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Analyses of Topical Policy Issues

Peer Effects in Financial Investment of Board-interlocked Firms: An Information Sharing Perspective

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ABSTRACT

This paper aims to investigate the peer effects in financial investment of board-interlocked firms from the information sharing perspective. Based on board interlock and financial information of A-share listed nonfinancial firms in China, we construct board interlocking networks where firms share at least one board member in common and conduct an empirical investigation into peer effects in financial investment of board interlocking firms. The results demonstrate that peer effects are noticeably found in nonfinancial firms even after ruling out endogenous concerns by applying peers' peers' characteristics as instrumental variables, and carrying out robustness tests and placebo tests. In addition, the main manifestation of these peer effects is that firms with inferior quality information, i.e., poor financial conditions, low market capitalization, and higher stock idiosyncratic volatility, tend to follow companies that are perceived as having superior quality information in the above-mentioned areas. Firms located in the core position of board interlocking network or with more assets are more likely to be influenced by peers, because they can obtain more high-quality information. Different from existing studies, this paper provides a board interlocking perspective to the study of peer effects, which offers a new explanation for the expansion of financial activities of firms in China.

1. Introduction

Peer effects, indicating a firm's behavior can be influenced by the average behavior of its peer group (Manski, 1993), are found to play an important role in corporate financial activities such as corporate fixed investments (Chen and Ma, 2017), financial policies (Leary and Roberts, 2014), dividend payments(Grennan, 2019), etc. These effects are examined from dimensions of the firm's features, such as its industry, region, and market (Foucault and Fresard, 2014; Leary and Roberts, 2014; Chen and Ma, 2017; Adhikari and Agrawal, 2018; Grennan, 2019), as well as dimensions of stakeholders' networks, such as common educational backgrounds (Shue, 2013), board interlocking networks (Renneboog and Zhao, 2014; Chuluun et al., 2017; Fracassi, 2017; Song and Wang, 2020; Zhang, 2021), and online networks (Jing and Zhang, 2021). Among them, board interlock networks, in which two firms are considered as connected if they share at least one board member in common (Song and Wang, 2020), are one of the most reliable and efficient communication ways among firms and play a significant role in peer effects in various corporate decisions, including financial policies (Bizjak et al., 2009; Chiu et al., 2013; Song and Wang, 2020), information disclosure, and governance (Bouwman, 2011; Cai et al.,

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2014), etc.

Financial investment, as one of the important financial policies that decided mainly by corporate boards, can also be affected by peers due to the dissemination of information and overlapping boards command. Taking Chinese listed firms as an example, the difference of financial investment between focal firms and their board interlocking peers in China is seen to be narrowing (Fig. 1).[1] However, peer effects in financial investments have not yet been explored from the perspective of board interlocks, especially the underlying mechanism of the peer effects. In this paper, we try to fill this gap in the existing literature by examining peer effects in financial investment of board-interlocked firms from an information sharing perspective.

Firstly, board interlocking networks of Chinese listed firms are constructed to verify peer effects in financial investment of board-interlocking firms using data of 23916 firm-year observations from 2007 to 2019. We adopt peers' peers' characteristics as the instrumental variable to identify peer effects and address endogenous problem. It is noted that peers' peers are indirectly connected with focal firms through peers and peers' peers who are in the same industry as the focal firm are excluded to assure the exogeneity of the instrumental variables. We also verify the robustness using the following methods: including control variables of firm-specific and peer firms' characteristics; fixing industry, region and year effects, changing the dependent variable and sample interval; and conducting placebo tests by regressing with "pseudo-interlocked" firms. Findings show that firm's financial investment ratio increases by about 0.1-0.4 units for each percent increase in financial investment ratio in peer firms.

In addition, this paper explores the potential mechanisms underlying peer effects in financial investments of board interlocking firms based on the imitation theory of Haunschild (1993) and the information-based theory of Lieberman and Asabas (2006). We find that information quality gap is an important determinant of peer effects. Firms with inferior-quality information are inclined to imitate firms with high-quality information, but not vice versa. Furthermore, it is the information reception, characterized by the position in the board interlocking network and the assets size, that determines the peer effects. Firms located in the core network or with more assets can access to more information and are more likely to be affected by peers.

To our knowledge, this paper is the first to explore peer effects in financial investment of board interlocking firms and the findings may provide a novel explanation for the expansion of financial activities of firms in developing countries such as China. There are three major aspects to this contribution.

Firstly, the findings of this paper provide a micro mechanism for understanding the expansion of corporate financial activities. Unlike existing studies that have examined the return gap and risk-adjusted return gap between financial and fixed investments (Demir, 2009; Zhang and Zheng, 2020), shadow banking activities (Du et al., 2017) and firms' ownership (Wang et al., 2021), etc., this paper takes a novel approach to explore the imitation motivation behind corporate financial investments, providing a new explanation for the expansion of corporate financial activities. Besides, the mechanism analysis provides explanations of peer effects in information sharing dimension. At the same time, the findings in this paper provide policy implications to guide nonfinancial firms to make financial decisions, i.e., by intervening financial investment of board interlocking firms or managing the delivery of specific information.

Secondly, we add a new perspective of board interlocking firms to the existing research on peer effects in financial investment, which is different from previous studies investigating peer effects of financial policies within the domain of industry, region, or market (Durnev and Mangen, 2009; Foucault and Fresard, 2014; Leary and Roberts, 2014; Chen and Ma, 2017; Adhikari and Agrawal, 2018; Grennan, 2019). Our findings suggest that financial investment behaviors of firms interlocked by boards are correlated.

Thirdly, we apply a novel but proven creditable identification strategy to verify the peer effects of financial polies of board interlocking firms, different from the research of Jing and Zhang (2021), which verified peer effects by grouping and studying the similarity of investment behavior of board interlocking firms. The empirical strategy is proposed and proved by Bramoullé et al. (2009), suggesting that peers' peers' characteristics are efficiently exogenous instrumental variables to solve the endogeneity problem. Song and Zhang (2020) and Aghamolla and Thakor (2022) tried to apply the methodology to detect peer effect of board interlocking firms in fixed investments and IPO decision-making in the US, respectively. Similarly, this paper firstly adopts the empirical strategy to investigate peer effects of financial investment of board interlocking firms in China. There will be a wide application for the strategy in the future.

The remainder of the paper is organized as follows: Section 2 presents a literature review and hypothesis development. Section 3 describes the research samples and identification strategies. Section 4 presents empirical results and discussion. Section 5 is mechanism analysis, and finally, Section 6 concludes with a summary of main findings and proposes policy recommendations accordingly.

[1] a) The definition of financial investment is based on that proposed by the Chinese Institute of Certified Public Accountants, CICPA, which defines 'financial assets' as assets involved in investment using excess funds from operating activities, and the approach of Zhang and Zheng (2020), which is shown in Section 3.3.2. It is noted that we exclude cash and cash equivalents from financial assets because the focus of this paper is firms' financial investment behaviors and the cash and cash equivalents are financial assets but not financial investment. b) The results are calculated based on the data of Chinese A-share firms, which are listed on either the Shanghai or Shenzhen Stock Exchange and whose shares are traded in Renminbi by domestic investors in China. Nonfinancial firms shall mean any firm or enterprise that is not in the financial or real estate sector. The reason why the financial investment ratio in this paper is much lower that of Zhang and Zheng (2020) is that we exclude cash and cash equivalents from financial assets. c) The differences of financial investment among board interlocked firms=financial investment ratio of focal firms - average financial investment ratio of their board interlocked firms. We take the average differences of all focal firms by the year. Similarly, the financial investment ratio is the average number of all nonfinancial firms by the year.

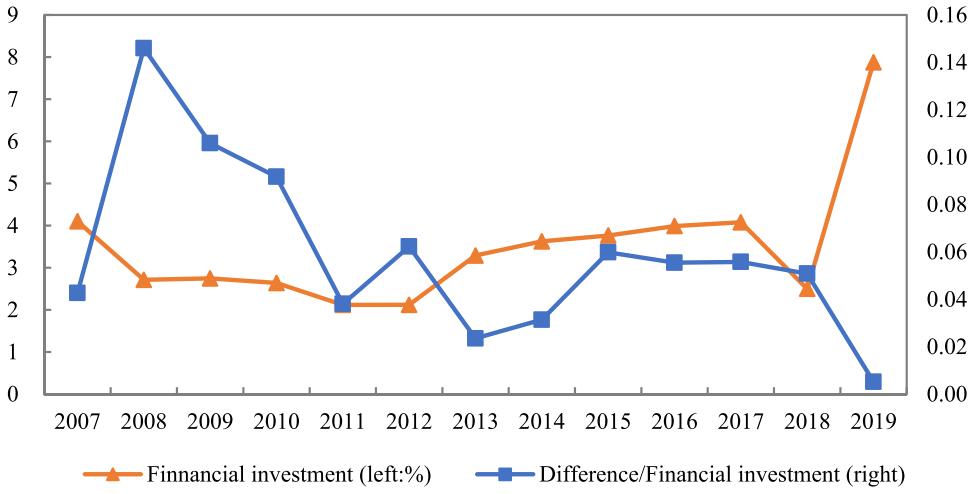

Fig. 1. Financial investment and difference among board interlocked firms.
Source: raw data are from China Stock Market and Accounting Research (CSMAR) database and we calculate the index based on the raw data.

2. Literature Review and Theoretical Hypothesis

2.1. Existence of peer effects in financial investment of board-interlocked firms

Firms are inclined to follow others when make decisions. Early research explained the phenomenon from the perspective of information. For example, Mohr et al. (1976) demonstrated that managers with limited rationality were particularly likely to be receptive to information implicit in the actions of others to reduce the uncertainty of outcomes when faced with uncertainty; Scharfstein and Stein (1990) found that managers were reluctant to make decisions based on their own information for fearing that their contrarian behavior would damage their reputations as sensible decision makers. Furthermore, Lieberman and Asaba (2006) illustrated peer effect from information-based theory and rivalry-based theory, in which the former indicated that firms were intended to follow others to reduce information-searching cost and the later exhibited that firms imitated others to maintain competitive parity or limit rivalry.

Existing research has provided empirical evidence on peer effects in financial decisions of firms. For example, Durnev and Mangen (2009) verified that corporate investment decisions were significantly influenced by restatements of financial reports of firms in the same industry. Foucault and Fresard (2014) found that firms responded to peers' valuations when making investment decisions. Leary and Roberts (2014) proposed that idiosyncratic stock returns of peers were important signals for firms to make financial decisions.

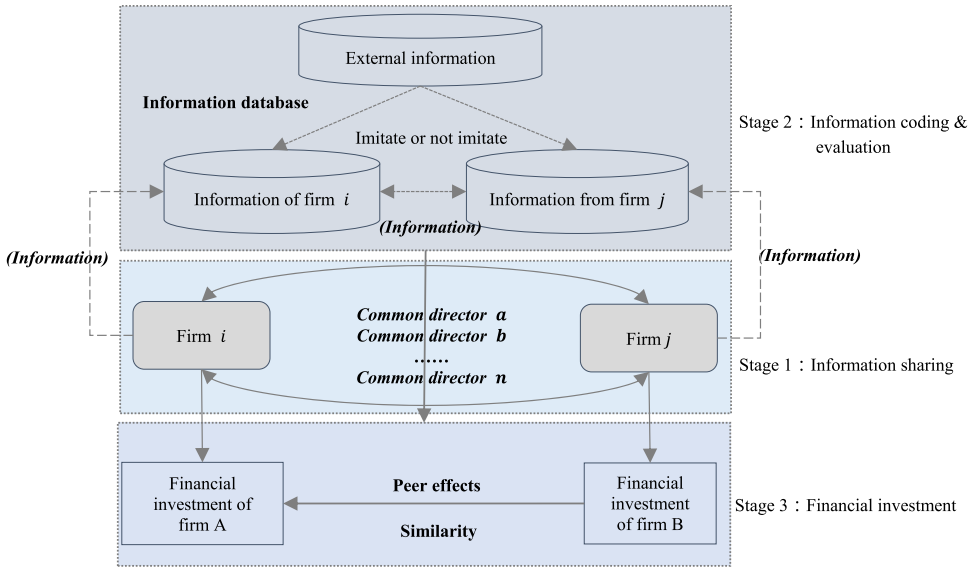

Fig. 2. The mechanism of peer effects in financial investment of board interlocked firms.

Also, the financial decisions of firms with overlapping managers or with managers who shared social connections have certain similarities (Shue, 2013; Fracassi, 2017; Bustamante and Fresard, 2021; Song and Wang, 2020; Jing and Zhang, 2021), due to the information sharing and overlap board command (Graham and Harvey, 2001).

Theoretically, peer effects exist only when the following three conditions are satisfied as imitation theory suggests: 1) the first-mover firms make decisions based on their private information at certain time; 2) the second-mover firms are exposed to the information delivered by first movers; 3) thereafter, the second-mover firms make decisions (Haunschild, 1993). And the imitation behavior and peer effects will be in appearance, only after the revealed information accumulates to a certain degree (Lieberman and Asaba, 2006).

In terms of peer effects in financial investment of board interlocked firms, we can divide the decisions into three stages based on the prospect theory of Kahneman and Tversky (1979) as Fig. 2 depicts. In stage 1, firm *i* gathers information from its financial performance, its peer firm *j* which shares the common director (Shue, 2013; Cai et al., 2014; Jing and Zhang, 2021) as well as external market. In stage 2, firm *i* encodes or evaluates all the information that gathered. In stage 3, firm *i* makes financial investment decisions based on the encoded information. In this case, firms who share at least one common director are more likely to have similar financial investment behaviors due to the dissemination of information (Haunschild, 1993; Hamdan, 2018; Song and Wang, 2020; Al Amosh and Khatib, 2022). Besides, it is likely for firms with overlapping boards to make decisions by the same manager(s), who is (are) in charge of financial decisions of the interlocking firms. Therefore, we propose the first hypothesis:

H1. Board interlocking firms show significant peer effects in financial investment.

2.2. Impacts of information quality and reception on peer effects

According to the herding model of Trueman (1994), whether the agents mimic or follow others depends on the information quality. Specifically, if the private information of the firm is inferior to its peers, the imitation will occur, otherwise, the firm is not motivated to follow others. As a result, the strategic imitation can be revealed from the directional peer effects (March, 1991; Leary and Roberts, 2014; Song and Wang, 2020). Specifically, it is more likely for firms with poor quality information follow peers that are perceived as having superior quality information to reduce competitive pressure and bankruptcy risk (Seo, 2021). In this paper, we define firms with inferior information, i.e., lower earnings growth, lower cashflow ratio, lower Tobin's Q and higher stock idiosyncratic volatility, who would make decisions by imitating others as followers (Song and Wang, 2020) (represented by frame filled with blue in Fig. 3). In contrast, firms with superior information, i.e., higher earnings growth, higher cashflow ratio, higher Tobin's Q and lower stock idiosyncratic volatility, which would influence other firms' decisions are defined as leaders (represented by frame filled with pink in Fig. 3). The relationship between information quality and directional peer effects is assumed as **H2a**.

H2a. Relative information quality is an important determinant of peer effects in financial investment, i.e., firms tend to imitate peers that have demonstrated superior information.

In addition, information sharing is another vital element of peer effects considering only disseminated information can be observed and utilized by firms which are exposed to the information (Dougal et al., 2015; Cao et al., 2019). In this condition, only firms delivering or exposed to the information (represented by frame filled with pink and blue in Fig. 3) can be identified and contribute to the peer effects. In reality, firms who are in the core position and serve as an information-transmitting portal are more likely to be leaders or followers due to their strong ability of information delivering (leaders) or reception (followers). Furthermore, firm size can be another signal of information delivering or reception, because large firms are usually able to transmit or receive information more easily due to their powerful market influence and high level of interlocking. We describe the above hypothesis by **H2b**.

H2b. Firms which deliver information or are exposed to the information are more inclined to be leaders or followers, respectively, i.e., firms in the core position (physical or network) or with large scales.

3. Research Samples and Identification Strategies

3.1. Research samples

Our sample includes all Chinese A-share firms and covers the period from 2007 to 2019. The period begins in 2007 because that is when a significant change to the Chinese Accounting Standard was introduced (Liu et al., 2021). Referring to Song and Wang (2020) and Zhang and Zheng (2020), the samples are processed as follows: (1) we exclude firms without a board interlock with any other firm and firms whose peers are without a board interlock with any other firm (except with firm *i*), and after this, 25315 observations are left; (2) we exclude firms with missing values on firms' and peers' characteristics, firms in the financial and real estate sectors, firms with abnormal performance or status, like ST*, ST and S firms. In the end, 23916 firm-year observations are obtained.

The datasets on board information and financial information of listed firms are obtained from the China Stock Market and Accounting Research (CSMAR) database, and macroeconomic data are obtained from the National Bureau of Statistics of China.

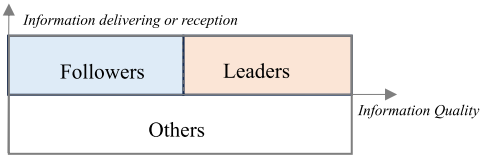

Fig. 3. Information quality, delivering or reception and directional peer effects.

3.2. The definition of board interlocking firms and network

Board interlock refers to a circumstance under which at least one director (including the chairman, managing director, supervisor, etc.) of the firm serves on the board of directors of another public firm. Otherwise, it is considered that there is no board interlock between the two firms.

The board interlocking network covers board interlocks of all A-share listed firms. We can use a symmetric matrix L for a visual representation.

$$L = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix}$$

Where the diagonal elements a_{11}, $a_{22}\ldots a_{nn}$ equal to 0. a_{ij} represents the number of directors in common between company i and company j. If there is at least one director in common, then a_{ij} is 1; otherwise, it is 0. This notation is symmetrical, so $a_{ij} = a_{ji}$.

The definition of peers and peers' peers: If firm B is directly interlocked to firm A, then firm B is considered as firm A's peer; if firm C is indirectly interlocked to firm A via firm B, then firm C is considered as one of firm A's peers' peers. It is noted that if firm D is both directly interlocked to firm A and indirectly interlocked to firm A via firm B, we only define firm D as one of firm A's peers rather than one of A's peers' peers. The board interlocking network is visualized in Fig. 4.

We use Matlab R2016a to calculate the board interlocks of Chinese A-share listed firms in years from 2007 to 2019. The board interlocks vary slightly across different years, therefore, we take calculations year by year. Taking 2019 as an example, we summarize the network structure as Table 1 shows. Among 300,4 firms, the average number of a firm's peers is 4.36, the maximum number is 20, and the minimum number is 0. Less than 2% firms have no common directors, more than 75% firms have 1-6 peers and less than 10% firms have more than 8 peers.[2] In addition, we further visualize the board interlocks among Chinese listed companies by Fig. 5 with *Gephi*.

Take the firm Yunnan Baiyao (YNBY) as an example of a network of peers and peers' peers.[3] As is shown in Fig. 6, the red node in the left panel is YNBY, the blue nodes are YNBY's peers or peers' peers, and the black nodes are YNBY's peers' peers. Further, some of YNBY's peers' peers are also its peers, which are represented by the green nodes in the right panel; we only identify them as peers. The data show that the number of YNBY's peers is 20 (the number of firms that are only YNBY's peers is 2, and the number of firms that are both its peers and peers' peers is 18), and the number of its peers' peers is 62.

3.3. Variable definitions and summary statistics

3.3.1. Dependent variable

The dependent variable is the financial investment ratio, which is expressed as the total amount of financial assets divided by the total assets. Referring to the definition of financial assets by the Chinese Institute of Certified Public Accountants (CICPA) and the method of Zhang and Zheng (2020), we define the financial assets of a firm during the period 2007 to 2017 as the sum of nine accounting items: *financial derivatives* + *financial assets available for trading* + *interest receivable* + *dividend receivable* + *redemptory monetary capital for sale* + *financial assets available for sale* + *held-to-maturity investments* + *long-term receivables* + *investment properties*. In 2018, the accounting standards redefined the scope of financial assets so the financial assets in 2018 and 2019 are defined as the sum of 11 accounting items: *financial derivatives* + *financial assets available for trading* + *interest receivable* + *dividend receivable* + *buy-back financial assets* + *debt investments* + *other debt investments* + *investments in other equity instruments* + *other non-current financial assets* + *long-term receivables* + *investment properties*.

3.3.2. The core independent variable and the instrumental variables

The core independent variable is the financial investment ratio of peer firms, which is represented by the mean of the financial investment ratio of the peers, i.e., $L1Fin_i = (\sum_{j=1}^{n_i} Fin_j / n_i)$, where $L1Fin_i$ denotes the average financial investment ratio of firm i's peers, firm j is the peers of firm i, and n_i is the total number of i's peers. The instrumental variables are the average age and cashflow of the

[2] It is noted that not as said in Section 3.1, we neither take account of whether the firm has peers or peers' peers, nor consider whether it has missing values. The only aim here is to describe the whole interlocked picture of all firms.

[3] A listed SOE producing a namesake traditional Chinese Medicine (TCM) used for wound healing.

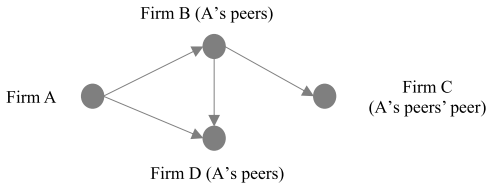

Fig. 4. Schematic diagram of peers and peers' peers of the board interlocking network.

Table 1
Summary statistics of board interlocking networks in 2019.

A: Basic characteristic of board interlocking networks in 2019

Obs.	Mean	Median	Mode	Standard deviation	Max	Min
3004	4.36	4	2	2.84	20	0

B: Number of firms with different number of peers in 2019

Group	0	[1, 3)	[3,5)	[5,7)	[7,9)	>=9
Number of firms	59	839	844	654	348	260
Fraction of firms	1.96%	27.93%	28.10%	21.77%	11.58%	8.66%

Note: This table shows the summary statistics of board interlocking networks in 2019. Specifically, Panel A depicts the basic statistics of board interlocking networks of 3004 firms. The average number of peers is 4.36 and the median is 4. Most firms have two peers and the maximum number of peers is 20. In Panel B, we can see the number and the fraction of firms with different number of peers. It is depicted that less than 2% firms have no peers, nearly 60% firms have 1-4 peers, more than 1/3 firms have 5-8 peers and 8.66% firms have more than 8 peers.

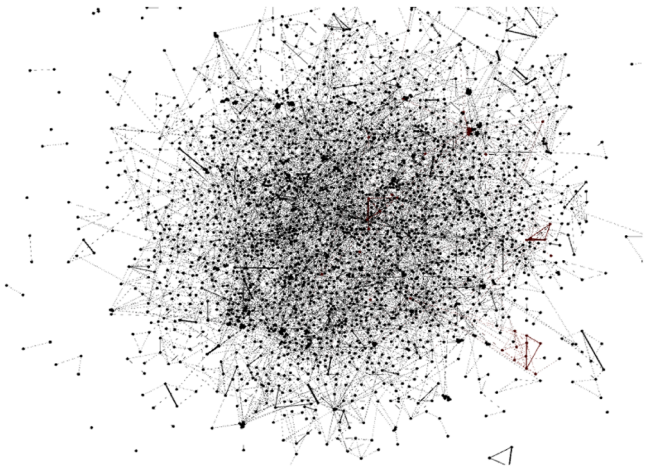

Fig. 5. Visualization of the board interlocking network of A-share listed nonfinancial firms in China in 2019.

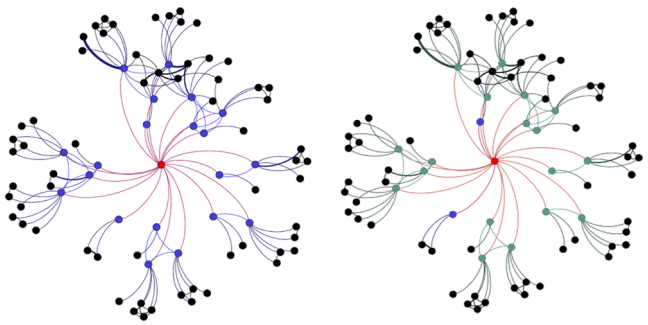

Fig. 6. YNBY's board interlocking network in 2019 (excluding firms in the financial and real estate sectors).

peers' peers, i.e., $L2Age_i = (\sum_{k=1}^{m_i} Age_k / m_i)$, $L2CashFlow_i = (\sum_{k=1}^{m_i} CashFlow_k / m_i)$. Firm k is the peers' peers of firm i and m_i is the total number of the peers' peers of firm i.

3.3.3. Control variables

Following Bramoullé et al. (2009), Foucault and Fresard (2014), Leary and Roberts (2014), Gulen and Ion (2016), and Song and Wang (2020), we add the financial characteristics of the focal firm and its peers as control variables, including: the logarithmized firm's age (*lnAge*), measured by the logarithmized number of years since the firm went public; logarithmized total assets (*lnAssets*); return on assets (*ROA*), measured by the rate of net profits over average total assets; operating income growth rate (*GIncome*), measured by the operating income in the previous year divided by operating income in the current year then minus 1; leverage (*Debt*), measured by the share of total liabilities divided by total assets; the shares' percentage of top ten shareholders (*PEquity*); operating cashflow ratio (*CashFlow*), measured by the ratio of cash received by selling goods and providing services relative to average total assets; and Tobin's Q (*TobinQ*), measured by the ratio of the sum of the market value of stock markets and the book value of liabilities over book value of total assets. The characteristics of peers are calculated in the same way as the average financial investment ratio of peers. In addition, all continuous variables are winsorized at 1% and 99% levels to avoid problems with outliers. After considering the covariance of the variables, the final variables are shown in Table 2, which includes the definitions and calculation methods of all key variables.

3.3.4. Descriptive statistics

Table 3 shows the descriptive statistics for our regression variables. It can be seen that the average financial investment ratio from 2007 to 2019 is 3.77%, the maximum is 40.87%, and the minimum is 0.[4] The corresponding average financial investment ratio of peers is a little bit higher.[5] The average return on assets, leverage, cashflow ratio, and earnings growth rate are 4.78%, 41.94%, 0.70, and 15.36%, respectively. The average age is 7.56 years and the average percentage of shared held by the top ten shareholders is 59.20%.

Table 4 provides the Pearson correlation coefficients between variables. Financial investment ratio is significantly positive with that of peers with a Pearson correlation of 0.165, indicating that financial investment behaviors of board interlocking firms are significantly correlated. In addition, the correlations of control variables are lower than 0.5 and the variance inflation factors (VIF) of models including all control variables are all lower than 5. Therefore, we can basically think that the multicollinearity is not a concern in our paper.

3.4. Identification strategies

3.4.1. Baseline model

To verify whether there is a causal relationship between the financial investment of firm i and that of its peers, we include Eq. (1) as follows.

$$Fin_{i,t} = \beta_0 + \beta_1 L1Fin_{i,t} + \mathbf{X_{i,t-1}}\boldsymbol{\beta}_2 + \mathbf{L1X}_{i,t-1}\boldsymbol{\beta}_3 + \sigma_t + \delta_j + \vartheta_k + \varepsilon_{i,t} \quad (1)$$

where $Fin_{i,t}$ is the financial investment ratio of firm i in period t, $L1Fin_{i,t}$ is the average financial investment ratio of firm i' peers in period t. It is noted that the financial investment of focal firms and their peers are in the same period to limit the amount of time for firms to respond to one another (Leary and Roberts, 2014). $\mathbf{X_{i,t-1}}$ and $\mathbf{L1X_{i,t-1}}$ are the matrices of control variables of firm i and its peers in period $t-1$, respectively, σ_t, δ_j and ϑ_k represent year fixed effects, industry fixed effects and province fixed effects[6], respectively, and $\varepsilon_{i,t}$ is the random error term.

3.4.2. Addressing the endogeneity problem

A major challenge in empirical studies of peer effects is how to address the endogeneity problem considering three fundamentals: a) the behaviors of peers are influenced by each other, i.e., the reflection problem proposed by Manski (1993); b) the behavior of individuals in the same group may be jointly influenced by one or several common factors, e.g., certain fundamentals that are common across firms in the same industry indicate those firms may have a homogenous preference for cash holdings, financial investments, etc.; and c) firms' decision-making structures are generally complex and some independent variables may be neglected in empirical analyses. Similarly, there is endogeneity concern about financial investment. Firstly, the financial investment behavior of interlocking firms may affect each other, that is, the financial investment behavior of firm i may affect that of its peers (i.e., reflection problem) (Manski, 1993). Secondly, there are many factors affecting firms' financial investment behavior, which are not fully included in the model (i.e., the omitted variable bias). Thirdly, the financial investment behavior of the firm's peers may be jointly influenced by one

[4] The reason why the financial investment ratio in this paper is much lower that of Zhang and Zheng (2020) is that we exclude cash and cash equivalents from financial assets.

[5] If all the firms are interlocked with all other firms without themselves, there will be no differences between the firms' average financial investment ratio and the peers' average financial investment ratio. Firms are not locked with all other firms in the reality, so the difference is random and it is dependent on the interlocking networks among firms.

[6] It is noted that the industry classification when we control industry fixed effects is according to the industry category defined by the China Securities Regulatory Commission (CSRC) in 2013.

Table 2
Variable definition and calculation.

Variables	Definition	Calculation
Dependent variable		
Fin	Financial investment ratio	Total amount of financial assets divided by total assets
Independent variable		
L1Fin	Peers' average financial investment ratio	Mean value of financial investment ratio of firm *i*'s peers
Control variables: firm's characteristics		
lnAssets	Firm's size	Logarithmized total assets
ROA	Return on assets	Rate of net profits over average total assets in year t and $t-1$
Debt	Leverage	Rate of short-term and long-term debts divided by total assets
CashFlow	Cashflow	Rate of cash received by selling goods and providing services relative to average total assets in year t and $t-1$
lnAge	Logarithmized age	Number of years since the firm went public
GIncome	Growth ratio of income	Rate of Operating income in year $t-1$ divided by operating income in year t then minus 1
PEquity	Ownership concentration	Percentage of shares held by the top ten shareholders
Control variables: peers' characteristics		
lnL1Assets	Average of peers' size	Average value of peers
L1ROA	Average of peers' ROA	Average value of peers
L1TobinQ	Average of peers' Tobin's Q	Average value of peers. Tobin's Q is measured by the ratio of the sum of the market value of stock markets and the book value of liabilities over book value of total assets
L1CashFlow	Average of peers' cashflow	Average value of peers
L1lnAge	Average of logarithmized peers' age	Average value of peers
L1GIncome	Average of peers' growth ratio of income	Average value of peers
L1PEquity	Average of peers' ownership concentration	Average value of peers
DROE	Return gap	ROE of the industry firm *i* operates in minus ROE of financial industry
lnInd_Assets	Average size of the industry firm *i* operates in	Logarithmized total assets of the industry firm *i* operates in
lnprogdp	Economy development	Logarithmized GDP at province level
lnFinAssets	Financial market development	Logarithmized total deposits in the regional banking institutions
Instrumental variables		
lnL2Age	Average logarithmized age of peers' peers	Average value of peers' peers
L2CashFlow	Average cashflow of peers' peers	Average value of peers' peers

Note: This table shows the definition and calculation of main variables in this paper, including the dependent and independent variables, control variables and instrumental variables. We include control variables about firm-level characteristics and peers-level characteristics.

Table 3
Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min.	Max.
Fin (%)	23916	3.7653	7.1910	0.0000	40.8674
L1Fin (%)	23916	3.9071	4.6292	0.0000	24.6832
lnAssets	23916	12.8560	1.2695	10.5933	16.7892
ROA (%)	23916	4.7786	6.0199	-19.3833	23.0835
Debt (%)	23916	41.9407	20.3810	5.1395	89.3670
CashFlow	23916	0.6997	0.5031	0.0852	2.9309
GIncome (%)	23916	15.3648	29.8187	-48.9209	152.8891
lnAge	23912	2.7828	0.3695	0.0000	4.1589
PEquity (%)	23916	59.1975	15.1652	23.4800	90.5700
lnL1Assets	23916	13.4042	1.0764	11.1840	16.5387
L1ROA (%)	23916	4.6831	3.7321	-8.7959	15.6536
L1CashFlow	23916	0.7103	0.3261	0.1844	2.0588
L1TobinQ	23916	2.0264	0.8192	0.9888	5.4912
L1GIncome (%)	23916	16.2938	21.2930	-25.8684	118.5922
L1PEquity (%)	23916	59.0550	9.2505	32.5200	82.0800
L2CashFlow (%)	23916	0.7232	0.2210	0.2986	1.5656
lnL2Age	23916	2.8365	0.2061	1.6094	3.6889

Note: This table shows descriptive statistics of main variables. The sample includes 23916 firm-year observations from 2007-2019. The symbol L1 is for variables of peers. For example, *L1Fin* means the average financial investment ratio of peers for a certain firm. The symbol L2 is for variables of peers' peers. For example, *L2CashFlow* means the average cashflow of peers' peers for a certain firm.

Table 4
Correlation coefficients.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) *Fin*	1.000														
(2) *L1Fin2*	0.165*	1.000													
(3) *lnAssets*	0.038*	0.036*	1.000												
(4) *ROA*	-0.021*	-0.013	-0.049*	1.000											
(5) *Debt*	-0.017*	0.000	0.466*	-0.393*	1.000										
(6) *CashFlow*	-0.077*	-0.010	0.088*	0.128*	0.185*	1.000									
(7) *lnAge*	0.154*	0.122*	0.149*	-0.109*	0.113*	-0.008	1.000								
(8) *GIncome*	-0.044*	-0.015	0.000	0.277*	-0.005	0.086*	-0.081*	1.000							
(9) *PEquity*	-0.121*	-0.019*	0.113*	0.273*	-0.147*	0.056*	-0.241*	0.079*	1.000						
(10) *lnL1Assets*	0.028*	0.057*	0.345*	-0.048*	0.128*	-0.003	0.105*	-0.035*	0.065*	1.000					
(11) *L1ROA*	-0.013	-0.032*	-0.041*	0.092*	-0.070*	0.030*	-0.071*	0.058*	0.041*	-0.058*	1.000				
(12) *L1CashFlow*	-0.016	-0.088*	-0.008	0.030*	0.030*	0.130*	-0.101*	0.011	0.004	0.032*	0.154*	1.000			
(13) *L1TobinQ*	0.008	0.031*	-0.075*	0.026*	-0.047*	-0.017*	-0.006	0.019*	-0.048*	-0.265*	0.162*	-0.025*	1.000		
(14) *L1GIncome*	-0.015	-0.055*	-0.029*	0.049*	-0.022*	0.011	-0.037*	0.094*	0.023*	-0.014	0.256*	0.088*	0.044*	1.000	
(15) *L1PEquity*	-0.015	-0.125*	0.080*	0.031*	-0.022*	-0.001	-0.034*	0.019*	0.122*	0.166*	0.258*	0.066*	-0.133*	0.086*	1.000

Note: This table shows the Pearson correlation coefficients for main variables in our basic regression models. It is indicated that there is a significant positive relationship between financial investment ratio of firm *i* and that of its peers. The definition and calculation of all variables are shown in Table 2 and the descriptive statistics are revealed in Table 3.

or several external factors, such as market liquidity, economic policy uncertainty, and economic development stage (i.e., correlated effects).

We address the endogeneity problem by incorporating instrumental variables (IVs) and regressing with IV-2SLS model. The instrumental variables should fulfill the following three properties: i) the IVs should be correlated with endogenous variables, which are usually independent variables in econometric model; ii) the IVs cannot be affected by outcome variables, which usually refer to dependent variables; iii) there is the only channel that endogenous variables affect outcome variables.

Specifically, we adopt the peers' peers' characteristics, i.e., peers' peers' average logarithmized age ($lnL2Age_{i,t}$) and cashflow with the lag of 1 period ($L2CashFlow_{i,t-1}$) as instrumental variables to make empirical analysis. Bramoullé et al. (2009) and Song and Wang (2020) have proved using peer's peers' characteristics as instrumental variables are reasonable in both theory and practice as they can meet the following three conditions. Firstly, peers' peers' characteristics affect endogenous variable, i.e., the peers' outcomes. In this paper, peers' peers' characteristics are age and cashflow. Generally, the firm's age and cashflow are important signals for information quality (Song and Wang, 2020). Firms going public earlier and with better cashflow are more inclined to be imitated by peers due to their convincing development experience and information quality, therefore affect peers' financial investment.

Secondly, peers' peers' characteristics cannot be influenced by focal firms' outcomes if they meet the following conditions. The first one is that all the firms' peers' peers are indirectly connected with focal firms by deleting any firms which belong to both firm A's peers' peer and firm A's peer, ruling out reverse causation. The second condition is that peers' peers' characteristics are lagged to rule out the simultaneity problem.

Thirdly, peers' peers' characteristics affect firms' financial investment only through peers' financial investment if the following two conditions are fulfilled. One is that firms in the group of peers' peers which in the same industry of the focal firm are removed, making there are no industrial factors affecting firms' peers' peers and focal firms simultaneously. The other is that firms' peers' peers are not directly connected with focal firms, but directly connected by the peers, indicating that the peers' financial investment is the only channel for peers' peers' characteristics affecting focal firms' financial investment.

It is noted that in the Section 4.2 and the rest parts, the samples are processed in the following ways to make the instrumental variables reasonable. Firstly, any firms which belong to both firm A's peers' peer and firm A's peer are deleted to rule out reverse causation. The process is shown in Fig. 4. Secondly, firms in the group of peers' peers which in the same industry of the focal firm are removed to assure that peers' peers' characteristics affect focal firms' financial investment only through peers' financial investment. Fig. 7 depicts the screening strategy. Firm C and firm E are both peers' peers of firm A, but firm E is in the same industry as firm A. Therefore, firm E is excluded from the peers' peers. In addition, the peers' peers' cashflow is lagged by one year to rule out the simultaneity problem. The proving process is shown in Appendix.

Besides, we also verify the robustness of peer effects in financial investment of board interlocking firms with the following methods: including control variables of firm-specific and peer firms' characteristics; changing the dependent variable and the sample interval; and conducting placebo tests.

4. Empirical Results and Discussion

4.1. Baseline estimates

Based on Eq. (1), this paper first uses the Ordinary Least Squares (OLS) regression model to verify the peer effects of board interlocking firms in financial investment and the results are reported in Table 5. Column (1) only includes the firm's financial investment ratio and its peers' average financial investment ratio. In column (2) and column (3), we successively add the firm characteristics and peers' characteristics variables to control the effects of the firm's and peers' characteristics on the firm's financial investment behavior. The results show that the financial investment behaviors are significantly correlated with those of their peers with the significance of 1% and the coefficients are about 0.1, indicating that one-unit increase in peer average financial investment leads to 0.1 increase in focal firm's financial investment.

4.2. Endogeneity and robustness tests

4.2.1. Endogenous analysis

To alleviate the potential endogeneity concern, referring to the identification strategy proposed by Bramoullé et al. (2009) and Song and Wang (2020), we include the average logarithmized age and the average one-year lagged cashflow of the peers' peers as the

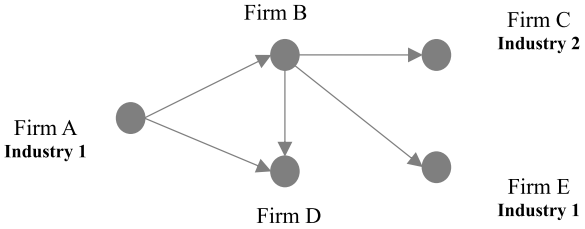

Fig. 7. Screening of peers' peers to exclude firms in the same industry.

Table 5
Existence of peer effects of board interlocking firms in financial investment (OLS model).

Dependent variable: *Fin*	(1)	(2)	(3)
L1Fin	0.0921***	0.0853***	0.0867***
	(10.02)	(6.648)	(6.679)
lnAssets		0.337***	0.344***
		(6.637)	(7.727)
ROA		0.0345*	0.0350*
		(2.124)	(2.141)
Debt		-0.0231*	-0.0232*
		(-1.930)	(-1.944)
CashFlow		-1.530***	-1.524***
		(-9.213)	(-9.082)
lnAge		1.273***	1.275***
		(8.507)	(8.450)
GIncome		-0.00690	-0.00694
		(-1.400)	(-1.400)
PEquity		-0.0538***	-0.0542***
		(-6.746)	(-6.724)
lnL1Assets			-0.0546
			(-1.117)
L1ROA			-0.0151
			(-1.093)
L1CashFlow			-0.0594
			(-0.529)
L1TobinQ			-0.0830
			(-1.511)
L1GIncome			0.00162
			(0.725)
L1PEquity			0.00672
			(0.880)
Constant	3.513***	0.928	1.440
	(6.748)	(1.413)	(1.617)
Year FE	Y	Y	Y
Industry FE	Y	Y	Y
Province FE	Y	Y	Y
Observations	23,916	19,996	19,996
R^2	0.091	0.128	0.128

Note: This table shows the peer effects of board interlock firms in financial investment. The dependent variable is the financial investment ratio of the focal firm and the independent variable is the peers' average financial investment ratio during the same period. Control variables, including firms' characteristics and peers' characteristics are all lagged one year. All continuous variables are winsorized at the top and bottom 1%. The results are estimated by Ordinary Least Squares (OLS). The t-values are in parentheses, and *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively.

instrumental variables for the average financial investment ratio of the peers, and apply the 2SLS regression model to estimate. Table 6 reports the regression results of IV-2SLS. Column (1) only includes the firm's and its peers' financial investment ratio; column (2) includes the firm's characteristics; column (3) includes the peers' characteristics. As can be seen, although the magnitude of the regression coefficients has changed to a certain extent as is compared with Table 5, the direction and significance of the coefficients are basically unchanged, and they have passed the weak instruments test and overidentification test[7]. More specifically, the results in column (3) show that the focal firm's financial investment ratio increases by about 0.4% for every 1% increase in the peers' financial investment ratio, which is larger than the results from OLS models and is consistent with that of Song and Wang (2020).

Furthermore, firms in the group of peers' peers which in the same industry of the focal firm are removed and the results are shown in Table 7. In the left two columns, peers' peers which are in the same six-digit Shenwan industry are excluded and in the right two columns, we exclude peers' peers which are in the same two-digit Shenwan industry. The coefficients of OLS and IV-2SLS models are all significantly positive but the coefficients of IV-2SLS models are lower than those in Table 6 and the significance decreases to a large extent, indicating that the peer effects in financial investment are weakened after further eliminating the endogeneity factors.

It is noted that the endogeneity concern has been reduced extensively based on the more stringent conditions of the two-digit Shenwan industries. Therefore, regression results reported in the latter part of this paper are all based on samples in which firms in the group of peers' peers which are in the same two-digit Shenwan industry as the focal firm have been excluded.

[7] The Cragg-Donald Wald test is a common way to test for weak instruments in IV-2SLS regression. If the F statistic value is small, it indicates that the statistical result of the first-stage regression is poor and the instrument is weak. The P-value of the Sargan test is a signal of overidentification test. If the P-value is less than 0.1, it indicates that there is an overidentification problem of the IVs; otherwise, the IVs are considered appropriate. The overidentification problem may occur only when the number of IVs is more than that of endogenous variables. When the number of IVs and endogenous variables is the same, it is not necessary to test the overidentification problem.

Table 6
Existence of peer effects of board interlocks on financial investment (IV-2SLS model).

Dependent variable: *Fin*	(1)	(2)	(3)
L1Fin	0.382***	0.343**	0.355**
	(2.790)	(2.543)	(2.533)
lnAssets		0.332***	0.335***
		(7.008)	(6.882)
ROA		0.0357***	0.0366***
		(3.665)	(3.745)
Debt		-0.0239***	-0.0238***
		(-7.319)	(-7.315)
CashFlow		-1.490***	-1.486***
		(-13.53)	(-13.49)
lnAge		0.0666***	0.0672***
		(6.671)	(6.770)
GIncome		-0.00678***	-0.00684***
		(-4.031)	(-4.063)
PEquity		-0.0539***	-0.0548***
		(-15.53)	(-15.81)
lnL1Assets			-0.0710
			(-1.369)
L1ROA			-0.0224
			(-1.501)
L1CashFlow			0.0875
			(0.514)
L1TobinQ			-0.118
			(-1.582)
L1GIncome			0.00234
			(0.976)
L1PEquity			0.0169**
			(2.149)
First stage Instruments			
lnL2Age	3.081***	3.068***	2.8234***
	(11.73)	(11.69)	(10.76)
L2CashFlow	0.155	0.160	0.5404***
	(1.06)	(1.10)	(3.46)
Year FE	Y	Y	Y
Industry FE	Y	Y	Y
Province FE	Y	Y	Y
Cragg-Donald Wald F statistic	69.727	69.258	64.832
Sargan Test (P-value)	0.3780	0.5621	0.4334
Observations	19,996	19,996	19,996

Note: This table shows the peer effects of board interlocking firms in financial investment. The dependent variable is the financial investment ratio of the focal firm and the independent variable is the peers' average financial investment ratio during the same period. Instrumental variables are peers' peers' average age and cashflow in year $t-1$. Specifically, column 2 only includes the firm's characteristics and column 3 further includes peers' characteristics. Unless specified, the following models all include firm's characteristics and peers' characteristics with one-year lag as control variables. All continuous variables are winsorized at the top and bottom 1%. The results are estimated by IV-2SLS model. The t-values are in parentheses, and *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively.

In addition, idiosyncratic stock returns[8] of peers are also included as instrumental variables to make further endogenous analysis, according to the study of Leary and Roberts (2014). The results are shown in Table 8. In column (1), no control variables are included, in column (2), the firm's characteristics are included and in column (3), the peers' characteristics are further included. It is shown that the coefficients are about 0.4 with the significance of 5% or 1%, which is basically consistent with IV-2SLS results with peers' peers' characteristics as instrumental variables.

4.2.2. Robustness checks

We make robustness checks by changing dependent variables and statistical criteria. The results are shown in Table 9. Firstly, we replace the dependent variable with *DInd_Fin*, which indicates the difference in the financial investment ratio between the firm and the industry it operates in to further exclude the influence of internal characteristics of industries on corporate financial investment behavior. The results are shown in the columns (1)-(2). It is shown that the coefficient is 0.08 in OLS model, indicating that one unit increase in peers' average financial investment will lead to a 0.08 increase of the difference of financial investment ratio and the industry. Furthermore, observations from 2018 and 2019 are excluded in columns (3)-(4) to rule out the influence of changes in the

[8] For the calculation of stock idiosyncratic volatility, this paper refers to Leary and Robert (2014) and Fama and French (2015) and is based on monthly stock price data of the sample firms. The calculation procedures and results are omitted in the paper but are available upon request.

Table 7
Excluding firms in the group of peers' peers which are in the same industry as the focal firm (IV-2SLS).

Dependent variable: *Fin*	(1)	(2)	(3)	(4)
	OLS	IV-2SLS	OLS	IV-2SLS
	Six-digit Shenwan industries		Two-digit Shenwan industries	
L1Fin	0.0920***	0.264*	0.0905***	0.284*
	(7.624)	(1.724)	(7.445)	(1.806)
Control variables	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Province FE	Y	Y	Y	Y
Cragg-Donald Wald F statistic	-	54.635	-	51.778
Sargan Test (Chi-sq(2) P-val)	-	0.1386	-	0.3427
Observations	20,031	20,031	19,966	19,966

Note: This table shows the peer effects of board interlocking firms in financial investment. The dependent variable is the financial investment ratio of the focal firm and the independent variable is the peers' average financial investment ratio during the same period. Control variables include the firm's characteristics and peers' characteristics in year $t-1$. Instrumental variables are peers' peers' average logarithmized age and cashflow in year $t-1$. Specifically, we exclude the peers' peers which are in the same Shenwan industry as firm i. In the left two columns, peers' peers which are in the same six-digit Shenwan industry are excluded and in the right two columns, we exclude peers' peers which are in the same two-digit Shenwan industry. All continuous variables are winsorized at the top and bottom 1%. The results are estimated by OLS and IV-2SLS models. The t-values are in parentheses, and *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively.

Table 8
Existence of peer effects of board interlocks on financial investment (IV-2SLS model-idiosyncratic stock returns of peers as instrumental variable).

Dependent variable: *Fin*	(1)	(2)	(3)
L1Fin	0.382***	0.343**	0.355**
	(2.790)	(2.543)	(2.533)
Control variables	N	Part	Y
First stage Instruments			
L1Vol	2.975**	3.005***	2.852**
	(2.55)	(2.58)	(2.39)
Year FE	Y	Y	Y
Industry FE	Y	Y	Y
Province FE	Y	Y	Y
Cragg-Donald Wald F statistic	6.518	6.652	5.694
Observations	12,624	12,624	12,624

Note: This table shows the peer effects of board interlocking firms in financial investment. The dependent variable is the financial investment ratio of the focal firm and the independent variable is the peers' average financial investment ratio during the same period. Instrumental variables are peers' idiosyncratic stock returns in year $t-1$. Specifically, column 2 only includes the firm's characteristics and column 3 further includes peers' characteristics. All continuous variables are winsorized at the top and bottom 1%. The results are estimated by IV-2SLS model. The t-values are in parentheses, and *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively.

statistical criteria of financial assets on the regression results. The results show that the coefficients are still significant, but decrease after excluding observations from 2018 and 2019.

4.2.3. Placebo test

Although endogeneity concerns are addressed in various ways above, the following possibilities may still exist: a) the expansion of financial activities is a natural result of the economy at a certain stage of development; and b) the expansion of financial activities is a common result of the exogenous economic shock on all firms, rather than the result of imitation. To exclude the effect of unobservable exogenous shock on corporate financial investment behavior, the hypothesis is further verified with a placebo test. This is done by randomly classifying all firms in a certain year and verifying whether there are peer effects in financial investment of "pseudo-interlocked" firms[9]. We perform 1,000 random groupings and apply the IV-2SLS regression model to estimate the β coefficients and t-test values.

The results in Table 10 show that the average of coefficients for 1,000 random groupings is 0.0146, and the maximum value of T-

[9] Specifically, we randomly disrupt the average financial investments of board interlocked firms and then distribute them to any focal firms. In this case, the independent variable is the average financial investment of "pseudo-interlocked" firms.

Table 9
Robustness test (changing the dependent variables and statistical criteria).

Dependent variable	(1)	(2)	(3)	(4)
	DInd_Fin	*DInd_Fin*	*DInd_Fin*	*DInd_Fin*
	OLS	IV-2SLS	OLS	IV-2SLS
L1Fin	0.0802***	0.290**	0.0681***	0.282*
	(7.926)	(2.207)	(5.984)	(1.798)
Control variables	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Province FE	Y	Y	Y	Y
Cragg-Donald Wald F statistic	-	72.548	-	50.217
Sargan Test (Chi-sq(2) P-val)	-	0.8318	-	0.3604
Observations	19,830	19,830	14,619	14,619

Note: This table shows the peer effects in financial investment of board interlocking firms. The dependent variables are the difference of the financial investment ratio of the focal firm and the average financial investment ratio of the industry in which the focal firm operates. In columns (3) and (4), we exclude observations from 2018 and 2019 to rule out the influence of changes in the statistical criteria of financial assets on the regression results. The results are estimated by OLS in columns (1) and (3), while the results in columns (2) and (4) are estimated by IV-2SLS. The independent variable is the peers' average financial investment ratio during the same period. Control variables include the firm's characteristics and peers' characteristics in year $t-1$.. Instrumental variables are peers' peers' average age and cashflow in year $t-1$. Specifically, we exclude those peers' peers that are in the same two-digit Shenwan industry as the focal firm. All continuous variables are winsorized at the top and bottom 1%. Standard errors are clustered by year. The t-values are in parentheses, and *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively.

Table 10
Placebo test by random grouping.

Variables	Obs. (Groups)	Mean	Std. Dev.	Min.	Max.
β_1 for regression of random grouping	1,000	0.0146	4.1771	-45.4704	49.5810
T-value	1,000	0.0211	0.8576	-1.6981	1.7593

Note: This table shows the statistics of the coefficient β_1 and t-test value of the regression estimators of peer effects in financial investment with regards to "pseudo-interlocked" firms under 1,000 random groupings. The model and estimation method are consistent with the results exhibited in column (4) of Table 7. From the results, it can be seen that after the firms are randomly grouped in a certain year, the average effects of peers' average financial investment ratio on firm *i* is 0.0146 and the maximum value of the t-test is 1.7593, which is less than the t-test under the real board interlocks of 1.806 in column (4) of Table 7.

test is 1.7593, which is smaller than the t-test value of 1.806 for the real grouping (column (4) in Table 7). As such, it is reasonable to reject the existence of peer effects in financial investment of "pseudo-interlocked" firms and the existence of peer effects of corporate financial investment is verified again.

In summary, we verify the existence of peer effects in financial investment of board interlocking firms, i.e., hypothesis H1. Specifically, the values of the peer effects are about 0.1-0.4 after adding control variables and fixing year, industry and province effects, which indicates that the firm's financial investment ratio increases by about 0.1-0.4 units for each percent increase in financial investment ratio in peer firms. Our results are basically in accordance with those of Grieser et al. (2022), in which the peer-effect coefficients estimated by Spatial Autoregressive (SAR) model and extended Spatial Autoregressive (SAR) model are from 0.02 to 0.3. The results illustrate that peer effects are one of the important driving forces that lead to the overall increase of firms' financial investment. Therefore, one of the important measures to guide more firms to refocus on their "main businesses" is to discourage firms from blindly imitating financial investment behaviors. For example, more professional training (e.g., the explanation about current economy and policy, the risk assessment, etc.) on managers is essential for nonfinancial firms.

5. Mechanism Analysis

5.1. Information quality and directional peer effects

To investigate whether information quality affects peer effects, we group all firms as either 'leaders' or 'followers' based on four performance indicators: earnings growth, cashflow ratio, Tobin's Q, and stock idiosyncratic volatility (Song and Wang, 2020). Specifically, if an indicator of firm *i* outperforms the mean of its peers, the focal firm is defined as a leader; otherwise, it is defined as a follower. Among the indicators, earnings growth and cashflow ratio reflect the operating conditions of the firm, and the higher the value of the two indicators, the better the operating conditions of the firm. Tobin's Q reflects the market value of the firm, and stock idiosyncratic volatility reflects the relative information quality of the firm's stock price. In general, the higher the volatility, the noisier of information conveyed by the stock price, and the lower the value it can provide for the firm's decision-making, and vice versa (Song

Table 11
Directional analysis of the peer effects of board interlocking firms in financial investment (IV-2SLS).

Dependent variable: *Fin*	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Growth ratio of income		Tobin's Q		Cashflow		Idiosyncratic volatility	
	Followers	Leaders	Followers	Leaders	Followers	Leaders	Followers	Leaders
L1Fin	0.579***	0.194	0.437**	-0.0570	0.761***	-0.172	0.433*	0.0760
	(2.650)	(1.194)	(2.254)	(-0.246)	(2.871)	(-1.054)	(1.784)	(0.203)
Control variables	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y	Y	Y
Province FE	Y	Y	Y	Y	Y	Y	Y	Y
Cragg-Donald Wald F statistic	30.315	43.303	35.489	22.778	27.128	28.934	24.992	8.768
Sargan Test (P-val)	0.9475	0.2037	0.7140	0.7347	0.2709	0.7042	0.8402	0.8439
Observations	10,857	9,174	11,522	8,509	11,570	8,461	7,247	5,603

Note: This table reports the directional peer effects of board interlocking firms in financial investment. The dependent variable is the financial investment ratio of the focal firms. The independent variable is the peers' average financial investment ratio during the same period. Control variables include the firm's characteristics and peers' characteristics, industry-level characteristics, and region-level characteristics in year $t-1$. Instrumental variables are peers' peers' average age and cashflow in year. Firms are identified as followers or leaders based on the comparative values between focal firms' revenue growth rate, cashflow ratio, Tobin's Q, and idiosyncratic volatility and those of peers. Specifically, if the focal firm's revenue growth rate or cashflow or Tobin's Q is less than the average value of peers, then the focal firm is identified as a follower, otherwise it is a leader. Furthermore, if the focal firm's idiosyncratic volatility is higher than that of peers, the focal firm is a follower, otherwise it is a leader. All continuous variables are winsorized at the top and bottom 1%. The results are estimated by IV-2SLS model. Standard errors are clustered by year. The t-values are in parentheses, and *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively.

and Wang, 2020).

The regression results are displayed in Table 11. It is shown that the core coefficients representing peer effects are only significant for followers in columns (1), (3), (5) and (7), while they are nonsignificant for leaders in columns (2), (4), (6) and (8). The results indicate that peer effects are mainly reflected in the imitation of leaders by followers. The coefficients in columns (1), (3), (5) and (7) for followers are greater than those for all firms in Section 4, which further verifies the peer effects only occur in followers.

As the imitation theory proposed, information-quality gap is an important driving force of peer effects. That is, firms with inferior quality information are inclined to follow firms with superior quality information, i.e., firms with higher earnings growth, higher cashflow ratios, higher market value, and better information quality, to alleviate risks and competition. The findings are consistent with conclusion of Leary and Roberts (2014), Song and Wang (2020), Seo (2021) and Vo et al. (2021), that is peer effects are directional, firms are inclined to imitate board interlocking peers with information and industry advantages, so as to maintain their industrial competitiveness (Durnev and Mangen, 2009). This verifies hypotheses H2a.

Firms usually make decisions by the announced financial indicators, which are usually lagged by one period. In this case, we make robustness analysis by identifying leaders and followers by one-year lagged financial indicators, i.e., one-year lagged earnings growth, cashflow ratio, Tobin's Q, and stock idiosyncratic volatility. The results in Table 12 still hold.

5.2. *Information delivering or exposure and peer effects*

Generally, firms will follow others only after obtaining effective information. Therefore, we will next investigate how information delivering or exposure affects peer effects. In this paper, the firms (including all sample firms and follower firms mentioned in Section 5.1) are divided into two groups based on their betweenness centralities in the board interlocking networks (Nandy et al., 2020)[10] and assets holdings. More specifically, firms with higher betweenness centralities can usually obtain more information as the nodes on the shortest paths among interlocked firms. In addition, large firms usually have more access to information. In this case, firms, whose betweenness centralities or assets are higher than the median values are classified into higher-information-reception group, and firms whose betweenness centralities or assets are lower than the median values are classified into lower-information-reception group.

The regression results grouping by betweenness centralities are shown in Table 13. In columns (1) and (2), the samples are all firms, while in columns (3)-(10), the samples are followers. The results in Table 14 are calculated by asset-based group regression, and the samples in different columns are in line with those in Table 13. It is shown that coefficients in columns (1), (3), (5), (7) and (9) are positive significantly, while they are nonsignificant in other columns. The results prove our hypothesis H2b, i.e., firms located in the

[10] There are three main indicators to characterize the importance of the node: degree centrality, closeness centrality, and betweenness centrality. Degree centrality is the number of links incident upon a node; closeness centrality is a measure of centrality in a network, calculated as the reciprocal of the sum of the length of the shortest paths between the node and all other nodes in the graph; and betweenness centrality measures the extent to which a vertex lies on paths between other vertices, indicating the resource acquisition ability, i.e., information reception ability. As this paper aims to explore how information reception affects peer effects, we only adopt betweenness centrality to portray the location of the firm in the network.

Table 12
Directional analysis of the peer effects of board interlocking firms in financial investment (IV-2SLS).

Dependent variable: *Fin*	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	L. Growth ratio of income		L. Tobin's Q		L. CashFlow		L. Idiosyncratic volatility	
	Followers	Leaders	Followers	Leaders	Followers	Leaders	Followers	Leaders
L1Fin	0.428**	0.300	0.313*	0.138	0.565**	-0.0738	0.575*	-0.0310
	(2.320)	(1.581)	(1.715)	(0.532)	(2.521)	(-0.390)	(1.927)	(-0.103)
Control variables	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y	Y	Y
Province FE	Y	Y	Y	Y	Y	Y	Y	Y
Cragg-Donald Wald F statistic	40.861	32.070	36.639	19.672	33.367	23.929	16.701	14.213
Sargan Test (P-val)	0.7182	0.0766	0.4867	0.5716	0.3558	0.2317	0.8077	0.1532
Observations	10,845	9,186	11,650	8,381	11,483	8,548	7,006	5,844

Note: This table reports the heterogenous peer effects of board interlocking firms in followers' and leaders' financial investment. The dependent variable is the financial investment ratio of the focal firms. The independent variable is the peers' average financial investment ratio during the same period. Control variables include the firm's characteristics and peers' characteristics, industry-level characteristics, and region-level characteristics in year $t-1$. Instrumental variables are peers' peers' average age and cashflow in year. Firms are identified as followers and leaders based on the comparative values between one-year lagged revenue growth rate, cashflow ratio, Tobin's Q, and idiosyncratic volatility between focal firms and peers. Specifically, if the focal firm's one-year lagged revenue growth rate or cashflow or Tobin's Q is less than the average value of peers, then the focal firm is identified as a follower, otherwise it is a leader. Furthermore, if the focal firm's one-year lagged idiosyncratic volatility is higher than that of peers, the focal firm is a follower, otherwise it is a leader. All continuous variables are winsorized at the top and bottom 1%. The results are estimated by IV-2SLS model. Standard errors are clustered by year. The t-values are in parentheses, and *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively.

Table 13
Betweenness centrality and peer effects of board interlocking firms in financial investment (IV-2SLS).

Dependent variable: *Fin*	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	All firms		Followers: CashFlow		Followers: Growth ratio of income		Followers: Tobin's Q		Followers: Idiosyncratic volatility	
	High	Low	High	Low	High	Low	High	Low	High	Low
L1Fin	0.730***	-0.237	1.524***	0.120	0.750**	-0.0998	1.030***	0.0124	0.739**	0.300
	(3.305)	(-1.081)	(2.921)	(0.357)	(2.510)	(-0.246)	(3.279)	(0.0519)	(1.987)	(0.965)
Control variables	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Province FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Cragg-Donald Wald F statistic	35.803	22.684	10.851	13.004	20.536	6.898	19.431	18.307	15.180	11.190
Sargan Test (P-val)	0.1297	0.6587	0.2985	0.3822	0.0785	0.5280	0.4124	0.3878	0.5049	0.2639
Observations	10,534	9,296	5,774	5,682	5,586	5,166	7,410	4,005	4,103	3,144

Note: This table reports the heterogenous peer effects in financial investment of board interlocking firms located in different positions in the network and with different assets. The dependent variable is the financial investment ratio of the focal firms. The independent variable is the peers' average financial investment ratio during the same period. Instrumental variables are peers' peers' average age and cashflow in year $t-1$. Firms with high betweenness centrality are identified to locate in core position of the board interlocking network, and firms with low betweenness centrality are identified to locate in marginal position of the board interlocking network. For high-information-reception firm, its betweenness centrality is higher than the median values of firms in the same industry and year, and firm whose betweenness centrality is lower than the median values is identified as low-information-reception firm. Followers are defined in Section 5.1. All continuous variables are winsorized at the top and bottom 1%. The results are estimated by IV-2SLS model. Standard errors are clustered by year. The t-values are in parentheses, and *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively.

core position in the board interlocking network (with higher betweenness centralities) and with more assets are more likely to be affected by peers.

The result reveals that firms with inferior quality information are intended to imitate only if they are exactly exposed to the superior quality information, and firms located in core positions (physical or network) or with large scales are more likely to obtain information from the surroundings. The findings also prove the importance of information delivering in peer effects of board interlocked firms.

6. Conclusions and Policy Recommendations

Based on the board interlocking information of Chinese A-share listed firms, we have obtained the following conclusions. Firstly,

Table 14
Firm size and peer effects of board interlocking firms in financial investment (IV-2SLS).

Dependent variable: *Fin*	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	All firms		Followers: CashFlow		Followers: Growth ratio of income		Followers: Tobin's Q		Followers: Idiosyncratic volatility	
	High	Low	High	Low	High	Low	High	Low	High	Low
L1Fin	0.361**	0.100	1.018***	0.538*	0.689***	0.193	0.469**	0.366	0.447*	0.497
	(2.384)	(0.429)	(3.244)	(1.682)	(2.869)	(0.514)	(2.573)	(1.148)	(1.737)	(1.303)
Control variables	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Province FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Cragg-Donald Wald F statistic	53.827	23.212	21.300	16.474	25.598	9.535	41.322	11.636	20.863	10.306
Sargan Test (P-val)	0.6186	0.9958	0.7785	0.9182	0.8962	0.9748	0.3279	0.1978	0.0617	0.1836
Observations	10,534	9,296	5,774	5,682	5,586	5,166	7,410	4,005	4,103	3,144

Note: This table reports the heterogenous peer effects in financial investment of board interlocking firms located in different positions in the network and with different assets. The dependent variable is the financial investment ratio of the focal firms. The independent variable is the peers' average financial investment ratio during the same period. Instrumental variables are peers' peers' average age and cashflow in year $t-1$. Firms with high assets are identified to have more information in the market, and firms with low assets are identified to have less information. For high-information-reception firm, its assets are higher than the median values of firms in the same industry and year, and firm whose assets are lower than the median values is identified as low-information-reception firm. Followers are defined in Section 5.1. All continuous variables are winsorized at the top and bottom 1%. The results are estimated by IV-2SLS model. Standard errors are clustered by year. The t-values are in parentheses, and *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively.

board interlocking firms exhibit significant peer effects in their financial investment, i.e., firms tend to imitate the financial investment behaviors of the board interlocking peers. Specifically, the focal firm's financial investment ratio increases by about 0.1%-0.4% for every 1% increase in the peers' financial investment ratio. The peer effects can explain the narrowing differences of financial investment of board-interlocked firms, as well as the increasing financial investment ratio of nonfinancial firms in China, i.e., financial-activities expansion or financialization. Secondly, information quality gap is an important driving force of peer effects, the phenomena that firms with inferior quality information are intended to imitate financial investment behaviors of leaders, which are recognized to have superior-quality information. Better financial performance, higher market capitalization, and low stock idiosyncratic volatility are signals of superior-quality information. Finally, information reception level determines the peer effects. Only firms which can access to superior quality information imitates their interlocked peers. Firms located in the core position of the board interlocking networks or with more assets usually can obtain more high-quality information. The conclusions convey the important roles of leader firms and information management.

The findings provide a new perspective on understanding the expansion of financial investment activities by nonfinancial firms in developing countries such as China. In accordance with the conclusions, policy recommendations can be derived as follows. Firstly, policy makers can guide firms' financial investments by intervening those of their board interlocking firms in order to drive the level of financialization of the whole economy to an ideal level, considering the peer effects of financial investment for board interlocking firms. Secondly, the mechanism analysis proves that the intervention in firms with superior information is more efficient considering their leadership in financial investment. Thirdly, the information management of nonfinancial firms is an important task during the guidance of financial investment considering the impacts of information delivering on peer effects.

In the future, we can make further analysis in the following two aspects. Firstly, further research can construct new board interlocking networks including the power differences between board roles and demonstrate how peer effects vary across different board interlocking networks. Secondly, we can analyze peer effects in other firms' behaviors, such as green investment, innovation investment, etc.

Declaration of Competing Interest

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Appendix

To clearly point out and address the endogeneity problem, we start with a simple network-effects model without correlated effects. Suppose there are a set of firms i, $i \in \{1, 2, \ldots, n\}$; y_i denotes the level of investment activities by firm i; X_i be a $1 \times K$ vector of characteristics of i including firm's age and cashflow. The main assumptions are as following: first, each firm i may have a specific

network group P_i of size n_i, $i \notin P_i$; second, a firm's activities (e.g., investment) may be affected by the activities of its peer group, its own characteristics (e.g., Tobin's Q, cashflow, and sales growth, etc.), and characteristics of its peer group.

Formally, the structural network effects model is given by:

$$y_{it} = \mu + \beta \bar{y}_{it} + \gamma X_{it-1} + \lambda \overline{X}_{it} + \epsilon_{it} \tag{1}$$

where $\bar{y}_{it}$ is the mean of network firms' investment, X_{it-1} is $n \times K$ vector of the firm's own characteristics at time $t-1$, and $\overline{X}_{it}$ is an $n \times K$ vector of network firms' average characteristics. The parameter β captures the endogenous effect, and λ captures the endogenous effect, and μ includes a set of unobservables, such as firm-fixed effects, time-fixed effects, and state-fixed effects. The error term ϵ_{it} reflects unobserved drivers of firm i's investment at time t and is uncorrelated with the set of regressors. The aggregate-level uncertainty σ_t is omitted for the sake of simplicity.

In matrix notation, the structural model Eq. (1) becomes:

$$\boldsymbol{y} = \mu \boldsymbol{l} + \beta \boldsymbol{G}\boldsymbol{y} + \gamma \boldsymbol{X} + \lambda \boldsymbol{G}\boldsymbol{x} + \epsilon \tag{2}$$

where $\boldsymbol{y}$ is an $n \times 1$ vector of investment activities for the network, $\boldsymbol{l}$ is an $n \times 1$ vector of ones. We impose that $|\beta| < 1$, which is a standard requirement. We assume that the expected outer product $(\boldsymbol{l},\boldsymbol{x})$ has a full rank. $\boldsymbol{G}$ is an $n \times n$ interaction matrix with

$$G_{it} = \begin{cases} 1/n_i, & j = -i \\ 0, & j \neq -i \end{cases}$$

We show that $\theta = (\mu, \beta, \gamma, \lambda)$ is identified given the moment restriction $E(\epsilon|\boldsymbol{x}) = 0$ and the restrictions on $\boldsymbol{G}$. Therefore, we assume there are no correlated effects or network-fixed effects since the data we consider show time-varying networks among the firms. Now, we write a reduced form of Eq. (2). Since $|\beta| < 1$, $(\boldsymbol{I} - \beta \boldsymbol{G})$ is inevitable. We get

$$\boldsymbol{y} = \mu(\boldsymbol{I} - \beta \boldsymbol{G})^{-1}\boldsymbol{l} + (\boldsymbol{I} - \beta \boldsymbol{G})^{-1}(\gamma \boldsymbol{I} + \lambda \boldsymbol{G})\boldsymbol{x} + (\boldsymbol{I} - \beta \boldsymbol{G})^{-1}\epsilon \tag{3}$$

where the intercept is simply $\mu/(1-\beta)$ if the firm is not isolated and μ, otherwise.

Since $(\boldsymbol{I} - \beta \boldsymbol{G})^{-1} = \sum_{k=0}^{\infty} \beta^k \boldsymbol{G}^k$, expanding Eq. (3) gives

$$\boldsymbol{y} = \mu/(1-\beta)\boldsymbol{l} + \gamma \boldsymbol{x} + (\gamma\beta + \lambda) \sum_{k=0}^{\infty} \beta^k \boldsymbol{G}^{k+1}\boldsymbol{x} + \sum_{k=0}^{\infty} \beta^k \boldsymbol{G}^k \epsilon \tag{4}$$

Note that $(\gamma\beta + \lambda) \neq 0$ is straight-forward in the firm network setting. It means that characteristics of network firms have some (direct and/or indirect) effects on a firm's expected investment activities. When it is violated, network effects are absent from the reduced form because endogenous and exogenous effects exactly cancel out (Bramoullé et al., 2009). From Eq. (4), the expected mean of network groups' investment activities conditional on **x** can be written as:

$$E(\boldsymbol{G}\boldsymbol{y}|\boldsymbol{x}) = \mu/(1-\beta)\boldsymbol{l} + \gamma \boldsymbol{G}\boldsymbol{x} + (\gamma\beta + \lambda) \sum_{k=0}^{\infty} \beta^k \boldsymbol{G}^{k+2}\boldsymbol{x} \tag{5}$$

Thus, the endogenous network groups' investment is determined by three terms: a constant, their own characteristics, and their network group's characteristics. This is a typical first step regression equation in the two-stage least square regression. The constant and the exogenous regressor $\boldsymbol{G}\boldsymbol{x}$ show up in the structural Eq. (2). The variables $\boldsymbol{G}^{k+2}\boldsymbol{x}$, $k \geq 0$, are the excluded instrumental variables. As long as the instruments are strongly correlated with the endogenous regressor, they can be used as valid instruments.

For instance, $\boldsymbol{G}^2\boldsymbol{x}$ can be used as a valid identifying instrument and therefore can be used to consistently estimate the parameters. The instrument $\boldsymbol{G}^2\boldsymbol{x}$ represents an $n \times m$ vector of averages of characteristics (such as firm's age and cashflow) of the peers' peers of the firm i in the network where m is the number of instruments. As pointed out in Bramoullé et al. (2009), we note that when no firm is isolated, the matrices **I, G**, and $\boldsymbol{G}^2$ are linearly independent if and only if the expected mean $E(\boldsymbol{G}\boldsymbol{y}|\boldsymbol{x})$ is not perfectly collinear with the regressors $(\boldsymbol{l}, \boldsymbol{x}, \boldsymbol{G}\boldsymbol{x})$ in Eq. (2). The intransitive triad nature of the network guarantees that the matrices **I, G**, and $\boldsymbol{G}^2$ are linearly independent. This means that $\boldsymbol{G}^2\boldsymbol{x}$ is a valid identifying instrument for $\boldsymbol{G}\boldsymbol{y}$, since $\boldsymbol{G}^2\boldsymbol{x}$ affects $\boldsymbol{y}$ only indirectly through its effects on $\boldsymbol{G}\boldsymbol{y}$.

In our empirical estimation, to identify peers' peers, we remove any firms belonging to both firm's peers' peer group and firm's peer group, to assure that the firms' friends' friends are not the firms' direct friends. We also exclude the firms in the group of peers' peers which are in the same industry of firm i, in order to guarantee that **I, G**, and $\boldsymbol{G}^2$ are linearly independent.

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