTUN
score_median		0.828***	−0.006*	−0.04***	−0.034***	−0.025**	−0.045	−0.022*
score_max	0.850***		−0.015**	−0.039***	−0.045***	−0.021*	−0.044	−0.024**
TUN	−0.057***	−0.071***		0.807***	0.844***	0.651***	0.607***	0.545***
ΔTUN	−0.045***	−0.049***	0.532***		0.716***	0.889***	0.445***	0.526***
ABNTUN	−0.063***	−0.074***	0.648***	0.391***		0.779***	0.144***	0.144***
ΔABNTUN	−0.04***	−0.037***	0.296***	0.722***	0.472***		0.099***	0.127***
NMTUN	−0.019	−0.036***	0.788***	0.331***	0.25***	0.026**		0.87***
ΔNMTUN	−0.029**	−0.044***	0.461***	0.603***	0.132***	0.108***	0.532***	

Note: Spearman correlations are listed in the upper right of this table and Pearson correlations in the lower left.
* Significance at the 10% level.
** Significance at the 5% level.
*** Significance at the 1% level.

Neither the Spearman nor the Pearson coefficients of NMTUN, score_median and score_max are significant. Although there are generally negative correlations between the network centrality of independent directors and tunneling by controlling shareholders, this relationship does not exist when measured by the use of operating funds. The correlation matrix, however, merely shows the univariate results. Multivariate tests are needed to obtain more meaningful empirical findings. The correlations of the non-listed variables are no higher than 0.5, thus indicating that multicollinearity is not a serious problem in this study.

5.2. Multivariate regression analysis

Table 4 lists the main regression results and shows that when the dependent variable is TUN, the coefficient on score_median is negative and marginally significant (t-value of −1.58) and the coefficient on score_max is significantly negative at the 5% level. When the dependent variable is ABNTUN, the coefficients on both score_median and score_max are significantly negative. However, when the dependent variable is NMTUN, the coefficients on score_median and score_max are insignificant. These results imply that controlling shareholders are more likely to tunnel by using non-operating funds than by appropriating operating funds and that the effect of independent director network centrality is mainly reflected in the use of non-operating funds. Thus, the empirical results reported above show that the greater the network centrality of independent directors, the less pervasive tunneling is by controlling shareholders. Our prediction is thus supported, showing that the board networks of independent directors have the effect of suppressing tunneling by controlling shareholders. These empirical results demonstrate that studying independent director networks is more meaningful than merely testing the ratio of independent directors on each board.

Among the control variables, the coefficients on SOE are significantly positive at the 1% level, thus indicating that tunneling is more likely to occur in SOEs, which is similar to the finding of Gao et al. (2006). The coefficients on FSHR are significantly positive at the 1% level, implying that the larger the ownership stake of the largest shareholder, the more serious tunneling is likely to be, thus corroborating the findings of Yu and Xia (2004) and Li et al. (2004). MKT is significantly negatively related to all of the dependent variables, other than ABNTUN, thus showing that tunneling by controlling shareholders is weaker under better market environments, a result confirming that of Luo and Tang (2006). GG is significantly negatively related to tunneling, thus demonstrating that the incentive for tunneling diminished as shares owned by controlling shareholders became tradable after the non-tradable share reform.

5.3. Robustness tests[12]

When testing for tunneling by controlling shareholders, the transfer of funds from controlling shareholders to the listed company must also be considered (Gao et al., 2006; Zeng and Chen, 2009). Therefore, the first

[12] Results not reported here can be provided to interested readers.

Table 4
Multivariate results for independent director network centrality and tunneling.

	TUN		ABNTUN		NMTUN	
	score_median	score_max	score_median	score_max	score_median	score_max
CEN	−0.0006	−0.0008**	−0.0009**	−0.0010***	0.0001	−0.0001
	(−1.58)	(−2.46)	(−2.55)	(−3.03)	(0.59)	(−0.49)
SOE	0.0101***	0.0107***	0.0069***	0.0069***	0.0072***	0.0072***
	(5.21)	(5.45)	(3.38)	(3.40)	(5.39)	(5.45)
FSHR	0.0536***	0.0485***	0.0286***	0.0285***	0.0360***	0.0358***
	(9.40)	(8.36)	(4.79)	(4.77)	(9.19)	(9.16)
HFD	0.0200	0.0123	−0.0075	−0.0095	0.0292	0.0284
	(0.59)	(0.36)	(−0.22)	(−0.27)	(1.28)	(1.24)
CO	0.0003	−0.0001	−0.0007	−0.0007	−0.0002	−0.0001
	(0.32)	(−0.10)	(−0.62)	(−0.62)	(−0.23)	(−0.21)
GROUP	0.0037*	0.0027	0.0001	0.0001	0.0005	0.0005
	(1.84)	(1.25)	(0.04)	(0.03)	(0.36)	(0.35)
ROE	−0.0629***	−0.0645***	−0.0682***	−0.0681***	−0.0117***	−0.0116***
	(−12.53)	(−12.69)	(−13.59)	(−13.56)	(−3.41)	(−3.36)
SIZE	−0.0017**	−0.0003	0.0014	0.0014	0.0007	0.0008
	(−2.00)	(−0.35)	(1.49)	(1.52)	(1.16)	(1.29)
LEV	0.0118***	0.0088*	0.0130***	0.0130***	−0.0043	−0.0044
	(2.66)	(1.92)	(2.78)	(2.79)	(−1.42)	(−1.43)
MKT	−0.0044**	−0.0047***	0.0010	0.0011	−0.0049***	−0.0047***
	(−2.56)	(−2.72)	(0.58)	(0.61)	(−4.20)	(−4.07)
GG	−0.0109***	−0.0064*	−0.0047	−0.0046	−0.0014	−0.0014
	(−5.06)	(−1.72)	(−1.18)	(−1.15)	(−0.56)	(−0.57)
BOARD	−0.0009**	−0.0008*	−0.0016***	−0.0016***	0.0001	0.0002
	(−2.26)	(−1.82)	(−3.79)	(−3.64)	(0.49)	(0.66)
DUAL	−0.0031	−0.0026	0.0019	0.0018	−0.0052***	−0.0052***
	(−1.30)	(−1.08)	(0.77)	(0.74)	(−3.17)	(−3.19)
OUT	−0.0721***	−0.0654***	−0.0584***	−0.0545***	−0.0368***	−0.0363***
	(−4.12)	(−3.71)	(−3.29)	(−3.06)	(−3.14)	(−3.09)
Constant	0.0502***	0.0172	−0.0132	−0.0153	−0.0328***	−0.0340***
	(2.83)	(0.93)	(−0.69)	(−0.81)	(−2.65)	(−2.74)
IND/YEAR	√	√	√	√	√	√
Pseudo R^2 (R^2)	0.061	0.079	0.211	0.212	0.058	0.058
LR chi2 (F-Value)	565.9	729.24	790.29	792.94	525.94	525.84
Obs.	6305	6259	5609	5609	5609	5609

Note: t-values are reported in brackets.
* Significance at the 10% level.
** Significance at the 5% level.
*** Significance at the 1% level.

robustness test measures the net balance of tunneling by controlling shareholders. Since Gao et al. (2006) find that there are two types of incentives for related party transactions, tunneling and propping, we exclude propping firms from our sample. We delete observations with negative values for ΔTUN, ΔABNTUN and ΔNMTUN and rerun the regressions.[13] The results are reported in Table 5, which shows that the network centrality of independent directors is significantly negatively related to tunneling by controlling shareholders and that this holds for both total tunneling (ΔTUN) and the use of non-operating funds (ΔABNTUN). Tunneling by using non-operating funds (ΔNMTUN) is, however, insignificantly related to network centrality, reflecting the main results in Table 4. Because controlling shareholders tunnel listed firms mainly by using company funds in related party transactions and independent directors have difficulty recognizing whether operating transactions constitute tunneling behavior, as do investors (Ye et al., 2007), most of the effect of independent directors in suppressing tunneling by controlling shareholders is reflected in the use of non-operating funds.

[13] The results do not change if these observations are not deleted from the sample.

Table 5
Results for the net value of tunneling and independent director network centrality.

	ΔTUN		ΔABNTUN		ΔNMTUN	
	score_median	score_max	score_median	score_max	score_median	score_max
CEN	−0.0010*	−0.0014***	−0.0012**	−0.0013***	0.0002	−0.0000
	(−1.86)	(−2.98)	(−2.17)	(−2.58)	(0.62)	(−0.05)
SOE	0.0097***	0.0098***	0.0124***	0.0125***	0.0053***	0.0053***
	(3.46)	(3.50)	(4.02)	(4.05)	(3.29)	(3.33)
FSHR	0.0255***	0.0251***	0.0022	0.0020	0.0282***	0.0281***
	(3.07)	(3.04)	(0.25)	(0.22)	(5.96)	(5.93)
HFD	−0.0195	−0.0232	−0.0450	−0.0481	0.0065	0.0060
	(−0.40)	(−0.48)	(−0.87)	(−0.94)	(0.23)	(0.22)
CO	0.0001	0.0001	−0.0007	−0.0007	0.0001	0.0001
	(0.06)	(0.08)	(−0.45)	(−0.45)	(0.11)	(0.12)
GROUP	0.0023	0.0022	0.0029	0.0028	−0.0004	−0.0004
	(0.75)	(0.74)	(0.91)	(0.90)	(−0.24)	(−0.24)
ROE	−0.0900***	−0.0895***	−0.0919***	−0.0916***	−0.0155***	−0.0154***
	(−12.54)	(−12.48)	(−12.51)	(−12.48)	(−3.76)	(−3.73)
SIZE	−0.0015	−0.0013	−0.0003	−0.0003	−0.0013*	−0.0012*
	(−1.14)	(−1.02)	(−0.22)	(−0.20)	(−1.73)	(−1.65)
LEV	−0.0104	−0.0105	0.0042	0.0042	−0.0074**	−0.0074**
	(−1.57)	(−1.59)	(0.59)	(0.60)	(−1.99)	(−2.00)
MKT	−0.0048*	−0.0045*	0.0023	0.0024	−0.0039***	−0.0038***
	(−1.93)	(−1.84)	(0.85)	(0.89)	(−2.79)	(−2.70)
GG	−0.0081	−0.0080	−0.0119*	−0.0118*	−0.0014	−0.0015
	(−1.48)	(−1.47)	(−1.88)	(−1.86)	(−0.48)	(−0.49)
BOARD	−0.0016***	−0.0015**	−0.0022***	−0.0021***	−0.0001	−0.0000
	(−2.65)	(−2.40)	(−3.48)	(−3.34)	(−0.23)	(−0.13)
DUAL	−0.0019	−0.0020	0.0016	0.0015	−0.0047**	−0.0048**
	(−0.56)	(−0.57)	(0.45)	(0.42)	(−2.40)	(−2.41)
OUT	−0.0837***	−0.0778***	−0.0738***	−0.0686***	−0.0394***	−0.0394***
	(−3.35)	(−3.11)	(−2.83)	(−2.62)	(−2.79)	(−2.78)
Constant	0.0561**	0.0515*	0.0281	0.0253	0.0102	0.0094
	(2.09)	(1.91)	(0.96)	(0.87)	(0.67)	(0.62)
IND/YEAR	√	√	√	√	√	√
Pseudo R^2	0.429	0.433	0.187	0.187	0.064	0.065
LR chi2	675.91	681.29	840.52	842.45	281.48	281.1
Obs.	6259	6259	5609	5609	5609	5609

Note: *t*-values are reported in brackets.
* Significance at the 10% level.
** Significance at the 5% level.
*** Significance at the 1% level.

We also run a two-stage linear regression to reduce the potential for endogeneity. Adams and Ferreira (2007) and Armstrong et al. (2010) find that the governance role of independent directors depends on the firm's information environment. We therefore choose a number of instrumental variables related to the information environment for inclusion in the regression: daily stock volatility over one year (STD), analyst following (NUM) and growth (TQ). In the first stage, we regress the network centrality of independent directors on the three instrumental variables, the ownership stake of the largest shareholder, the sum of the square of the second to fifth largest shareholders' ownership stakes, SOE, management ownership ratio, firm size, debt ratio and industry and year dummy variables. The model is specified as follows:

$$\mathrm{CEN}_t = \beta_0 + \beta_1 STD_t + \beta_2 NUM_t + \beta_3 TQ_t + \beta_4 FSHR_t + \beta_5 HFD_t + \beta_6 SOE_t + \beta_7 ESHR_t + \beta_8 SIZE_t + \beta_9 LEV_t + \sum IND + \sum YEAR + \gamma \quad (2)$$

where STD is the standard deviation of daily stock returns during the year; NUM is the analyst following in year *t*; TQ = (stock price × outstanding shares + net assets per share × non-trading shares + book value to

Table 6
Two-stage instrumental variable regression results.

	TUN		ABNTUN		NMTUN	
	score_median	score_max	score_median	score_max	score_median	score_max
PCEN	−0.0050*	−0.0045*	−0.0075*	−0.0039*	−0.0037	−0.0029
	(−1.84)	(−1.87)	(−1.85)	(−1.67)	(−1.61)	(−1.59)
SOE	0.0060***	0.0061***	0.0050**	0.0047**	0.0051***	0.0051***
	(2.80)	(2.84)	(2.41)	(2.28)	(4.09)	(4.14)
FSHR	0.0291***	0.0291***	−0.0023	−0.0044	0.0292***	0.0286***
	(4.61)	(4.60)	(−0.38)	(−0.72)	(8.04)	(7.94)
HFD	0.0623	0.0623	0.0508	0.0354	0.0348	0.0332
	(1.61)	(1.60)	(1.36)	(0.96)	(1.57)	(1.51)
CO	0.0002	0.0003	0.0005	0.0008	−0.0007	−0.0006
	(0.22)	(0.25)	(0.45)	(0.72)	(−1.10)	(−0.96)
GROUP	−0.0007	−0.0007	−0.0034	−0.0028	0.0010	−0.0002
	(−0.30)	(−0.27)	(−1.45)	(−1.20)	(0.72)	(−0.11)
ROE	−0.0992***	−0.0990***	−0.0923***	−0.0921***	−0.0129***	−0.0125***
	(−16.83)	(−16.76)	(−16.58)	(−16.62)	(−3.84)	(−3.73)
SIZE	−0.0020*	−0.0020*	0.0009	0.0003	0.0012*	0.0011*
	(−1.90)	(−1.81)	(0.75)	(0.33)	(1.73)	(1.71)
LEV	0.0276***	0.0278***	0.0294***	0.0288***	0.0036	0.0038
	(5.39)	(5.41)	(5.87)	(5.84)	(1.22)	(1.30)
MKT	−0.0013	−0.0014	0.0057***	0.0061***	−0.0040***	−0.0040***
	(−0.68)	(−0.71)	(2.94)	(3.18)	(−3.56)	(−3.52)
GG	−0.0069	−0.0068	−0.0087**	−0.0091**	0.0012	0.0001
	(−1.61)	(−1.59)	(−2.07)	(−2.17)	(0.51)	(0.08)
BOARD	−0.0013***	−0.0013***	−0.0015***	−0.0015***	−0.0002	−0.0002
	(−2.82)	(−2.69)	(−3.31)	(−3.22)	(−0.58)	(−0.60)
DUAL	−0.0031	−0.0032	0.0012	0.0013	−0.0057***	−0.0058***
	(−1.17)	(−1.23)	(0.45)	(0.52)	(−3.77)	(−3.82)
OUT	−0.0957***	−0.0966***	−0.0680***	−0.0695***	−0.0277**	−0.0248**
	(−4.84)	(−4.88)	(−3.59)	(−3.67)	(−2.48)	(−2.23)
Constant	0.1152***	0.1105***	0.0683***	0.0497**	−0.0179	−0.0197*
	(5.48)	(5.32)	(3.24)	(2.48)	(−1.45)	(−1.66)
IND/YEAR	√	√	√	√	√	√
Pseudo R^2 (R^2)	0.061	0.062	0.107	0.103	0.047	0.046
LR chi2 (F-Value)	749.71	755.87	839.15	809.4	647.16	637.49
Obs.	7375	7375	6904	6904	6904	6904

Note: t-values are reported in brackets.
* Significance at the 10% level.
** Significance at the 5% level.
*** Significance at the 1% level.

liabilities)/total assets at the end of the year (if all shares are tradable, TQ = (total market value of equity + -book value of total liabilities)/total assets at the end of the year). The predicted value of the network centrality of independent directors from the first-stage regression is then added to the second regression model as follows:

$$\mathrm{TUNNEL}_t = \alpha_0 + \alpha_1 PCEN_t + \sum Controls + \sum IND + \sum YEAR + \lambda \quad (3)$$

As shown in Table 6, the results based on this two-stage regression are consistent with those of the main tests, regardless of whether score_median or score_max is used.

We also follow Xiao et al. (2009) and Chen et al. (2010) by running a proxy variable two-stage regression.[14] In the first stage, we regress the network centrality of independent directors on director size, duality, independence of directors, and the ownership stake of the largest shareholder, the square of the sum of the ownership

[14] This proxy variable approach provides useful information from the residual values of the model with which to run the second-stage regression, but no regression is run on the explanatory variables. This approach can be used to find the instrumental variables more easily.

stakes of the second to fifth largest shareholders, SOE, firm size, debt ratio, and return on total assets in the previous year. The residuals of the first-stage regression are then added to the second stage model. Unreported results show that the CEN_residual is negatively related to TUN at the 5% or 10% level of significance.

In a third robustness test of the main results, we use the two integrated measures of score_median and score_max to proxy for the network centrality of independent directors. Our results also hold when using the mean and minimum values of firm-level centrality. The results show that the coefficients for two of the three measures of centrality are significant, the exception being that for the eigenvector centrality of the network. Rank index values of network centrality also provide similar results. In summary, all of our robustness tests support our hypothesis.

Moreover, because Jiang and Yue (2005) and Jiang et al. (2010) find that all "other receivables" can be used for tunneling, we also use this measure. In untabulated analysis, our main results hold when using "other receivables" as the proxy for controlling shareholders' tunneling behavior.

6. Conclusions

In China, the motivation for establishing a system of independent directors was to constrain the tunneling behavior of controlling shareholders and protect the interests of minority investors. However, because the appointment of independent directors is controlled by controlling shareholders themselves, the expectation that the monitoring ability of independent directors would be enhanced by increasing their number and proportion has undoubtedly proven futile. Moreover, given their concern with social status and reputation, not all independent directors are willing to serve as whistleblowers. Hence, more attention should be paid to the motivations and abilities enabling prospective independent directors to monitor controlling shareholders. Few prior studies focus in detail on the relationship between social networks and corporate governance. This paper adopts a social networking perspective to investigate the governance role of independent directors in China. Specifically, using various indicators of the use of company funds by controlling shareholders, we examine the relationship between the network centrality of independent directors and controlling shareholders' appropriation of firm funds. Empirical evidence shows that tunneling behavior is negatively related to network centrality, especially when non-operating cash is used as the measure of tunneling. All of our results imply that independent directors can reduce tunneling by large shareholders through their board network and play a positive and meaningful role in corporate governance.

Although we define networks as direct connections among directors sitting on at least one common board, we also recognize that other networks of independent directors that are unrelated to their board activities, such as school ties, will also have an effect on their governance role. We look forward to collecting data relevant to such networks for further study.

Appendix A. Measurement of board network centrality

We follow Freeman (1979), Wasserman and Faust (1994) and Xie and Chen (2012) by using network centrality analysis, which is part of social network analysis, to represent independent directors' positions in the board network of all listed firms. The basic measures are degree centrality, betweenness centrality, closeness centrality and eigenvector centrality, which together characterize the different elements of network centrality. The specific calculation methods are as follows:

(1) Degree centrality: $Degree_i = \frac{\sum_j X_{ji}}{g-1}$

This measure represents the number of direct ties a director has in a board network, which characterizes the director's participation in the network. Where i measures a director, j measures all directors other than i in one year; X_{ji} is a network relation indicator that takes the value of 1 if director i and director j are on the same board and 0 otherwise; g is the number of directors in the board network in one year. As the scope of the board network differs between years, $(g - 1)$ is used to eliminate the scale difference.

(2) Betweenness centrality: $Betweenness_i = \frac{\sum_{j<k} g_{jk(n_i)}/g_{jk}}{(g-1)(g-2)}$

This measure represents the degree to which one director controls communication among others and reflects the degree to which the same director reduces the path distance between all pairs of other directors. It is a measure of the extent to which the director acts as a "bridge" in helping others to form connections. Where $g_{jk(n_i)}$ is the number of geodesics in which director j communicates with director k. $\sum_{j<k} g_{jk(n_i)}/g_{jk}$ means the geodesics of all pairs of other directors including director i. We use $(g-1)(g-2)/2$ to eliminate differences in board size (Freeman, 1979).

(3) Closeness centrality: $Closeness_i = \left[\frac{\sum_{j=1}^{g} d(i,j)}{g-1}\right]^{-1}$

This measure is defined as the reciprocal value of the sum of distances travelled when director i communicates with all other directors and indicates how quickly and independently one director can relate to others. Where $d(i, j)$is the distance between director i and director j. If one director does not connect with all other directors, then this method cannot be used to accurately calculate the degree of centrality. Therefore, similar to Liu (2010), we divide the number of directors to whom he can relate directly in the network, then multiply the result by the proportion it bears to the total number of directors in the board network.

(4) Eigenvector centrality: $Eigenvector_i = \frac{1}{\lambda}\sum_j b_{ij}E_j$

This measure is the weighted value of a director's direct connections and indicates the extent to which a director's network centrality is related to that of his neighbors (Bonacich, 1972). The weights represent the importance of the directors to whom he connects. Eigenvector centrality can be calculated by the standard "eigenvalue–eigenvector" model: $BE = \lambda E$, where b_{ij} is an adjacency matrix that takes the value of 1 if director i and director j are on the same board and 0 otherwise. λ is the largest eigenvalue and E_j is the eigenvalue of director j's centrality. In the social network field, actors who receive more information are valuable sources of information. This measure of centrality is aimed at finding the most central actor, but does not focus on the fractional structure (Bonacich, 1972).

References

Adams, R.B., Ferreira, D., 2007. A theory of friendly boards. Journal of Finance 62 (1), 217–250.

Andres, C., Lehmann, M. 2010. Is busy really busy? Board governance revisited. Working paper, University of Mannheim.

Armstrong, C.S., Guay, W.R., Weber, J.P., 2010. The role of information and financial reporting in corporate governance and contracting. Journal of Accounting and Economics 50 (4), 179–234.

Barnea, A., Guedj, I. 2009. Director Networks. Working Paper, University of Texas at Austin.

Bonacich, P., 1972. Factoring and Weighting Approaches to Status Scores and Clique Identification. Journal of Mathematical Sociology 2, 113–120.

Cashman, G.D., Gillan, S.L. Whitby R., 2010. Expertise, Connections, and the Labor Market for Corporate Directors: Is It What You Know or Who You Know? Working Paper, Texas Tech University.

Chen, X., Wang, K., 2005. Related party transactions, corporate governance and state ownership reform. Economic Research Journal 4, 77–86 (in Chinese).

Chen, Y.S., Xie, D.R., 2011. Board network, independent directors' governance and investment efficiency. Management World 7, 47–62 (in Chinese).

Chen, Y.S., Xie, D.R., 2012. Board network, independent directors' governance and executive incentives. Journal of Financial Research 3, 168–182 (in Chinese).

Chen, X.L., Lin, X., Kong, D.M., 2010. Independent directors' financial expertise, firm idiographic information and accounting conservatism. China Accounting and Finance Review 3, 1–27.

Chuluun, T., Prevost, A., Puthenpurackal, J. 2010. Board networks and the Cost of Corporate Debt. Working Paper, Loyola University Maryland.

Claessens, S., Djankov, S., Lang, H.P., 2000. The separation of ownership and control in east asian corporations. Journal of Financial Economics 58, 81–112.

Conyon, M.J., Muldoon, M.R., 2006. The small world of corporate boards. Journal of Business Finance and Accounting 33 (9), 1321–1343.

Crespi, R., Fuster, B.P. 2009. Executive Directors Pay and Networks in Spanish Listed Companies. Working Paper, Universitat de les Illes Balears.
Davis, G.F., Yoo, M., Baker, W.E., 2003. The small world of the American corporate elite: 1982–2001. Strategic Organization 1 (3), 301–326.
Du, X.Q., Guo, J.H., Lei, Y., 2010. Controlling shareholders' cash embezzlement, external auditing and corporate governance. Economic Management Journal 1, 111–117 (in Chinese).
Engelberg, J., Gao, P., Parsons, C.A., 2012. Friends with money. Journal of Financial Economics 103 (1), 169–188.
Fama, E.F., 1980. Agency problems and the theory of the firm. Journal of Political Economics 88 (2), 288–307.
Fama, E.F., Jensen, M.C., 1983. Separation of ownership and control. Journal of Law and Economics 26, 301–325.
Fan, G., Wang, X.L., Zhu, H.P. 2010. Chinese marketization index: the process of marketization of different provinces. Beijing: economic science press (in Chinese).
Farina, V. 2009. Banks' centrality in corporate interlock networks: evidences in Italy. Working paper. University of Rome "Tor Vergata".
Fich, E.M., Shivdasani, A., 2006. Are busy boards effective monitors? The Journal of Finance 2, 689–724.
Firth, M., Fung, P.Y., Rui, O.M., 2007. How ownership and corporate governance influence chief executive pay in China's listed firms. Journal of Business Research 60 (7), 776–785.
Fracassi, C., Tate, M., 2012. External networking and internal firm governance. Journal of Finance 67 (1), 153–194.
Freeman, L., 1979. Centrality in social networks: conceptual clarification. Social Networks 1, 215–239.
Friedman, E., Simon, J., Todd, M., 2003. Propping and tunneling. Journal of Comparative Economics 31 (4), 732–750.
Gao, L., He, S.H., Huang, Z.Z., 2006. Corporate governance and tunneling. China Economic Quarterly 5 (4), 1157–1178 (in Chinese).
Granovetter, M., 1985. Economic action and social structure: the problem of embeddedness. American Journal of Sociology 91 (3), 481–510.
Hochberg, Y., Ljungqvist, A., Lu, Y., 2007. Whom you know matters: venture capital networks and investment performance. The Journal of Finance 62, 251–301.
Horton, J., Millo, Y., Serafeim, G. 2009. Paid for connections? Social networks, executive and outside director compensation, working paper, London School of Economics.
Huang, J., Pan, M.X., 2010. Effectiveness of independent director and related transactions of controlling shareholders. The Theory and Practice of Finance and Economics 2, 47–51 (in Chinese).
Hwang, B.H., Kim, S., 2009. It pays to have friends. Journal of Financial Economics 93, 138–158.
Jian, M., Wong, T.J., 2010. Propping through related party transactions. Review of Accounting Studies 15 (1), 70–105.
Jiang, G.H., Yue, H., 2005. A study of the relationship between big shareholders' diverting listed companies' capital and the stock returns of these companies. Management World 9, 119–126 (in Chinese).
Jiang, G.H., Lee, M.C., Yue, H., 2010. Tunneling through inter-corporate loans: the China experience. Journal of Financial Economics 98, 1–20.
Johnson, S., La, Porta, R., Lopez-de-Silanes, F., Shleifer, A., 2000. Tunneling. The American Economic Review 90 (2), 22–27.
Ju, X.Q., Pan, A.L., 2010. Determinants of violations of related party transactions of listed companies in China. Shandong Social Sciences 7, 71–75 (in Chinese).
Kuhnen, C.M., 2009. Business networks, corporate governance, and contracting in the mutual fund industry. Journal of Finance 5, 2185–2220.
La Porta, R., Lopez-de-Silanes, F., Shleifer, A., 1999. Corporate ownership around the world. Journal of Finance 54 (2), 471–517.
Larcker, D.F., So, E.C., Wang, C.C.Y., 2013. Boardroom centrality and stock returns. Journal of Accounting and Economics 55 (2-3), 225–250.
Li, Z.Q., Sun, Z., Wang, Z.W., 2004. Tunneling and ownership structure of a firm: evidence from controlling shareholder's embezzlement of listed company's funds in China. Accounting Research 12, 3–13 (in Chinese).
Liu, Y. 2010. The Role of Networks in the CEO and Director Labor Market, University of Maryland dissertation.
Lin, N., 2002. Social Capital: A Theory of Social Structure and Action. Cambridge University Press.
Luo, J.D., 2010. Social Network Analysis, second ed. Social Sciences Academic Press, Beijing (in Chinese).
Luo, D.L., Tang, Q.Q., 2006. The governance role of independent directors: evidence from related party transactions. South China Economics 9, 65–74 (in Chinese).
Luo, D.L., Tang, Q.Q., 2007. Market environment and controlling shareholders' tunneling behavior. Accounting Research 4, 71–76 (in Chinese).
Nguyen, B.D. 2009. Does the rolodex matter? Corporate elite's small world and the effectiveness of board of directors. Working paper, Chinese University of Hong Kong.
Peng, W., Wei, J.K.C., Yang, Z.S., 2010. Tunneling or propping: evidence from connected transaction in China. Journal of Corporate Finance 17 (2), 306–325.
Schonlau, R., Singh, P.V., 2009. Board Network and Merger Performance. Working Paper, University of Washington.
Shleifer, A., Vishny, R.W., 1997. A survey of corporate governance. Journal of Finance 52 (2), 737–783.
Tan, X.S., Du, J., Shen, H., 2010. Independent directors' monitoring incentive: evidence from voting behavior. Management World 9, 138–149 (in Chinese).
Tang, Q.Q., Luo, D.L., Wang, L., 2005. Controlling shareholders' tunneling and balancing power. China Accounting Review 4 (1), 63–86 (in Chinese).
Wang, H.J., 2007. Interpretation Chinese people's relationship recognition. Exploration and Free Views 12, 32–36 (in Chinese).

Wang, K., Xiao, X., 2005. The empirical study on the institutional ownership and resources expropriation by the related parties. Nankai Business Review 2, 27–33 (in Chinese).
Wasserman, S., Faust, K., 1994. Social Network Analysis: Methods and Applications. Cambridge University Press, NY.
Wang, K., Xiao, X., 2011. Controlling shareholder's tunneling and executive compensation: evidence from China. Journal of Accounting and Public Policy 30 (1), 89–100.
Xiao, W.J., Wang, Z.W., D, Y., 2009. Relation between independent directors and corporate performance under shareholders' control: Endogeneity perspective. Nankai Business Review 2, 90–97 (in Chinese).
Xie, D.R., Chen, Y.S., 2012. Board network: definition, attributes and measurement. Accounting Research 2, 53–65 (in Chinese).
Xu, Y.X., 2009. Research on corporate cash policy using large shareholders perspective [D] Tsinghua University dissertation.
Ye, K.T., Lu, Z.F., Zhang, Z.H., 2007. Can independent directors deter the tunneling of large shareholders? Economic Research Journal 4, 101–111 (in Chinese).
Ye, K.T., Zhu, J.G., Lu, Z.F., Zhang, R., 2011. Independent directors' independence: evidence form directors' voting. Economic Research Journal 1, 126–139 (in Chinese).
Yu, M.G., Xia, X.P., 2004. Controlling shareholder, agency problem and related party transaction: evidence from China's listed companies. Nankai Business Review 6, 33–38 (in Chinese).
Zeng, Q.S., Chen, X.Y., 2009. Policy Burden, The Largest Shareholders' Fund Occupation and Operating Performance: Empirical Evidence Based on State-Owned Enterprise Reform to List. Working Paper, Shanghai Univ. of Finance and Economics (in Chinese).
Zhang, H.Y., Jia, N., Kuang, F., 2010. Related party transactions and change role of large shareholders after the non-tradable reform period. Journal of Tsinghua University 6, 130–140 (in Chinese).
Zhou, J.G., 2010. Relationship strength, trust and identity: an interpretation for Chinese interpersonal. Social Science Research 1, 97–102 (in Chinese).