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Of stars and galaxies – Co-authorship network and research☆

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ABSTRACT

We examine the association between network centrality and research using the accounting research community setting. We establish co-authorship network using papers published in the five top accounting journals from 1980 to 2016. We find that the co-authorship network in accounting is a "small world" with some most connected authors playing a key role in connecting others. We use machine learning to label published papers with multiple topics and find patterns in topics over time. More importantly, we find that co-authorship network centrality is positively associated with future research productivity and topic innovation and that the impact of centrality on productivity is higher with more senior authors. Further, centrality of an author's co-authors also has an incrementally positive impact. We conclude that network centrality positively influences research output.

1. Introduction

A growing literature examines the economic consequences of network centrality based on personal connections among firm executives, board members, etc. For example, Faleye et al. (2014), El-Khatib et al. (2015)

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and Larcker et al. (2013) focus on the impact of network centrality on firm performance. However, they reach different conclusions. We study another important form of network, the co-authorship network among research scholars, and examine the impact of network centrality on individual researcher's output.

Network plays an especially important role in research. Collaboration in research activities is common and increasing among firms, organizations, and individuals (Becker and Dietz, 2004; Cowan et al., 2007; de Faria et al., 2010). The co-authorship network has expanded dramatically overtime. Further, researchers rely much more, compared with other work forces, on interactions with collaborators (Allen, 1971, 1977; Allen et al., 2007). Accordingly, the research community offers a unique and excellent setting for examining the association between network centrality and output.

We study the association between network centrality and output by employing a novel dataset on the co-authorship network constructed based on the publication records of accounting researchers. Specifically, using 5895 papers published in the top five accounting journals (*Journal of Accounting Research – JAR*; *The Accounting Review – TAR*; *Journal of Accounting and Economics – JAE*; *Contemporary Accounting Research – CAR*; and *Review of Accounting Studies – RAS*) from 1980 to 2016, we establish a co-authorship network and examine its property. We apply machine learning to label each paper with multiple topic tags, which allows us to more objectively depict the development of research ideas in the accounting literature in a large-sample setting. We then estimate the impact of individual authors' centrality in the co-authorship network on their future research output.

To establish a co-authorship network, we treat every author as a node in the network and define two authors as linked if they have a co-authorship relationship through published papers. Goyal et al. (2006) define a network as having a "small world" property if it satisfies four features. First, the number of nodes (authors) is very large relative to the number of links (co-author relationships). Second, there exists a giant component that covers a large proportion of the population.[1] Third, the average number of steps needed to connect any two nodes in the network is small. Fourth, within the network, the clustering coefficient which measures the overlap of co-authorship is high.[2] Our results show that the co-authorship network in accounting satisfies all four features. We further check the role played by the most connected authors who have high co-authorship compared with the average co-authorship of the population. These authors generally have more publications and a higher proportion of co-authored papers. More importantly, the clustering coefficient of the most connected authors is low relative to the network average. This suggests that, while these authors collaborate with many co-authors, their co-authors generally do not work with each other. Therefore, the most connected authors occupy an important position in sustaining the network.

Our main purpose is to examine the impact of co-authorship-based network centrality on individuals' research output, as measured by productivity and topic innovation. Centrality reflects the importance of an individual author in the network. We use three measures to capture centrality. The first measure is *Degree*, which is the number of co-authors for an author in the network. The second measure is *Closeness* (Sabidussi, 1966), which captures the inverse of the overall distance of an author to other authors. The third measure is *Betweenness* (Freeman, 1977), which captures the extent to which the shortest path between two authors goes through a given author. The higher are the values of these three measures, the more central an author is in the network. We find that an author's network centrality is positively associated with an author's future productivity and topic innovation.

As the three centrality measures are calculated based on the co-authorship network formed via an author's past publications, this can cause two potential endogeneity issues. First, if both an author's research output and network centrality are affected by common omitted variables, the association between co-authorship network centrality and research output can be biased. Second, it is possible that productive authors can attract more co-authors and hence gain centrality in the network. We use an instrumental variable approach to address endogeneity and the general tone of our findings does not change.

We execute several further analyses on the association between network features and research output. First, author seniority enhances the effect of centrality on research productivity but not on topic innovation. Second,

[1] A component is a sub-group of nodes in the network within which any two nodes can be connected through one or several steps.

[2] The clustering coefficient measures the extent to which an author's co-authors are also co-authors with each other. The higher is this coefficient, the more overlapping is co-authorship in the network.

while isolated authors have lower research productivity, they have a similar level of topic innovation compared with other authors. Third, we show that centrality of an author's co-authors also has an incrementally positive impact on research output. Overall, we provide evidence that network centrality affects research output.

We make several contributions. First, we contribute to the literature on the economic consequences of network centrality. Earlier studies have examined network centrality based on personal connections among board members/executives, and the impact of network centrality on firm performance, innovation and the cost of debt (Larcker et al., 2013; Chullun et al., 2014; Akbas et al., 2016; Faleye et al., 2014; El-Khatib et al., 2015). However, whether the effect of network centrality is positive or negative is far from being clear. We recognize that networking and collaboration are especially important in the academic research community. Using the accounting research community as a setting, we show that co-authorship-based network centrality positively influences research output. Ahuja et al. (2003) examine how individual centrality affects performance in a Virtual R&D group. Our study differs from them in several ways. First, individuals in their study all belong to a formal R&D group and thus have official access to each other, while in our study, most authors are not affiliated with the same organization. Second, they construct networks based on communication (email-messages) while we focus on co-authorship based network. Third, due to the nature of the individual network, Ahuja et al. (2003) focus on how individual centrality mediates the effects of individuals' functional, status and communication role on their performance. We, on the other hand, are interested in how centrality in the co-authorship network directly affects authors' research output.

Second, we contribute to an analysis of the accounting research community. While researchers can establish various social connections such as work affiliations, doctoral programs (Lohmann and Eulerich, 2017) or paper citations (Bonner et al., 2012), co-authorship is a particularly important form of social connection. Co-authorship has gained increased popularity as the communication cost has decreased substantially and research projects have become more challenging and complex. It is a long-lasting relationship that involves intense collaborations and risk-sharing. Researchers have examined the co-authorship network in other disciplines (Goyal et al., 2006; Goldenberg et al., 2010). We describe the co-authorship network in accounting and provide further insights into the evolution and impact of social networks in the research community.

Third, we apply a new research topic classification. Prior studies in this field classify accounting papers into a limited number of subjective topics (Oler et al., 2010). The Latent Dirichlet Allocation (LDA) model we employ generates multiple topic labels on an objective basis. Based on the LDA topic labels, we construct an author-paper level topic innovation measure. The topic innovation measure has two advantages. First, as the LDA topic modelling allows us to divide the accounting literature into a large number of topics, we are able to examine topic innovation for a large sample. Second, the LDA topic modelling is an objective algorithm that does not require discipline-specific information. Our measure can thus be easily applied to other disciplines to evaluate paper-level topic innovation. In this sense, our study not only contributes to an analysis of the accounting literature, but also provides a useful research output measure for analyses of literatures in other disciplines.

Finally, our research has "policy implications". Predicting research output is of great importance to universities in their recruiting and promotion decision-making process. Our findings suggest that co-authorship network centrality helps predict research output in addition to researchers' past number of publications, thus assisting universities' evaluation process.

This paper proceeds as follows. Section 2 reviews literature and formulate our hypothesis. Section 3 discusses sample formation. Section 4 describes the establishment of the co-authorship network and examines its property. Section 5 discusses methodologies and results of the paper topic analysis. Section 6 reports results on the impact of network centrality on research output. Section 7 summarizes and concludes.

2. Literature and hypothesis development

2.1. Literature on network centrality and hypothesis

Social networks provide channels for the flow of influence, support, information and other valuable resources among people and organizations (Larcker et al., 2013). Network centrality describes the position

of individuals or organizations in a network. The higher the centrality, the more important a person or an organization is in a network, and the easier it becomes for them to access resources in the network. Accordingly, several studies find that network centrality has positive effects on people and organizations. Faleye, Kovacs, and Venkateswaran (2014) use social centrality to measure CEO social connections. They argue that strong social connections provide CEOs with an information advantage to explore and utilize innovative ideas as well as high job security in the labour market, and thus reduce CEOs' risk aversion. Accordingly, they document that better-connected CEOs invest more in research and development and that their firms obtain more high quality patents. Larcker et al. (2013) argue that high board centrality can facilitate information and resource exchanges among firms, bring social capital to them and foster collaborations. They find that board centrality improves stock returns and return on assets. Chullun et al. (2014) suggest that high board centrality can enhance investor recognition, help firms build closer ties with financial institutions, and reduce information asymmetry by increasing firm visibility and reputation. They demonstrate empirically that high board centrality expands firms' access to external capital and reduces their cost of debt.

Network plays an especially important role in the research community. Increased complexity in knowledge creation and innovation has led to a tremendous growth in collaboration among firms, organizations and individuals in research activities (Becker and Dietz, 2004; de Faria et al., 2010). In the academic world, the proportion of co-authored papers has increased significantly, in almost all disciplines, over the past several decades. As a result, the co-authorship network has expanded dramatically overtime. Further, it has been documented that researchers rely five times more, compared with other work forces, on interactions with collaborators in their work (Allen, 1971, 1977; Allen et al., 2007). Therefore, the research community offers us a unique setting to examine the association between network centrality and output. In fact, as researchers, and especially academic researchers, rely more on collaboration, a positive association between network centrality and output is more likely to be found in the research community than in other business settings. Accordingly, we propose the following hypothesis:

Hypothesis. *There is a positive association between co-authorship-based network centrality and research output.*

Several features of the academic research community also make it an ideal setting for examining the association between network centrality and output. First, we can clearly identify individuals as well as their co-authorship links, which are important for establishing the social network. Second, due to the common practice of publishing university faculty members' CVs online, we can collect detailed personal information of researchers. Third, a publication-based evaluation system used by universities allows for better measurement of research output. While we normally use patents as a measure of firms' innovation output, many firms choose to keep some of their technologies as business secrets. As such, patent-based measures cannot capture the full picture of firms' innovation output and they are also endogenous to firms' operational and business decisions. Academic researchers' published papers less ambiguously reflect their research output. Fourth, data and machine learning technology allow us to construct a novel research output measure, topic innovation, which captures the extent to which academic researchers push their boundary of knowledge and explore new topics. Finally, the academic community is a proper setting to examine our research question as university researchers often have the freedom to choose topics that they are interested in and are less prone to commercial biases. Researchers in commercial institutions often have to conform to their employers' overall business strategies and thus face more restrictions in determining the topics and the interpretation of their results.

Of course, network centrality can also be associated with something negative. For example, El-Khatib et al. (2015) argue that CEOs with high centrality are more powerful and can exert a greater influence on their boards, which can potentially mitigate the effect of internal governance on CEOs and hurt shareholder value. They document a negative impact of CEO network centrality on merger performance. In the case of academic researchers, being central in a network can excessively consume their time, energy, and attention, and thus reduces their research output. This possibility adds tension to our prediction.

2.2. Patterns in research publications in accounting and other disciplines

A strand of literature examines patterns in academic publications. Hasselback et al. (2000) examine both the quantity and quality of publications of accounting scholars graduated from 1971 to 1993. Following this

work, Glover et al. (2006) and Glover et al. (2012) examine publication records of accounting scholars in the top 75 schools when they were promoted to associate or full professors from 1995 to 2009. Oler et al. (2010), by classifying citations according to disciplines, show that finance and economics make a growing contribution to the origination of ideas in accounting research. They further divide published articles into six topic categories (financial accounting, managerial accounting, auditing, tax, governance and other topics) and seven methodology categories (archival, experimental, field study, review, survey, theoretical and normative) and show changes in research topics and methodologies over forty eight years.

Some recent studies have started to investigate social networks and their impact on the accounting research community. Bonner et al. (2012) examine social structure through which accounting research ideas are communicated based on citations among authors. Lohmann and Eulerich (2017) identify and describe institutional networks based on work affiliations as well as doctoral programs for papers published in *The Accounting Review*. They find that while the work affiliation network has become more diverse overtime, the network based on Ph.D granting institutions is still concentrated in a relatively small group of universities.

Researchers in other disciplines have examined certain properties and impacts of the co-authorship network in their fields. Goldenberg et al. (2010) establish collaboration networks in marketing over forty years. Goyal et al. (2006) study social distance among economists based on the co-authorship network from 1970 to 2000 and identify "stars" in networks. Studies in the economics literature have also examined how co-authorship network properties affect individual authors' research productivity (Hollis, 2001, Medoff, 2003, Ductor, Fafchamps, Goyal and van der Leij, 2014; Ductor, 2015). We examine the property and development of the co-authorship network in the accounting research community. Further, we develop a research output measure, topic innovation, in addition to the traditional measure of research productivity.

3. Data

We focus on five top accounting journals, *JAR*, *TAR*, *JAE*, *CAR* and *RAS* from1980 to 2016.[3] We collect information on *JAE* papers from ScienceDirect, information on *JAR* and *TAR* papers from Ebscohost, information on *CAR* papers from ProQuest and information on *RAS* papers from Springer. For each paper, we obtain its title, author name(s), publication time and the abstract.

A key step in constructing the co-authorship network is identifying all unique authors and their publications in these five journals. While the data we collect contain author name(s) of each paper, an author's name can be presented differently in different papers and journals. To distinguish authors, we compare their last names and the initials of all their first names. For names that we are suspicious of duplications or errors, we manually check the original papers or authors' resumes. As a result, we identify 3628 unique authors. We also collect Ph.D graduation information for each author from the Brigham Young University (BYU) accounting researcher ranking database. For authors with missing graduation information in the BYU database, we manually collect this information from their resumes.

We calculate the percentage of single-author papers and the average number of authors per paper over time and show their time trends in Fig. 1. Fig. 1-A is the time trend of the proportion of single-author papers. It declines from above 0.6 in 1980 to below 0.2 in 2016. The average number of authors per paper increases from around 1.5 in 1980 to more than 2.5 in 2016 in Fig. 1-B. Overall, the practice of co-authorship has become increasingly popular over time.

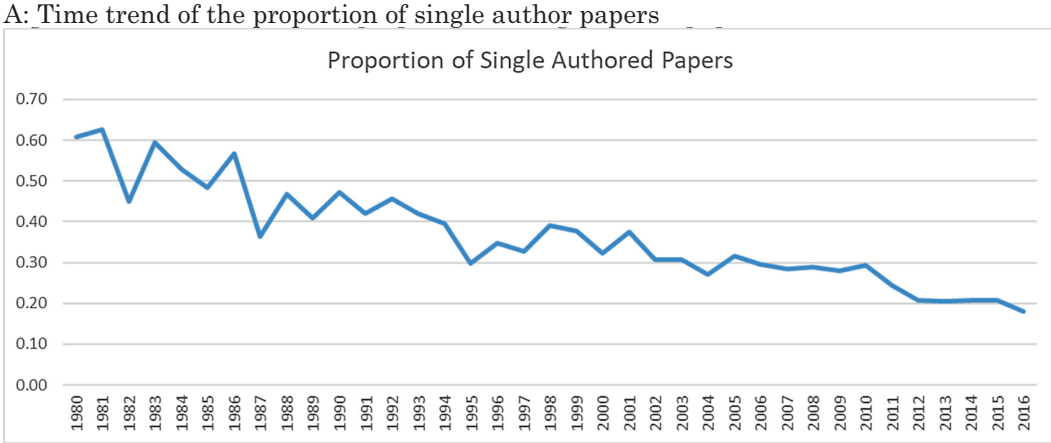
4. Co-Authorship network

4.1. Establishing the Co-Authorship network

We establish co-authorship network in a similar way as in Goyal et al. (2006) and Ductor (2015). Let $G_{t,s}$ denote a co-authorship network from Years $t-(s-1)$ to t. In the network $G_{t,s}$, $N_{t,s} = \{1, 2, \ldots, N\}$ is the set of authors who have publication(s) during the period $t-(s-1)$ to t. Two authors are linked through co-

[3] For *CAR* the data started in 1984 and for *RAS* the data started in 1996.

A: Time trend of the proportion of single author papers



B: Time trend of the average number of authors per paper

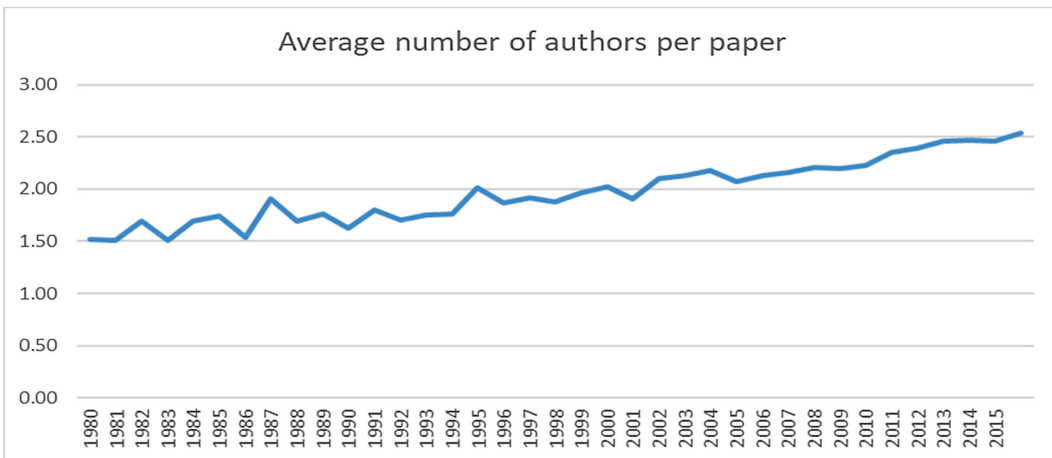


Fig. 1. Time trends of the proportion of single author papers and the number of authors per paper.

authorship between them. Specifically, $g_{i,j}$ is set to one if Authors i and j have published one or more papers together and zero otherwise.

To describe the network $G_{t,s}$, we first define a set of variables. *Total Authors*$_{t,s}$ (N) refers to the number of authors who publish at least one paper during the period $t-(s-1)$ to t. *Isolated Authors*$_{t,s}$ refers to authors that have zero co-authors over the period $t-(s-1)$ to t. A low percentage of isolated authors suggests that many researchers in the network are connected through co-authorship. *Degree* ($d_{i;\ t,s}$) is the number of co-authors for Author i over the period $t-(s-1)$ to t. A high value for *Degree* suggests that an author is central in a network. For the whole network, the average of *Degree* is given by

$$d(Gt,s)=\frac{\sum_{i\in N_{t,s}} d_{i;t,s}}{N}. \tag{1}$$

Following Watts and Strogatz (1998), we devise a *Clustering Coefficient* ($CL_{i;\ t,s}$) to measure the percentage of Author i's co-authors who are also co-authors with each other. Its formal definition is

$$CL_{i;t,s}=\frac{\sum_{l\in N_{i,t,s}}\sum_{k\in N_{i,t,s}} g_{l,k}}{d_{i;t,s}(d_{i;t,s}-1)} \tag{2}$$

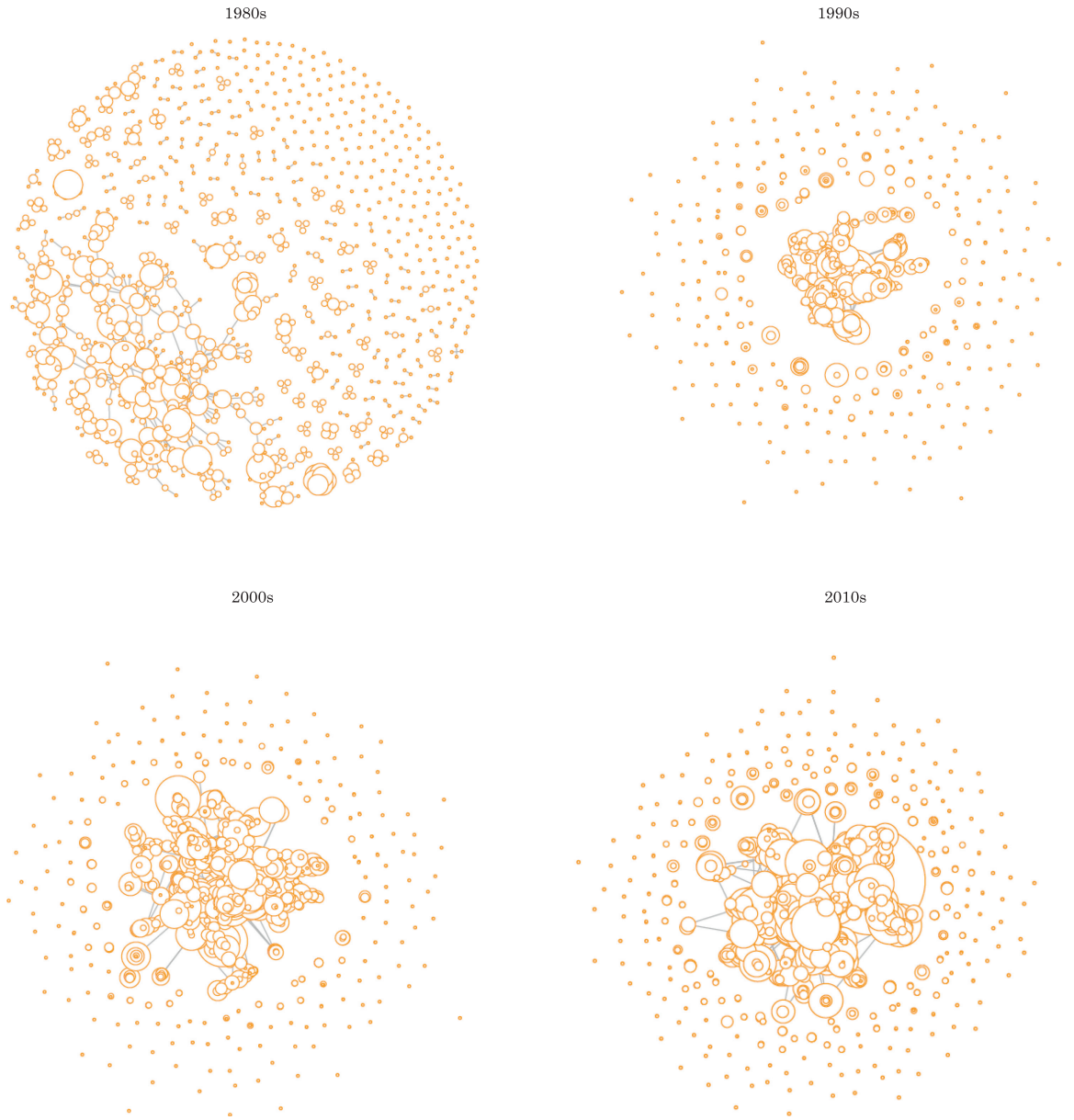


Fig. 2. Networks of co-authorship in top accounting journals from 1980s to 2010s. These figures present networks of co-authors based on publications on the top-five journals from 1980s to 2010s. The size of nodes is proportional to its degree.

where $N_{i,t,s}$ is the set of co-authors for Author *i*. $CL_{i;\ t,s}$ is available for authors with $d_{i;t,s} \geq 2$. To measure the overall *Clustering Coefficient* of a whole network, we use the weighted average of $CL_{i;\ t,s}$ that is

$$CL(Gt,s) = \sum_{i \in N'_{t,s}} \frac{d_{i;t,s}(d_{i;t,s}-1)}{\sum_{j \in N'_{t,s}} d_{i;t,s}(d_{i;t,s}-1)} CL_{i;t,s} \tag{3}$$

where $N'_{t,s}$ is the set of authors where each author's *Degree* is larger than or equal to two.

If two authors have co-authorship or if there is a set of distinct intermediate co-authors that link them, they are connected by a path. For each path, we count the number of steps it takes to connect two authors. Multiple paths can exist between any two authors. The length of the shortest path is defined as the distance

between Authors *i* and *j*, $dist(i,j;\ G_{t,s})$. Thus, the distance captures the most efficient way to connect two authors.

A component in $G_{t,s}$ is a sub-network where each pair of authors can be connected, directly or indirectly. A *Giant Component* ($GC(G_{t,s})$) is the largest component that contains a significant number of authors and it dominates other components. We calculate the average distance of the giant component as below

$$dist(GC(Gt,s)) = \frac{\sum_{\in N''_{t,s}} \sum_{j \in N''_{t,s}} dist(i,j;G_{t,s})}{N''(N''-1)} \tag{4}$$

where $N''_{t,s}$ is the set of authors that belong to $GC(G_{t,s})$ and N'' is the number of authors in $GC(G_{t,s})$. *Diameter* of $GC(G_{t,s})$ is the longest length of the shortest distance in the *Giant Component*. It captures the largest number of steps to connect two authors in this component. These two measures capture the overall connectedness of the *Giant Component*.

Goyal et al. (2006) define a network as having a "small world" property if it satisfies four features. First, the number of authors is significantly larger than the average *Degree*: $N \gg d(Gt,s)$. On average, each author does not have many co-authors compared with the size of the network. Second, the network needs to have a giant component that contains a large number of authors in the network. Although authors do not have many direct connections with each other through co-authorship, many of them can still be linked indirectly. Third, the average distance between authors in the giant component is short, e.g., $dist(Gt,s)$ is of order $\ln(N)$, where $\ln(N)$ represents the average distance of a typical random network. That is, it does not need too many steps to connect any two authors. Fourth, clustering is high, e.g., $CL(Gt,s) \gg d(Gt,s)/N$, where $d(Gt,s)/N$ is the typical clustering coefficient value if the network is random. That is, an author's co-authors have a significant chance of becoming co-authors in a network with a "small-world" property compared with those in a random network.

4.2. Co-Authorship network in five top journals

Table 1 presents statistics for the co-authorship network during the period 1980 to 2016. From 1980s to 2000s, we construct networks in 10-year windows. The network in the 2010s only covers papers from 2010 to 2016.

In Table 1, from 1980s to 2010s, the number of authors in the network has increased from 957 to 1870. However, the percentage of isolated authors has decreased significantly from 19.3% to 5.4%. Thus, co-

Table 1
Descriptive statistics for co-authorship networks.

	1980s	1990s	2000s	2010s
Total Authors	957	1036	1406	1870
Isolated Authors:				
Number	185	121	97	101
Percentage	0.193	0.117	0.069	0.054
Degree				
Mean	1.808	2.174	3.026	3.317
Std	1.789	1.959	2.506	2.816
Clustering coefficient	0.377	0.292	0.297	0.300
Giant Component:				
Size	335	492	1030	1329
Percentage	0.350	0.475	0.733	0.711
Average distance	8.219	7.701	7.098	6.687
Clustering coefficient	0.282	0.262	0.283	0.278
Diameter	21	23	16	17
Second largest component	15	14	13	15

This table presents summary statistics of co-authorship networks from 1980s to 2010s, based on articles published in *Journal of Accounting Economics* (*JAE*), *Journal of Accounting Research* (*JAR*), *The Accounting Review* (*TAR*), *Contemporary Accounting Research* (*CAR*), and *Review of Accounting Studies* (*RAS*).

authorship has become a common practice in the accounting academia. The ease of communication due technological advances, increased difficulty in publishing in top journals and the requirements for different skills, can be reasons for increased collaborations among authors.

We check whether our whole co-authorship network satisfies the four features of the small world property. For the first feature, we examine the average degree of the network d(Gt, s). Although the average degree has increased from 1.808 in the 1980s to 3.317 in the 2010s, it is small relative to the total number of authors in every period. For instance, in 1990, the average degree is 2.174, which is just 0.21% (2.174/1036) of the total number of authors. Therefore, the first feature of the small world property is satisfied.

Next, we examine the second feature. The size of the largest component is 335 in 1980s, 35.01% of the population. The largest component has grown substantially over time. In 2000s, it is 73.26% of the population with 1030 authors. The percentage in 2010s is smaller, due to the 2010s sample covering a shorter period. The size of the second largest component does not change significantly over time and it is small compared with the largest component. For instance, the second largest component in 2000s contains 13 authors and is only 0.92% (13/1406) of the largest component. Therefore, a giant component exists and has expanded significantly over time. As a result, the second feature is also satisfied.

We then move on to the third feature and examine the average distance of the giant component. The average distance of the giant component is 8.219 in 1980s, 7.701 in 1990s, 7.098 in 2000s, and 6.687 in 2010s. The average distance has been small and has decreased by around 13.17% ((6.687–8.219)/8.219) from 1980s to 2010s. On average, it takes no more than eight steps to connect two authors in the giant component. We compare the average distance of the giant component with ln(N), the typical average distance of a random network. ln(N) is 6.864, 6.943, 7.249 and 7.534 from 1980s to 2010s. The two values are comparable in all periods. Therefore, the third feature of the small-world property is also satisfied.

Finally, we examine the fourth feature. As mentioned earlier, the clustering coefficient measures the extent to which an author's co-authors are also co-authors to themselves. The clustering coefficient of the giant component is 0.282 in 1980s, 0.262 in 1990s, 0.283 in 2000s, and 0.278 in 2010s. We compare the clustering coefficient with $d(Gt,s)/N$, which is the probability of co-authorship formation when the link in the network is randomly assigned. In every period, the clustering coefficient is significantly larger than $d(Gt,s)/N$. For instance, $d(Gt,s)/N$ is 0.002 in 1980s, and the actual clustering coefficient is 188.5 times of this value. The fourth small world feature is satisfied.

Fig. 2 intuitively shows the development of the network and the small world property. In the graph, each node represents an author in the network. Two authors have a co-authorship relationship if there is a link between them. The size of the node is proportional to an author's *Degree*, that is, a large node represents an author with many co-authors. The proportion of nodes with no link (single authors) is becoming smaller. Many nodes are small, suggesting that these authors have a small number of co-authors. However, there is a large group of nodes that can be connected directly or indirectly and this group is becoming significantly larger over time. We can observe a clear expansion of the giant component.

In sum, we conclude that the co-authorship network satisfies the four features of the small world property. While each author does not have many co-authors compared with the number of authors in the network, there exists a giant component where a significant proportion of authors can be linked to others either directly or indirectly. The distance between any two authors is relatively small and has decreased slightly.

4.3. Role of the most connected authors

In Table 2, we examine the distribution of co-authorship in the network and its development over time. Overall, the number of co-authors differs significantly across authors and the gap in *Degree* between the most connected authors and the average has enlarged substantially. For example, *Degree* of the most connected author is 10 and it is 5.531 (10/1.808) times of the average *Degree* in 1980s. In 2010s, this ratio has increased to 11.226 (38/3.385). The most connected authors can also connect with more authors in exactly two steps. *Order 2* is the number of authors that can be connected to Author i in exactly two steps (not in one step). For the most connected author, *Order 2* is 34 in 1980s, 36 in 1990s, 54 in 2000s, and 67 in 2010s. The average *Order 2* is 2.813 in 1980s, 4.290 in 1990s, 8.074 in 2000s, and 10.198 in 2010s. This result suggests that the most connected authors also have a larger pool of potential co-authors.

Table 2
Network statistics for the most connected authors.

Panel A: 1980s					
Rank	*Papers*	*%Co-authored*	*Degree*	*Order 2*	*Clustering Coefficient*
1	10	90.0	10	34	0.156
2	12	83.3	10	27	0.089
3	11	72.7	10	20	0.178
Average top 50	6.840	85.0	7.360	10.280	0.299
Average all	2.129	71.0	1.808	2.813	0.377
Panel B: 1990s					
Rank	*Papers*	*%Co-authored*	*Degree*	*Order 2*	*Clustering Coefficient*
1	13	84.6	14	36	0.187
2	17	88.2	14	24	0.121
3	8	100	12	32	0.121
Average top 50	8.520	87.0	8.300	19.220	0.157
Average all	2.322	79.2	2.174	4.290	0.292
Panel C: 2000s					
Rank	*Papers*	*%Co-authored*	*Degree*	*Order 2*	*Clustering Coefficient*
1	18	100	20	54	0.100
2	13	84.6	18	36	0.072
3	10	100	16	5	0.083
Average top 50	9.440	91.1	11.320	33.040	0.156
Average all	2.544	86.7	3.026	8.074	0.297
Panel D: 2010s					
Rank	*Papers*	*%Co-authored*	*Degree*	*Order 2*	*Clustering Coefficient*
1	17	100	38	67	0.058
2	14	92.9	24	94	0.080
3	11	100	18	49	0.144
Average top 50	8.5	96.8	14.380	43.880	0.150
Average all	2.136	90.7	3.385	10.198	0.300

This table presents summary statistics for the most connected accounting scholars in each decade. *Papers* is the number of papers each author has published in that decade. *%Co-authored* is the percentage of papers that are co-authored. *Degree* is the number of co-authors of an author. *Order 2* is the number of authors that can be connected to the author in two steps. *Clustering Coefficient* measures the extent to which an author's co-authors are also co-authors with each other.

Another interesting and important feature of the most connected authors is that they have a low *Clustering Coefficient* than the sample average. For instance, *Clustering Coefficient* for the most connected author is 0.156 in 1980s, 0.187 in 1990s, 0.100 in 2000s, and 0.058 in 2010s. This number is 41.38% (0.156 / 0.377) of the average in 1980s and has declined to 19.33% (0.058 / 0.300) in 2010s. The average *Clustering Coefficient* of the top-50 most connected authors also decreases from 0.299 in 1980s to 0.150 in 2010s. This suggests that while authors with a very high *Degree* have high co-authorship, only a small portion of their co-authors work with each other. Thus, these high *Degree* authors play an important role in sustaining the network. In fact, *Clustering Coefficient* is opposite to our centrality measures introduced below.

5. Measuring publication content

In addition to identifying the co-authorship network, we also examine the contents of papers published in the five accounting journals since 1980. Such information will further our understanding of the development of the accounting literature. We also construct a research topic innovation measure using paper content information for further analysis. We first discuss the method we use to measure paper content.

5.1. Paper topic classification

While one can easily name some research topics in the accounting literature and give examples of papers related to these topics, to objectively label every paper with one or several topics is challenging. Some papers have author specified information related to their contents. One such information is the *JEL* codes. The *JEL* code is a standardized system to classify the economics literature. Usually around three to five *JEL* codes are assigned to a paper. Ductor (2015) use two digit *JEL* codes as topic classifications for papers published in economics journals. There are two problems with *JEL* codes in our sample. First, not all papers have an author specified *JEL* code. Second, *JEL* classification is for the entire economics literature, which is too general and narrow for accounting research. Another author specified information is keywords. However, keywords do not appear to be good topic labels as they involves different information such as measure names, methodologies, research settings, etc. In addition, keywords are not available for many papers in our sample. One available paper topic information system is the paper topic classification from the accounting scholar ranking database maintained by Brigham Young University (BYU). BYU provides a comprehensive list of publications of accounting researchers and labels each paper with several topic tags. However, this classification is also too general. They label a published paper according to research topics and methodologies. Their classification only includes six topics (accounting information system, audit, financial, managerial, tax and other topics) and four research methodologies (analytical, archival, experimental and other methods).

We construct our own classifications. One potential way is to read all the papers and assign topics to these papers. However, it will be subjective when there are no classification standards. To address this problem, we resort to machine learning technology which provides text mining algorithms in topic modelling. Topic modelling is *"a probabilistic framework for the term frequency occurrences in documents in a given corpus*" in machine learning (Grun and Hornik, 2011).[4] In topic models, a corpus is treated as bag of terms.[5] Each corpus can be represented by a vector of term frequencies. This transformation assumes that term orders are negligible, which is referred to the "exchangeability" of terms in the computing science language (Blei et al., 2003). Topic models use the term frequencies of each corpus to generate topic probabilities for each corpus. Different topic models have different assumptions about term distribution and fundamental probabilistic. See Blei and Lafferty (2009) for a review of different topic models and model assumptions.

We use the classic Latent Dirichlet Allocation (LDA) model developed by Blei et al. (2003) to classify sample papers. The LDA algorithm is a Bayesian mixture model which assumes that different topics identified in the model are uncorrelated with each other (Grun and Hornik, 2011). The model assumes that, the collection of term frequencies in each corpus (document) are random variables and represents an infinite mixture distribution. This model considers the exchangeability of both words and documents among topics (Blei et al., 2003). Given a target number of topics N (which is specified by the users) and M documents, the LDA model will generate an M by N probability matrix. The matrix reports the probability of every document to be related to a topic.

Table 3 represents an example of a LDA probability matrix with M documents and N topics. Prob(m, n) refers to the probability of document m to be related to topic n. Note that, for each document m, $\sum_{n=1}^{N} \mathrm{Prob}(m, n) = 1$. With a certain cut-off of probability, we can then decide that a paper belongs to several topics with reasonable probabilities. Note that LDA model is an unsupervised topic model. In such a model, there is no training dataset with already known topics. As such, while we can identify which papers are likely to be related to a certain topic, we do not know exactly what that topic is. There are also supervised topic models. In supervised models, one first starts with a training dataset, in which a set of documents is labelled with some topic titles. The supervised model will learn features of topic titles and apply the learned pattern to a new dataset to assign the already specified topic titles to documents in the new dataset. We do not use supervised topic models as the training model will also involve subjective evaluations. First, the pre-determination of topic titles for the training dataset is subjective. Second, even if we can get well specified topic titles for a small training sample, if the training dataset is not representative enough for all potential topics of the whole

[4] In natural language processing, a corpus refers to the text contents of an object (usually a document).
[5] A term refers to a unique word or word root.

Table 3
An example of an LDA topic distribution matrix.

	Topic 1	Topic 2	Topic 3	...	Topic N-1	Topic N
Document 1	Prob(1, 1)	Prob(1, 2)	Prob(1, 3)	...	Prob(1, N-1)	Prob(1, N)
Document 2	Prob(2, 1)	...	...	...	...	...
Document 3	Prob(3, 1)	...	...	...	...	...
Document 4	Prob(4, 1)	...	...	...	...	...
...	...	...	...	...	...	...
Document M−1	Prob(M−1, 1)	...	...	...	...	...
Document M	Prob(M, 1)	...	...	...	...	...

This table represents an example of an LDA probability matrix with M documents and N topics. Prob(m, n) refers to the probability of Document m being related to Topic n. The sum of the probabilities of all of the topics for a specific document equals one.

literature, the predicted topics will be biased. Since we do not have a systematic and generally accepted topic lists (for example, a list similar to *JEL* code), we cannot ensure that the training dataset is representative. After balancing advantages and disadvantages, we decide that an unsupervised LDA model is a better choice in our setting as it can classify papers according to contents on a relatively objective basis.

5.2. LDA model classification

To apply topic modelling, we need a paper content database to start with. Hall et al. (2008) examine topics in Computational Liguistics from 1978 to 2006 based on whole contents of papers. However, the length of a typical accounting research paper is much longer than a normal article or a typical computing science paper, which will inflate the dimensions of the term frequency vector as well as calculation complexity. Paper contents are affected by both research topics and authors' writing habits. The writing habits can affect the term frequency distribution of each paper, especially when authors assign different proportion of total length of a paper to different parts (such as literature review, empirical discussion, robustness checks, etc). To mitigate these problems, we choose to focus on paper abstracts. A good thing about an abstract is that, it covers the main ideas and results of a paper in limited words and is less affected by writing habits. Not all papers in our sample have an author provided abstract, especially for some early papers. However, the two databases where we collect the paper information from provide their own abstracts for most papers without author specified abstracts. Altogether, we have 5845 papers with available abstracts.

To apply the LDA mode, the first step is to clean the abstract text.[6] Though an abstract is clean relative to the whole body of a paper, some routine transformation is applied to the text. We removed all punctuations and numbers from the text and lowercased all the text. We then remove the stopwords based on the R stopwords vocabulary.[7] We then stem every word in the text so that different formats of a word become the same word root. Then for every term we count how many abstracts contain that term. For terms contained in more than 500 abstracts, we manually check the term list and pick up terms that are common in abstracts but are unlikely to be related to the research topics. We define such terms as customized stopwords and delete them. Finally, we remove terms that appear in less than 3% and that appear in more than 95% of abstracts. The rationale is that, if a term is contained in very few abstracts, it does not capture any common contents and if a term is contained in too many abstracts, it does not contribute to the uniqueness of a document. As a result, these terms are not useful for topic modelling.

We need to specify the number of total topics as an input to the LDA model. We refer to prior literature for benchmarks for the number of topics to classify. Studies on economic journals usually use two digit *JEL* code as topic classification (Ductor, 2015, Fafchamps et al., 2010). There are all together 135 *JEL* two digit codes in the *JEL* classification. Ductor (2015) reported that there are 121 *JEL* two-digit codes from economic journals covered in the EconLit database from 1970 to 2011. Hall et al. (2008) set the topic number parameter to 100 when using the LDA model to examine research topics in the Computational Linguistics literature from 1978

[6] We use the tm package in R to implement the LDA model. See Grun and Hornik (2011) for the description of the package.
[7] Stopwords refers to some commonly used words in a language with no special meanings.

to 2006. Based on these prior studies, we decide that 100 would be a reasonable number of topics. Following Hall et al. (2008), we use Gibbs sampling to estimate the topic probability matrix. This is a commonly implemented LDA model estimation (Griffiths and Steyvers, 2004, Grun and Hornik, 2011).

Panel A, Table 4 shows the distribution of topic probabilities. The 95% percentile of the probability is 3.24%. In other words, if we set the cut-off to be 3.24%, each paper will be attached to 5 topics on average. We finally set the cut-off to be 4%, which results in 20,970 paper-topic pairs, with a paper attached to 3.59 topics on average. This number is comparable to author specified *JEL* codes for *JEL* available papers. Among the 5845 papers, 5796 are labelled with at least one topic with a probability larger than 4%.

Panel B, Table 4 shows the distribution of the number of topics assigned to papers. A majority of the papers are labelled with 2 to 5 topics. Among the 100 topics, the number of related papers also varies. The topic with the fewest papers contains 104 papers and the topic with most papers contains 542 papers.

We calculate some features of topics across years and draw time patterns of these features. Fig. 3-A represents the number of different topics covered each year. We observe that, before 2002, the number of topics is volatile with some years only having as few as around 85 topics. After 2002, the number of topics covered each year becomes stable, ranging from 97 to 100. Fig. 3-B shows the pattern of the number of different topics divided by number of published papers in each year. This figure exhibits a significant drop in the scaled number of topics after 2000. Fig. 3-C shows the Herfindahl Index of topics in each year. The pattern of the Herfindahl Index suggests that research topics in the five journals have become less concentrated in recent years.

Each year, we calculate the number of papers for each topic and identify the top-10 topics accordingly. We then estimate a Probit model which regresses the probability of a topic to be a top-10 topic in Year t on its probabilities in Years $t-5$ to $t-1$. Table 5 reports the auto-regression results. *Top_topic* is an indicator variable which equals 1 if a topic is a top-10 topic in Year t. The sample period is from 1985 to 2015.[8] In Column (1), we estimate the results using papers from all the five journals. We then estimate the model for the five journals separately and report the results in Columns (2) to (6). The coefficients on the lagged *Top_topic* are all significantly positive in the six columns. Fig. 4 presents a visualized form of the magnitudes of these coefficients.

We also examine topic overlap among the five journals. We define $Topic_{i,j,t}$ as an indicator which equals 1 if Topic i is covered in Journal j in Year t and 0 otherwise. We also define $Top\_topic_{i,j,t}$ as an indicator which equals 1 if Topic i is the top-10 topic in Journal j in Year t. For each Topic i-Year t combination, we compute $Topic_{i,JAR,t}$, $Topic_{i,JAE,t}$, $Topic_{i,TAR,t}$, $Topic_{i,CAR,t}$, $Topic_{i,RAS,t}$, $Top\_topic_{i,JAR,t}$, $Top\_topic_{i,JAE,\ t}$, $Top\_topic_{i,TAR,t,}$ $Top\_topic_{i,CAR,t}$ and $Top\_topic_{i,RAS,t}$ respectively. We report correlation coefficients of the ten variables in Table 6. Panel A reports the correlations among $Topic_{i,JAR,t}$, $Topic_{i,JAE,t,}$ $Topic_{i,TAR,t}$, $Topic_{i,CAR,t}$ and $Topic_{i,RAS,t}$. Panel B reports the correlations among $Top\_topic_{i,JAR,t}$, $Top\_topic_{i,JAE,t}$, $Top\_topic_{i,TAR,t}$, $Top\_topic_{i,CAR,t}$ and $Top\_topic_{i,RAS,t}$. We observe that while most of the correlation coefficients are positive and significant, they are lower than 0.2. Results in Table 6 appear to suggest that the five top accounting journals have different topic specializations and/or tastes.

6. Impact of network centrality on research output

6.1. Capturing network centrality

Here, we examine the impact of the co-authorship network on scholars' research output. Specifically, we test how an author's centrality in the network is associated with his research output. Centrality measures the importance of a node (author) in a network. A node of high centrality suggests that it is central or important in the network. Different measures are developed to capture different aspects of centrality. We apply three commonly used centrality measures, *Degree*, *Closeness* and *Betweenness*. As defined earlier, *Degree* is the number of co-authors for Author i in the co-authorship network.

[8] For CAR, the sample starts from 1989 and for RAS the sample starts from 2001. We exclude 2016 data as our database does not cover all papers in 2016.

Table 4
Descriptive statistics of the LDA estimation results.

Panel A: Distribution of topic probabilities

Min	P5	P10	P25	P50	P75	P90	P95	Max
0.10%	0.34%	0.37%	0.43%	0.53%	0.72%	1.94%	3.24%	57.28%

Panel B: Number of topics assigned to a paper

Number of Topics Assigned	Frequency	Percentage (%)
1	302	5.21
2	955	16.48
3	1601	27.62
4	1451	25.03
5	943	16.27
6	401	6.92
7	116	2.00
8	25	0.43
9	2	0.03

This table presents summary statistics of the LDA results. In Panel A, we report the distribution of the topic probability generated by the LDA model. In Panel B, we show the distribution of the numbers of topics with greater than 4% probability assigned to each paper.

Closeness measures the overall closeness of an author to other authors in a network. Its formal definition, based on Sabidussi (1966), is

$$c_{i;t,s} = \frac{N-1}{\sum_{j \in N_{t,s}} d(i,j;G_{t,s})} \tag{5}$$

where $d(i,j;G_{t,s})$ is the distance between Authors i and j. *Closeness* is the inverse of the total distance of Author i from other authors multiplied by $N-1$. When there is no path between Authors i and j, the total number of authors (N) is used instead of $d(i,j;G_{t,s})$. An author with high *Closeness* can easily or quickly reach other authors and hence is more central in the network.

Betweenness measures centrality in terms of an author's role in connecting other authors. We follow Freeman (1977). Specifically, if an author lies on many paths that connect other authors, he is central in the network. The mathematical definition is

$$b_{i;\ t,s} = \sum j \neq k \neq i \in N_{t,s} \frac{\sigma(j,k|i)\sigma(j,k)}{(N-1)(N-2)/2}, \tag{6}$$

where $\sigma(j,k|i)$ is the total number of the shortest paths between Authors j and k that Author i lies on and $\sigma(j,k)$ is the total number of the shortest paths between Authors j and k. Author i with high *Betweenness* is located in a critical position of connecting or communicating with other authors. Therefore, high *Betweenness* means high centrality.

6.2. Author network centrality and research productivity

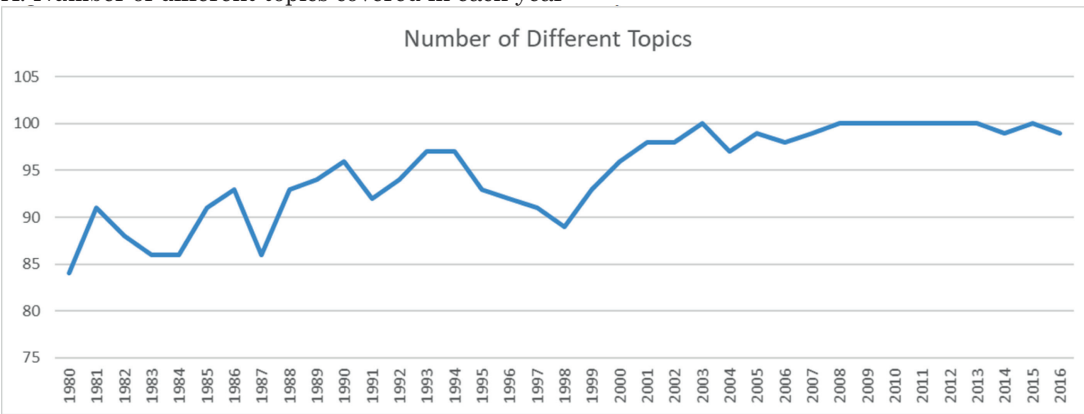
We apply the following Tobit regression model to examine whether *Centrality* can predict an author's future research productivity:

$$ln(1+q^f_{i;t}) = \beta_0 + \beta_1 Centrality_{i;t,s} + \beta_2 q^p_{i;t,s} + \beta_3 \bar{q}_{1i;t,s} + \beta_4 H_{i;t,s} + D'_{i,t}\omega + University_i + \mu_t + \epsilon_{i;t,s} \tag{7}$$

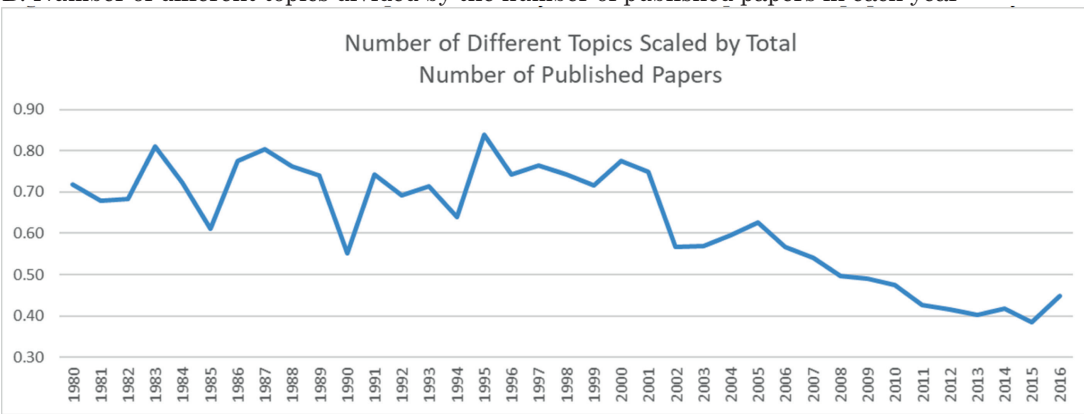
Our productivity measure $q^f_{i;t}$, is the sum of future three years' productivity, $q^f_{i;t} = q_{i;t+1} + q_{i;t+2} + q_{i;t+3}$, where $q_{i;t}$ is the relative length of papers of Author i in Year t (Ductor, 2015). Specifically,

$$q_{i;t} = \sum_{j=1}^{S} \frac{Pages_j}{Number\ \ of\ \ authors_j} \tag{8}$$

A: Number of different topics covered in each year



B: Number of different topics divided by the number of published papers in each year



C: Herfindahl index of topics in each year

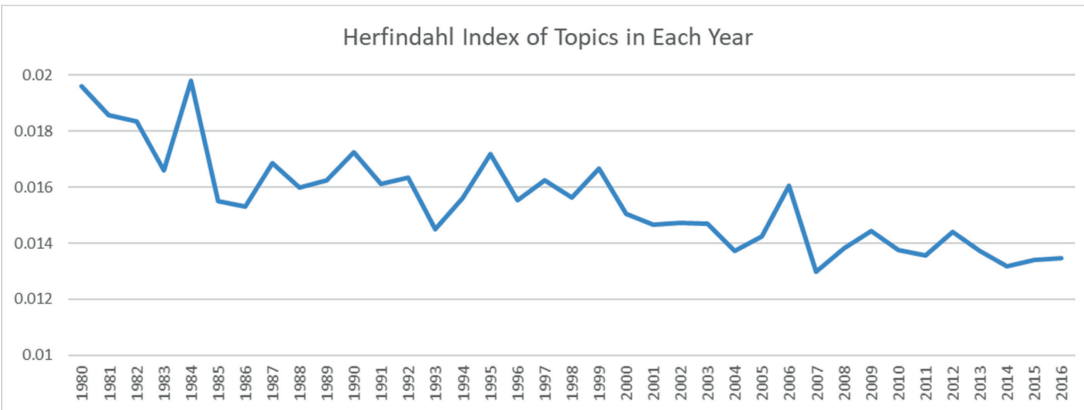


Fig. 3. Topic distribution.

Table 5
Auto-regression of the probability of a topic being a top-10 topic.

	All Five Journals	TAR	JAR	JAE	CAR	RAS
	(1)	(2)	(3)	(4)	(5)	(6)
Variables	*Top_topic*	*Top_topic*	*Top_topic*	*Top_topic*	*Top_topic*	*Top_topic*
Lag_top_topic	0.644	0.670	0.311	0.692	0.553	0.575
	(5.89)***	(6.05)***	(2.72)***	(5.42)***	(4.87)***	(3.49)***
Lag2_top_topic	0.588	0.707	0.786	0.564	0.599	0.774
	(5.26)***	(6.30)***	(7.42)***	(4.48)***	(5.28)***	(5.02)***
Lag3_top_topic	0.880	0.215	0.490	0.836	0.704	0.359
	(8.39)***	(1.74)*	(4.33)***	(6.75)***	(6.46)***	(2.01)**
Lag4_top_topic	0.272	0.610	0.520	0.545	0.437	0.832
	(2.27)**	(5.30)***	(4.91)***	(4.14)***	(3.69)***	(5.31)***
Lag5_top_topic	0.644	0.424	0.555	0.404	0.265	0.533
	(5.88)***	(3.47)***	(4.94)***	(2.97)***	(2.21)**	(3.12)***
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant	−1.873	−1.773	−1.633	−1.509	−2.147	−1.495
	(−8.43)***	(−8.97)***	(−8.72)***	(−8.68)***	(−9.53)***	(−8.52)***
N	3100	3100	3100	3100	2700	1500
pseudo R-sq	0.292	0.172	0.141	0.164	0.159	0.182

This table presents the regression results of the following Probit model:

$$Top\_topic = \beta_0 + \beta_1 * Lag\_top\_topic + \beta_2 * Lag2\_top\_topic + \beta_3 * Lag3\_top\_topic + \beta_4 * Lag4\_top\_topic + \beta_5 * Lag5\_top\_topic + Year\ Fixed\ Effects$$

where *Top_topic* is an indicator of whether a topic is among the top-10 topics in year *t*. We regress *Top_topic* on whether the topic is one of the top-10 topics in Years *t* – 5 to *t* – 1.

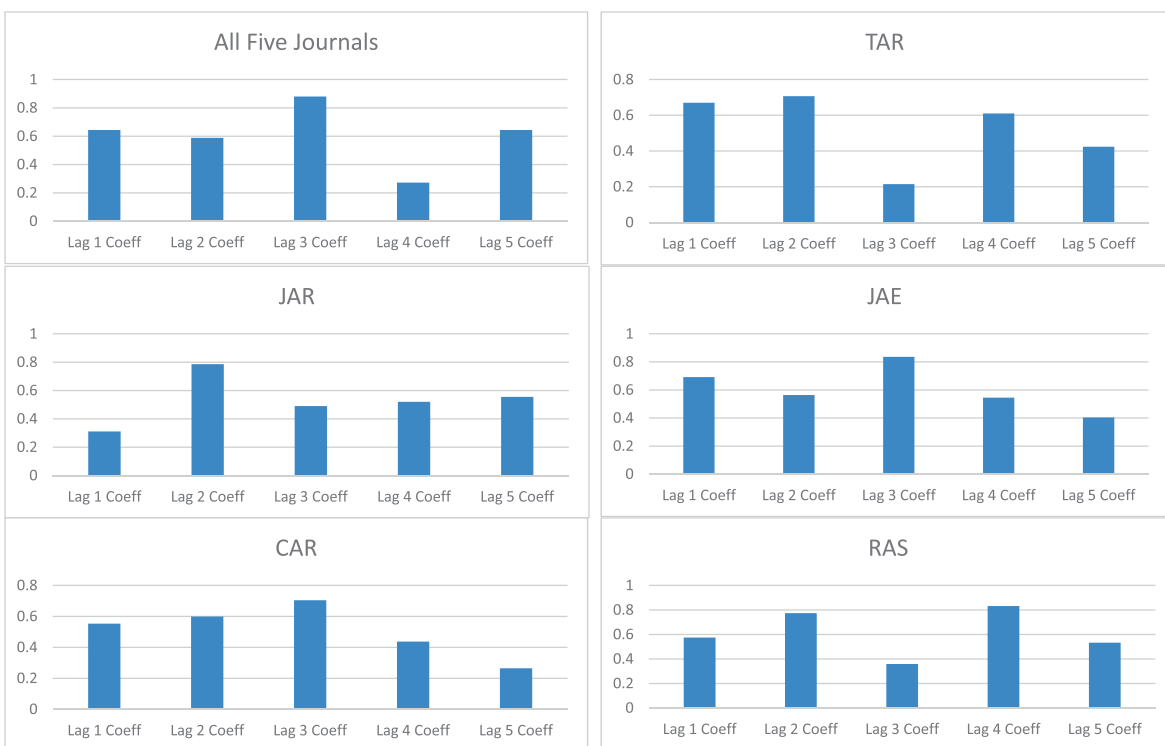


Fig. 4. Time trend of coefficients on lag Top_topics.

Table 6
Correlations for topic coverage among the five journals.

Panel A: Correlations between $Topic_{i,JAR,t}$, $Topic_{i,JAE,t}$, $Topic_{i,TAR,t}$, $Topic_{i,CAR,t}$, and $Topic_{i,RAS,t}$

	$Topic_{i,TAR,t}$,	$Topic_{i,JAR,t}$	$Topic_{i,JAE,t}$	$Topic_{i,CAR,t}$	$Topic_{i,RAS,t}$
$Topic_{i,TAR,t}$,	1				
$Topic_{i,JAR,t}$	0.1226***	1			
$Topic_{i,JAE,t}$	0.0936***	0.1104***	1		
$Topic_{i,CAR,t}$	0.1617***	0.0771***	0.1076***	1	
$Topic_{i,RAS,t}$	0.1676***	0.1281***	0.1765***	0.1419***	1

Panel B: Correlations between $Top\_topic_{i,TAR,t}$, $Top\_topic_{i,JAR,t}$, $Top\_topic_{i,JAE,t}$, $Top\_topic_{i,CAR,t}$, and $Top\_topic_{i,RAS,t}$

	$Top\_topic_{i,TAR,t}$,	$Top\_topic_{i,JAR,t}$	$Top\_topic_{i,JAE,t}$	$Top\_topic_{i,CAR,t}$	$Top\_topic_{i,RAS,t}$
$Top\_topic_{i,TAR,t}$,	1				
$Top\_topic_{i,JAR,t}$	0.1436***	1			
$Top\_topic_{i,JAE,t}$	0.1034***	0.1330***	1		
$Top\_topic_{i,CAR,t}$	0.1780***	0.1224***	0.0441	1	
$Top\_topic_{i,RAS,t}$	0.0963***	0.1019***	0.0748***	0.0857***	1

This table examines the overlap of topics among the five journals. Panel A presents the correlation coefficients between $Topic_{i,JAR,t}$, $Topic_{i,JAE,t}$, $Topic_{i,TAR,t}$, $Topic_{i,CAR,t}$, and $Topic_{i,RAS,t}$. $Topic_{i,j,t}$ is an indicator which equals 1 if Topic i is covered in Journal j in Year t and 0 otherwise. Panel B represents the correlation between $Top\_topic_{i,TAR,t}$, $Top\_topic_{i,JAR,t}$, $Top\_topic_{i,JAE,t}$. $Top\_topic_{i,CAR,t}$ and $Top\_topic_{i,RAS,t}$. $Top\_topic_{i,j,t}$ is an indicator which equals 1 if Topic i is a top-10 topic in Journal j in Year t and 0 otherwise. *** indicates significance at the 0.01 level.

where S is the total number of papers in Year t of Author i, $Pages_j$ is the number of pages of Paper j divided by the average number of pages of papers published during the same year, and $Number\ of\ authors_j$ is the number of authors of Paper j.[9] If there is no paper published in Year t, $q_{i;t}$ is set to zero. We use $ln(1+q^f_{i;t})$ to reduce the impact of extreme values. Due to infrequent publications in top journals, $q^f_{i;t}$ has many zero values. We use a Tobit regression model to address the truncation problem.

The main variable of interest is $Centrality_{i;t,s}$, and it includes *Degree, Closeness,* and *Betweenness,* respectively. We calculate centrality measures using 5-year co-authorship network. Therefore, s equals 5. We predict that central authors are more productive in the future as they have access to more ideas and have more opportunities for collaboration.

We also control for a set of variables that can affect research productivity. All time dependent control variables are estimated for the same period as the co-authorship network. Past productivity of Author i is $q^p_{i;t,s} = q_{i;t} + q_{i;t-1} + \cdots + q_{i;t-(s-1)}$. Authors who are productive in the past are likely to be productive in the future as past productivity can be an indicator of an author's skill and his number of on-going projects.

The average co-author's productivity, $\bar{q}_{1i;t,s}$, over the same period is

$$\bar{q}_{1i;t,s} = \frac{\sum_{j\in N_{i,t,s}} q^{-i}_{jt}}{N_i} \tag{9}$$

where $\sum_{j\in N_i(G_{t,s})} q^{-i}_{jt}$ is the sum of productivity of all co-authors of Author i, excluding papers co-authored with Author i. N_i is the number of co-authors of Author i between $t-(s-1)$ and t. $\bar{q}_{1i;t,s}$ is set to zero when Author i has no co-author during this period. The effect of co-authors' past productivity is *ex ante* ambiguous. Working with productive co-authors can generate a positive impact as they likely have high quality ideas and are experienced. However, productive co-authors can also have a negative effect as they are busy and thus have limited time for each project.

The degree of specialization, $H_{i;t,s}$, is captured by the Herfindahl index

[9] We also use an alternative productivity measure which replaces $Page_j$ with $Paper_j$, where $Paper_j$ equals one divided by the total number of papers published in the same journal during the same year. Our results are robust to this alternative measure of research productivity.

Table 7
Summary statistics of key regression variables.

Variables	*N*	Mean	Std	25%	Median	75%
Productivity	23,216	0.249	0.340	0.000	0.000	0.443
Past Productivity	23,216	0.606	0.351	0.328	0.501	0.812
Avg. co-authors' past productivity	23,216	0.642	0.760	0.000	0.400	1.023
Degree of specialization (HHI)	23,216	0.250	0.174	0.140	0.200	0.333
Degree	23,216	2.270	1.865	1.000	2.000	3.000
Closeness	23,216	0.002	0.001	0.001	0.002	0.002
Betweenness	23,216	0.001	0.004	0.000	0.000	0.000
Senior	23,216	0.382	0.486	0.000	0.000	1.000
Senior_degree	23,216	0.974	1.745	0.000	0.000	2.000
Senior_closeness	23,216	0.001	0.001	0.000	0.000	0.001
Senior_betweenness	23,216	0.001	0.003	0.000	0.000	0.000
Dif_degree	23,216	0.718	2.079	0.000	0.000	1.500
Dif_closeness	23,216	0.000	0.000	0.000	0.000	0.000
Dif_Betweenness	23,216	0.001	0.005	0.000	0.000	0.001
Percentage of New Topics	8895	0.861	0.209	0.750	1.000	1.000
Percentage of New Co-authors	8895	0.437	0.265	0.333	0.500	0.667
New Co-author's New Topics	8895	9.391	12.238	0.000	4.000	15.000
Gap	8895	1.989	1.172	1.000	2.000	3.000

This table reports summary statistics of variables used in the regression analyses. *Productivity* is the 3-year future productivity of individual authors. *Past Productivity* is the productivity of individual authors during the period when centrality measures are calculated. *Avg. co-authors' past productivity* is the average of past productivity of all the co-authors of an individual author during the period when centrality measures are calculated. *Degree of specialization* is the Herfindahl Index of paper topics for papers published during the period when centrality measures are calculated. *Degree*, *Closeness* and *Betweenness* are the three measures of centrality based on the 5-year network. *Percentage of New Topics* measures the topic innovation in a paper. *Percentage of New Co-authors* measures the percentage of new authors in a paper relative to the most recent paper. *New Co-author's New Topics* is the number of new topics the new co-authors in a paper has done before. *Senior* is an indicator that is equal to one if an author's career seniority is higher than 17 years, and zero otherwise. *Senior_degree, Senior_closeness* and *Senior_betweenness* are interaction terms of *Senior* and the three centrality measures. *Dif_degree* is an author's co-authors' average *Degree* relative to the author's *Degree. Dif_closeness* is an author's co-authors' average *Closeness* relative to the author's *Closeness. Dif_Betweenness* is an author's co-authors' average *Betweenness* relative to the author's *Betweenness. Gap* measures the time gap between the current year paper and the most recent paper when *Percentage of New Topics* is calculated.

$$H_{i;t,s} = \sum_{f=1}^{F} \left(\frac{n_{i;t,s}^{f}}{n_{i;t,s}} \right)^{2} \tag{10}$$

where $n_{i;t,s}^{f}$ is the number of articles published between $t-(s-1)$ to t on Topic f, and $n_{i;t,s} = \sum_{f=1}^{F} n_{i;t,s}^{f}$ is the total number of papers of Author i between $t-(s-1)$ and t. The effect of $H_{i;t,s}$ is also *ex ante* unclear. Finally, we control for career seniority ($D_{i,t}$), year (μ_t), and Ph.D granting university ($University_i$) fixed effects. $D_{i,t}$ captures the impact of experience on research output. To construct $D_{i,t}$, we first define $t_{i,0}$ as the PhD graduation year minus five and career seniority as $c_{i,t} = t_i - t_{i,0}$.[10] $D_{i,t}$ are indicator variables for $c_{i,t}$. μ_t are year indicator variables and help control for a potential time trend in author research productivity. University_i, controls for the Ph.D granting university effect.

Summary statistics for dependent and independent variables are reported in Table 7. Regression results of Model (7) are presented in Table 8. Continuous variables in this model and subsequent models are winsorized at the 1st and 99th percentiles. We calculate the centrality measures using the 5-year network from Years $t-4$ to t. The coefficients on the three centrality measures are positive and significant. Central authors in the network have high future productivity. The coefficient on *Degree* is 0.026 ($t = 22.73$). Authors with many co-authors generate high productivity in the future. These authors have better access to ideas and can engage in more research projects. The coefficient on *Closeness* is 73.449 ($t = 24.55$). Authors that are close to other authors can easily connect with them and hence are more productive in the future. The coefficient on *Between-*

[10] We subtract five from graduation year as some authors have published papers before Ph.D graduation. Still, several authors have publications before the start of PhD, and we use the first year of publication as $t_{i,0}$.

Table 8
Network centrality and research productivity.

Variables	(1)	(2)	(3)
	Productivity	*Productivity*	*Productivity*
Degree	0.026		
	(22.73)***		
Closeness		73.449	
		(24.55)***	
Betweenness			4.186
			(13.65)***
Past productivity ($q^{p}_{i;t,s}$)	0.569	0.606	0.595
	(100.14)***	(105.41)***	(106.27)***
Avg. co-authors' past productivity ($\bar{q}_{1i;t,s}$)	0.049	0.038	0.053
	(18.15)***	(13.37)***	(19.71)***
Degree of specialization ($H_{i;t,s}$)	−0.113	−0.156	−0.166
	(−9.55)***	(−12.52)***	(−13.65)***
Year fixed effects	Yes	Yes	Yes
Career seniority fixed effects	Yes	Yes	Yes
Ph.D Granting university fixed effects	Yes	Yes	Yes
N	23,216	23,216	23,216
Pseudo R-sq	0.180	0.179	0.178

This table presents results on the effect of author network centrality on research productivity. We estimate the following model:

$$Productivity_{i;t} = \beta_0 + \beta_1 Centrality_{i;t,s} + \beta_2 Past\ Productivity_{i;t,s} + \beta_3 Avg.coauthors'\ past\ productivity_{i;t,s} + \beta_4 Degree\ of\ specialization_{i;t,s} + Year\ Fixed\ Effects + Career\ seniority\ fixed\ effects + Ph.D\ Granting\ university\ fixed\ effects,$$

where $Productivity_{i;t}$ is the 3-year future productivity of Author i in Year t. $Centrality_{i;t,s}$ represents the centrality measures for Author i during the period of Years $t-4$ to t. We use *Degree, Closeness* and *Betweenness* to measure *Centrality* respectively. $Past\ Productivity_{i;t,s}$ is the productivity of Author i during the period of Years $t-4$ to t. $Avg.\ co\text{-}authors'\ past\ productivity_{i;t,s}$ is the average of past productivity of all the co-authors of Author i during the period of Years $t-4$ to t. $Degree\ of\ specialization_{i;t,s}$ is the Herfindahl Index of paper topics for papers published during the period of Years $t-4$ to t. All continuous variables are winsorized at the top and bottom 1% level. Year, career seniority and Ph.D granting university fixed effects are included and standard errors are adjusted for author level clustering. *, **, *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.

ness is 4.186 ($t = 13.65$). Authors that lie in the critical position of connecting authors have access to more information and produce more in the future.

For control variables, the coefficients on *Past productivity* ($q^{p}_{i;t,s}$) are positive and significant in all three columns. Consistent with our expectation, authors who are productive in the past tend to be productive in the future. The coefficients on the *Avg. co-authors' past productivity* ($\bar{q}_{1i;t,s}$) are positive and significant in all three columns. Working with productive co-authors has a positive impact on an author's future productivity. The coefficients on *Degree of specialization* ($H_{i;t,s}$) are negative and significant in all three columns. Therefore, a high concentration in a few topics has a negative impact on future productivity.

6.3. Author network centrality and topic innovation

Here, we examine how centrality affects an author's innovation in research topics. Assume that Author i publishes Paper p. We compare Paper p with Paper q published before Paper p. Paper p covers m LDA topics, among which n topics are covered in Paper q. Then, Paper p explores $(m-n)$ new topics relative to Paper q and we define $Percentage\ of\ New\ Topics_{i,p,q} = \frac{m-n}{m}$ as the percentage of new topics covered in Paper p relative to Paper q. Note that for the same Paper p, $Percentage\ of\ New\ Topics_{i,p,q}$ will change when a different Paper q is used as a comparison.

For each paper published in Year t, we compare it with the most recent papers published before Year t.[11] We then examine the impact of Author *i's* network centrality on $Percentage\ of\ New\ Topics_{i,p,q}$ using the following model:

$$\begin{aligned} Percentage\ of\ New\ Topics_{i,p,q,t+1} = {} & \alpha_0 + \alpha_1 Centrality + \alpha_2 Percentage\ of\ New\ Co_{author\,i,p,q} \\ & + \alpha_3 New\ Co\_author's\ New\ Topics_{i,p,q} + \alpha_4 Gap_{i,p,q} + D_{i,t}^{'}\omega \\ & + University_i + \mu_t + \epsilon_{i;t,s} \end{aligned} \tag{11}$$

where $Percentage\ of\ New\ Topics_{i,p,q,t+1}$ is $Percentage\ of\ New\ Topics_{i,p,q}$ for Author *i's* Paper p published in Year $t+1$, compared with the most recent papers published before Year $t+1$.[12] We regress $Percentage\ of\ New\ Topics_{i,p,q,t+1}$ on Author *i*'s centrality measures based on publications from Years $t-s+1$ to t.

For each *p-q* pair, we calculate the percentage of new co-authors in Paper p relative to Paper q:

$$Percentage\ of\ New\ Co\_author_{i,p,q} = \frac{Number\ of\ co-authors\ in\ paper\ p\ but\ not\ in\ paper\ q}{Number\ of\ total\ authors\ in\ paper\ p} \tag{12}$$

We expect that more new co-authors in Paper p relative to Paper q will lead to new topics being explored in Paper p relative to Paper q.

We further control for $New\ Co\_author's\ New\ Topics_{i,p,q}$, which is the number of new topics new co-authors in Paper p have done before. We define $New\ Co\_author's\ New\ Topics_{i,p,q}$ as follows. If Paper p has Authors i, a, b, c and Paper q has Authors i, a and d. b and c are defined as new co-authors in Paper p relative to Paper q. We count the number of topics that Authors b and c have done but Author i has not done before Paper p is published and define the total number of such topics as $New\ Co\_author's\ New\ Topics_{i,p,q}$. We expect that new topics that new co-authors have done will lead to new topics being explored in Paper p relative to Paper q.

As the time gap between Paper p and other most recent papers are different for different Author i, we control for $Gap_{i,p,q}$, which is the time gap between Paper p and Paper q. We also control for year, career seniority, μ_t, and Ph.D granting university, $University_i$, fixed effects.

We estimate Model (11) and report the results in Table 9. We calculate centrality measures based on co-authorship network from Years $t-4$ to t (five-year window). The coefficients on centrality measures are all positive and significant in Table 9 (0.003, $t = 2.75$ for *Degree,* 14.503, $t = 2.24$ for *Closeness* and 0.643, $t = 2.40$ for *Betweenness*). These results suggest that the higher is an author's network centrality, the more new topics he will explore in future publications.

The effects on *Percentage of New Co-authors* and *New Co-author's New Topics* are also consistent with our expectation. The coefficients on *Percentage of New Co-authors* and *New Co-author's New Topics* are significantly positive in all three columns. These results suggest that more new co-authors and more new topics these new co-authors have done will lead to more new topics being explored by an author.

6.4. Endogeneity

Our centrality measures are calculated based on the co-authorship network formed via an author's past publications. If both an author's research output and network centrality are affected by common omitted variables, the association between author network centrality and research output can be biased. Reverse causality is another concern. Several theoretical papers examine industrial firms' incentives in forming alliance with other firms in innovation activities (Cowan et al., 2007; Baum et al., 2010). Similarly, co-authorship links do not form randomly in our setting. Productive authors can attract more co-authors and hence gain high centrality in the network. We address endogeneity through an instrument variable (IV) approach. For *Degree*

[11] For example, if the most recent year before Year t an author has publications is Year $t-l$, then we compare with all papers published in Year $t-l$ and calculate $Percentage\ of\ New\ Topics_{i,p,q}$ for each comparison.

[12] Assume that Author i has 2 publications in Year $t+1$, 0 publication in Year t, 0 publication in Year $t-1$, and 3 publications in Year $t-2$, then he will have 2×3 $Percentage\ of\ New\ Co_{authors\,i,p,q,t+1}$ observations in the regression.

Table 9
Network centrality and topic innovation.

	(1) *Percentage of New Topics*	(2) *Percentage of New Topics*	(3) *Percentage of New Topics*
Degree	0.003		
	(2.75)***		
Closeness		14.503	
		(2.24)**	
Betweenness			0.643
			(2.40)**
Percentage of New Co-authors	0.095	0.097	0.096
	(8.66)***	(8.77)***	(8.69)***
New Co-author's New Topics	0.001	0.001	0.001
	(2.68)***	(2.52)**	(2.55)**
Gap	−0.008	−0.009	−0.009
	(−3.32)***	(−4.01)***	(−3.93)***
Year fixed effects	Yes	Yes	Yes
Career seniority fixed effects	Yes	Yes	Yes
Granting university fixed effects	Yes	Yes	Yes
N	8895	8895	8895
Adj. R-sq	0.054	0.054	0.054

This table presents results on the effect of author network centrality on the topic innovation. We estimate the following model:

$$\begin{aligned} \textit{Percentage of New Topics}_{i,p,q,t+1} = {} & \beta_0 + \beta_1 \textit{Centrality}_{i;t,s} + \beta_2 \textit{Percentage of New Co-author}_{i,p,q} \\ & + \beta_3 \textit{New Co\_author's New Topics}_{i,p,q} + \beta_4 \textit{Gap}_{i,p,q} + \textit{Year Fixed Effects} \\ & + \textit{Career seniority fixed effects} + \textit{Ph.D Granting university fixed effects}, \end{aligned}$$

where $\textit{Percentage of New Topics}_{i,p,q,t+1}$ is percentage of new topics for Author *i's* Paper *p* published in Year *t* relative to Author *i's* most recent Paper *q*. $\textit{Centrality}_{i;t,s}$ represents the centrality measures for Author *i* during the period of Years $t-4$ to *t*. We use *Degree, Closeness* and *Betweenness* to measure *Centrality* respectively. $\textit{Percentage of New Co-author}_{i,p,q}$ is the percentage of new authors for Author *i's* Paper *p* relative to the author's most recent Paper *q*. $\textit{New Co\_author's New Topics}_{i,p,q}$ is the number of topics the new co-authors in Paper *p* relative to Paper *q* has done while Author *i* has never done before Year *t*. $\textit{Gap}_{i,p,q}$ measures the time gap between the publication year of Paper *p* and Paper *q*. All continuous variables are winsorized at the top and bottom 1% level. Year, career seniority and Ph.D granting university fixed effects are included and standard errors are adjusted for author level clustering. *, **, *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.

and *Closeness*, we use the number of authors that can be indirectly connected to an author through three steps as an instrumental variable. We define *Order 3* as the number of three-step connected authors. *Order 3* serves as a proxy for a pool of potential co-authors as they are close to the author. Therefore, *Order 3* should be positively associated with subsequent period *Degree*. In addition, when an author has more potential co-authors to work with, her distance to other co-authors in the subsequent period is also likely to be close. We expect *Order 3* to be also positively associated with *Closeness*. However, *Order 3* of the previous period should not directly affect research output as these authors do not directly collaborate with the author.

The instrumental variable estimation results when *Degree* is used as a centrality measure are reported in Panel A, Table 10. Columns (1) and (2) report results for research productivity. Column (1) presents the first stage results. Consistent with our expectation, the coefficient on *Order 3* is positive and significant (0.084, $t = 85.89$). Authors with a large number of three-step authors tend to have high *Degree*. Column (2) reports the second stage result for the instrumented *Degree* (*IV_Degree*). The coefficient1 on *IV_ Degree* is positive and significant (0.037, $t = 7.08$). Columns (3) and (4) report results for topic innovation. Similarly, the coefficient on *Order 3* in the first stage is positive and significant (0.094, $t = 45.42$). The coefficient on *IV_Degree* is positive and significant (0.003, $t = 2.12$).

The instrumental variable estimation results for *Closeness* are reported in Panel B, Table 10. Similarly, the coefficients on *Order 3* in the first stage estimations are both positive and significant (0.00002, $t = 72.37$ in Column (1) and 0.00001, $t = 29.04$ in Column (3)). The coefficients on *IV_Closeness* are both positive and significant for research productivity and topic innovation (172.659, $t = 7.31$ for *Productivity* in Column (2) and 26.453, $t = 2.12$ for *Percentage of New Topics* in Column (4)).

Table 10
Centrality and research output: Instrumental variable approach.

Panel A: *Degree* and Research Output

	Productivity		Topic Innovation	
	First Stage	Second Stage	First Stage	Second Stage
	(1)	(2)	(3)	(4)
Variables	*Degree*	*Productivity*	*Degree*	*Percentage of New Topics*
IV_Degree	–	0.037		0.003
	–	(7.08)***		(2.12)**
Order 3	0.084		0.094	
	(85.89)***		(45.42)***	
Past productivity ($q^{p}_{i;t,s}$)	1.151	0.55		
	(37.01)***	(33.04)***		
Avg. co-authors' past productivity ($\bar{q}_{1i;t,s}$)	−0.147	0.046		
	(−11.02)***	(7.76)***		
Degree of specialization ($H_{i;t,s}$)	−1.745	−0.09		
	(−29.52)***	(−2.85)***		
Percentage of New Co-authors			0.709	0.095
			(7.82)***	(8.97)***
New Co-author's New Topics			−0.011	0.001
			(−5.59)***	(2.99)***
Gap			−0.513	−0.007
			(–32.33)***	(−3.07)***
Year fixed effects	Yes	Yes	Yes	Yes
Career seniority fixed effects	Yes	Yes	Yes	Yes
PhD Granting university fixed effects	Yes	Yes	Yes	Yes
N	23,216	23,216	8895	8895
Adj. R-sq		0.5005		0.054

Panel B: *Closeness* and Research Output

	Productivity		Topic Innovation	
	First Stage	Second Stage	First Stage	Second Stage
	(1)	(2)	(3)	(4)
Variables	*Closeness*	*Productivity*	*Closeness*	*Percentage of New Topics*
IV_Closeness	–	172.659		
	–	(7.31)***	–	26.453
Order 3	0.00002	–	–	(2.12)**
	(72.37)***	–	0.00001	–
Past productivity ($q^{p}_{i;t,s}$)	0.00001	0.593		
	(1.24)	(40.80)***		
Avg. co-authors' past productivity ($\bar{q}_{1i;t,s}$)	0.00016	0.012		
	(45.89)***	(1.45)		
Degree of specialization ($H_{i;t,s}$)	−0.00014	−0.134		
	(−8.79)***	(−4.42)***		
Percentage of New Co-authors			0.00001	0.097
			(0.51)	(9.21)***
New Co-author's New Topics			0.00000	0.001
			(0.67)	(2.79)***
Gap			−0.00003	−0.008
			(−8.88)***	(−3.62)***
Year fixed effects	Yes	Yes	Yes	Yes
Career seniority fixed effects	Yes	Yes	Yes	Yes
PhD Granting university fixed effects	Yes	Yes	Yes	Yes
Constant	0.00173	−4.307	0.00052	0.738
	(15.06)***	(−99.67)***	(7.26)***	(23.23)***
N	23,216	23,216	8895	8895
Adj. R-sq	0.535			0.053

Panel C: *Betweenness* and Research Output

	Productivity		Topic Innovation	
	First Stage	Second Stage	First Stage	Second Stage
	(1)	(2)	(3)	(4)
Variables	*Betweenness*	*Productivity*	*Betweenness*	*Percentage of New Topics*
IV_Betweenness	–	32.470	–	0.452
	–	(8.08)***	–	(0.58)
Clustering Coefficient	−0.005	–	−0.010	–
	(−32.66)***	–	(−36.19)***	–
Past productivity ($q^{p}_{i;t,s}$)	0.003	0.439		
	(21.11)***	(15.39)***		
Avg. co-authors' past productivity ($\bar{q}_{1i;t,s}$)	0.001	0.029		
	(16.93)***	(3.41)***		
Degree of specialization ($H_{i;t,s}$)	0.000	−0.033		
	(1.32)	(−0.73)		
Percentage of New Co-authors			0.002	0.088
			(4.82)***	(7.33)***
New Co-author's New Topics			0.000	0.001
			(1.20)	(2.26)**
Gap			−0.001	−0.006
			(−8.29)***	(−2.37)**
Year fixed effects	Yes	Yes	Yes	Yes
Career seniority fixed effects	Yes	Yes	Yes	Yes
PhD Granting university fixed effects	Yes	Yes	Yes	Yes
Constant	−0.001	−0.316	0.016	0.779
	(−0.64)	(−1.75)*	(9.89)***	(27.76)***
N	14,680	14,680	6898	6898
Adj. R-sq		0.342		0.046

This presents results for the instrumental variable two-stage results for the association between three centrality measures and research output.

In Panel A, we present the results for the association between *Degree* and research output. We use *Order 3*, which is the number of three-step-connected authors as an instrumental variable for *Degree*. *IV_Degree* is the instrumented *Degree* from the first stage. In Panel B, we present the results for the association between *Closeness* and research output. We use *Order 3*, which is the number of three-step-connected authors as an instrumental variable for *Closeness*. *IV_Closeness* is the instrumented *Closeness* from the first stage. In Panel C, we present the results for the association between *Betweenness* and research output. We use *Cluster Coefficients* as an instrumental variable for *Betweenness*. *IV_Betweeness* is the instrumented *Betweenness* from the first stage.

In each panel, the results for productivity are reported in Columns (1) and (2) and the results for topic innovation are reported in Columns (3) and (4).

$Productivity_{i;t,s}$ is the 3-year future productivity of Author *i* in Year *t*. $Percentage\ of\ New\ Topics_{i,p,q,t+1}$ is the percentage of new topics for Author *i's* Paper *p* published in Year *t* relative to Author *i's* most recent Paper *q*. $Past\ Productivity_{i;t,s}$ is the productivity of Author *i* during the period of Years $t-4$ to *t*. $Avg.\ co\text{-}authors'\ past\ productivity_{i;t,s}$ is the average of past productivity of all the co-authors of Author *i* during the period of Years $t-4$ to *t*. $Degree\ of\ specialization_{i;t,s}$ is the Herfindahl Index of paper topics for papers published during the period of Years $t-4$ to *t*. $Percentage\ of\ New\ Co\text{-}author_{i,p,q}$ is the percentage of new authors for Author *i's* Paper *p* relative to the author's most recent Paper *q*. $New\ Co\_author's\ New\ Topics_{i,p,q}$ is the number of topics the new co-authors in Paper *p* relative to Paper *q* has done while Author *i* has never done before Year *t*. $Gap_{i,p,q}$ measures the time gap between the publication year of Paper *p* and Paper *q*. All continuous variables are winsorized at the top and bottom 1% level. Year, career seniority and Ph.D granting university fixed effects are included. For productivity, estimate the two-stage Tobit model and standard errors are adjusted for two-stage estimation. For topic innovation, standard errors are adjusted for two stage estimation. *, **, *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.

Finally, we use *Clustering Coefficient* as an instrumental variable for *Betweenness*. Note that *Betweenness* measures the extent to which the shortest link connecting any two authors in the network passes through a given author. On the one hand, *Clustering Coefficient* can affect *Betweenness*. *Clustering Coefficient* measures the extent to which an author's co-authors are also co-authors of each other. One extreme case is that, when an author's *Clustering Coefficient* equals zero, none of the author's co-authors are directly connected to each other. As a result, all the shortest ways of connecting any two of the author's co-authors will have to pass through the author. Another extreme scenario is that, when an author's *Clustering Coefficient* equals one,

any two of the author's co-authors are directly connected. In this case, none of the shortest ways will go through the author. Therefore, *Clustering Coefficient* has a negative impact on an author's *Betweenness*. On the other hand, *Clustering Coefficient* is a result of an author's co-authors' interactions and is not under his control.

We report the instrumental variable estimation results in Panel C, Table 10. Due to the nature of *Clustering Coefficient*, only authors with *Degree* equal to or larger than two will have *Clustering Coefficient*. Our sample in this test is based on authors with two or more co-authors. Columns (1) and (2) report results for the impact of *Betweenness* on research productivity. In Column (1), consistent with our expectation, the coefficient on *Clustering Coefficient* is negative and significant (−0.005, $t = -32.66$). Column (2) reports the second stage result of the instrumented *Betweenness* (*IV_Betweenness*). The coefficient on *IV_Betweenness* is positive and significant (32.470, $t = 8.08$). Columns (3) and (4) report results on topic innovation. The coefficient on *Clustering Coefficient* for the first stage is negative and significant (−0.10, $t = -36.19$). The coefficients on *IV_Betweenness* is positive but insignificant (0.452, $t = 0.58$). Using the instrumental variable approach, the positive association between *Betweenness* and research productivity still holds.

In sum, using a more rigorous empirical design to deal with endogeneity does not change the general tone of our findings.

6.5. Author seniority and the impact of centrality

We next examine whether the impact of centrality differs with author seniority. We define an indicator variable, *Senior*, that equals one if an author's career seniority is higher than seventeen years, and zero otherwise. *Senior* is interacted with centrality measures and included in the regression.

Table 11
Author seniority and the impact of network centrality.

Panel A: Research productivity			
Variables	(1)	(2)	(3)
	Productivity	*Productivity*	*Productivity*
Degree	0.019		
	(15.60)***		
Closeness		68.279	
		(22.05)***	
Betweenness			2.419
			(6.42)***
Senior_Degree	0.015		
	(9.82)***		
Senior_Closeness		12.169	
		(2.95)***	
Senior_Betweenness			4.441
			(8.35)***
Senior	−2.843	−2.876	−2.862
	(−421.17)***	(−381.87)***	(−453.09)***
Past productivity ($q^{p}_{i;t,s}$)	0.566	0.605	0.594
	(98.05)***	(102.64)***	(104.48)***
Avg. co-authors' past productivity ($\bar{q}_{1i;t,s}$)	0.050	0.038	0.053
	(18.55)***	(13.22)***	(19.66)***
Degree of specialization ($H_{i;t,s}$)	−0.116	−0.156	−0.167
	(−9.60)***	(−12.29)***	(−13.42)***
Year fixed effects	Yes	Yes	Yes
Career seniority fixed effects	Yes	Yes	Yes
PhD Granting university fixed effects	Yes	Yes	Yes
N	23,216	23,216	23,216
Pseudo R-sq	0.180	0.179	0.178

Panel B: Topic innovation

	(1) *Percentage of New Topics*	(2) *Percentage of New Topics*	(3) *Percentage of New Topics*
Degree	0.003		
	(2.16)**		
Closeness		13.472	
		(1.74)*	
Betweenness			0.439
			(1.30)
Senior_Degree	−0.000		
	(−0.23)		
Senior_Closeness		2.341	
		(0.23)	
Senior_Betweenness			0.455
			(0.96)
Senior	0.359	0.357	0.357
	(15.33)***	(14.10)***	(15.05)***
Percentage of New Co-authors	0.096	0.097	0.096
	(8.68)***	(8.76)***	(8.65)***
New Co-author's New Topics	0.001	0.001	0.001
	(2.66)***	(2.52)**	(2.62)***
Gap	−0.008	−0.009	−0.009
	(−3.32)***	(−4.00)***	(−3.93)***
Year fixed effects	Yes	Yes	Yes
Career seniority fixed effects	Yes	Yes	Yes
Granting university fixed effects	Yes	Yes	Yes
N	8895	8895	8895
Adj. R-sq	0.054	0.054	0.054

This table presents results on the effect of career seniority on the association between author network centrality and the research output. In panel A, we estimate the following model:

$$Productivity_{i,t} = \beta_0 + \beta_1 Centrality_{i,t,s} + \beta_2 Past\ Productivity_{i,t,s} + \beta_3 Avg.coauthors'\ past\ productivity_{i,t,s} + \beta_4 Degree\ of\ specialization_{i,t,s} + \beta_5 Senior_{i,t} + \beta_6 Senior\_Centrality_{i,t,s} + Year\ Fixed\ Effects + Career\ seniority\ fixed\ effects + Ph.D\ Granting\ university\ fixed\ effects$$

In panel B, we estimate the following model:

$$Percentage\ of\ New\ Topics_{i,p,q,t+1} = \beta_0 + \beta_1 Centrality_{i,t,s} + \beta_2 Percentage\ of\ New\ Co\text{-}author_{i,p,q} + \beta_3 New\ Co\_author's\ New\ Topics_{i,p,q} + \beta_4 Gap_{i,p,q} + \beta_5 Senior_{i,t} + \beta_6 Senior\_Centrality_{i,t,s} + Year\ Fixed\ Effects + Career\ seniority\ fixed\ effects + Ph.D\ Granting\ university\ fixed\ effects$$

$Productivity_{i,t,s}$ is the 3-year future productivity of Author i in Year t. $Percentage\ of\ New\ Topics_{i,p,q,t+1}$ is the percentage of new topics for Author *i's* Paper p published in Year t relative to Author *i's* most recent Paper q. $Centrality_{i,t,s}$ are centrality measures for Author i during the period of Years $t-4$ to t. We use *Degree, Closeness* and *Betweenness* to measure *Centrality* respectively. $Past\ Productivity_{i,t,s}$ is the productivity of Author i during the period of Years $t-4$ to t. $Avg.\ co\text{-}authors'\ past\ productivity_{i,t,s}$ is the average of past productivity of all the co-authors of Author i during the period of Years $t-4$ to t. $Degree\ of\ specialization_{i,t,s}$ is the Herfindahl Index of paper topics for papers published during the period of Years $t-4$ to t. $Percentage\ of\ New\ Co\text{-}author_{i,p,q}$ is the percentage of new authors for Author *i's* Paper p relative to the author's most recent Paper q. $New\ Co\_author's\ New\ Topics_{i,p,q}$ is the number of topics the new co-authors in Paper p relative to Paper q has done while Author i has never done before Year t. $Gap_{i,p,q}$ measures the time gap between the publication year of Paper p and Paper q. $Senior_{i,t}$ is an indicator that equals one if Author i's career seniority is higher than 17 years, and zero otherwise. $Senior\_Centrality_{i,t,s}$ is the interaction of $Senior_{i,t}$ and $Centrality_{i,t,s}$. All continuous variables are winsorized at the top and bottom 1% level. Year, career seniority and Ph.D granting university fixed effects are included and standard errors are adjusted for author level clustering. *, **, *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.

Results for productivity are reported in Panel A, Table 11. The coefficients on the centrality measures remain positive and significant. The coefficients *on Senior_Centrality* are all positive and significant (0.015, $t = 9.82$ for *Senior_Degree*, 12.169, $t = 2.95$ for *Senior_Closeness* and 4.441, $t = 8.35$ for *Senior_Betweenness*). Therefore, the positive association between centrality and productivity generally strengthens with more senior authors.

Table 12
Isolated authors and research output.

Panel A: Research productivity	
Variables	*Productivity*
Isolated	−0.065
	(−16.30)***
Past productivity ($q^{p}_{i;t,s}$)	0.625
	(112.91)***
Avg. co-authors' past productivity ($\bar{q}_{1i;t,s}$)	0.047
	(17.36)***
Degree of specialization ($H_{i;t,s}$)	−0.151
	(−12.25)***
Year fixed effects	Yes
Career seniority fixed effects	Yes
PhD granting university fixed effects	Yes
N	23,216
Pseudo R-sq	0.178
Panel B: Topic innovation	
	Percentage of New Topics
Isolated	−0.010
	(−0.96)
Percentage of New Co-authors	0.099
	(8.85)***
New Co-author's New Topics	0.001
	(2.55)**
Gap	−0.009
	(−4.28)***
Year fixed effects	Yes
Career seniority fixed effects	Yes
Granting university fixed effects	Yes
Constant	0.608
	(31.93)***
N	8895
Adj. R-sq	0.053

This table presents results of the association between isolated author and research output.
In panel A, we estimate the following model:

$$Productivity_{i;t} = \beta_0 + \beta_1 Isolated_{i;t,s} + \beta_2 Past\ Productivity_{i;t,s} + \beta_3 Avg.coauthors'\ past\ productivity_{i;t,s} + \beta_4 Degree\ of\ specialization_{i;t,s} + Year\ Fixed\ Effects + Career\ seniority\ fixed\ effects + Ph.D\ Granting\ university\ fixed\ effects$$

In panel B, we estimate the following model:

$$Percentage\ of\ New\ Topics_{i,p,q,t+1} = \beta_0 + \beta_1 Isolated_{i;t,s} + \beta_2 Percentage\ of\ New\ Co\text{-}author_{i,p,q} + \beta_3 New\ Co\_author's\ New\ Topics_{i,p,q} + \beta_4 Gap_{i,p,q} + Year\ Fixed\ Effects + Career\ seniority\ fixed\ effects + Ph.D\ Granting\ university\ fixed\ effects,$$

$Isolated_{i;t,s}$ is an indicator equals one if Author i is an isolated author during the period of Years $t-4$ to t, and zero otherwise. $Productivity_{i;t,s}$ is the 3-year future productivity of Author i in Year t. $Percentage\ of\ New\ Topics_{i,p,q,t+1}$ is the percentage of new topics for Author *i's* Paper p published in Year t relative to Author *i's* most recent Paper q. $Past\ Productivity_{i;t,s}$ is the productivity of Author i during the period of Years $t-4$ to t. $Avg.\ co\text{-}authors'\ past\ productivity_{i;t,s}$ is the average of past productivity of all the co-authors of Author i during the period of Years $t-4$ to t. $Degree\ of\ specialization_{i;t,s}$ is the Herfindahl Index of paper topics for papers published during the period of Years $t-4$ to t. $Percentage\ of\ New\ Co\text{-}author_{i,p,q}$ is the percentage of new authors for Author *i's* Paper p relative to the author's most recent Paper q. $New\ Co\_author's\ New\ Topics_{i,p,q}$ is the number of topics the new co-authors in Paper p relative to Paper q has done while Author i has never done before Year t. $Gap_{i,p,q}$ measures the time gap between the publication year of Paper p and Paper q. All continuous variables are winsorized at the top and bottom 1% level. Year, career seniority and Ph.D granting university fixed effects are included and standard errors are adjusted for author level clustering. *, **, *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.

We next examine how an author's seniority affects the association between the centrality and topic innovation. We report the results in Panel B, Table 11. The coefficients on *Degree* (0.003, $t = 2.16$) and *Closeness* (13.472, $t = 1.74$) are positive and significant but the coefficient on *Betweenness* is insignificant (0.439, $t = 1.30$). The coefficients on the interactions *Senior_Degree* (−0.000, $t = -0.23$), *Senior_Closenss* (2.341, $t = 0.23$) and *Senior_Betweenness* (0.455, $t = 0.96$) are all insignificant. Therefore, it appears that author seniority does not exert an impact on the positive association between centrality and topic innovation.

6.6. Isolated authors

Here, we examine the association between isolated authors and their research output. We are interested in whether isolated authors have different research output compared with connected authors as isolated authors may adopt different strategies or work styles compared with other researchers. We define an indicator variable *Isolate* that equals one if an author is isolated, and zero otherwise. We replace *Centrality* in Models (7) and (11) with *Isolate*. The regression results are reported in Table 12. Panel A presents results for *Productivity*. The coefficient on *Isolate* is negative and significant (−0.065, $t = -16.30$), suggesting that isolated authors have lower productivity. Panel B reports the results for topic innovation. The coefficient on *Isolate* is negative but insignificant (−0.10, $t = -0.96$). Therefore, while isolated authors have lower productivity, they do not lag in topic innovation.

6.7. Co-Authors' network centrality

Finally, we examine whether co-authors' network centrality has an impact on an author's research output. We are interested in the effect of the centrality difference between an author and their co-authors. We define three centrality difference measures. *Dif_Degree* is defined as the average co-authors' *Degree* minus an author's

Table 13
Co-author network centrality and research output.

Panel A: Research productivity

Variables	(1)	(2)	(3)
	Productivity	*Productivity*	*Productivity*
Degree	0.031		
	(26.15)***		
Closeness		70.703	
		(23.70)***	
Betweenness			5.863
			(17.28)***
Dif_Degree	0.008		
	(12.50)***		
Dif _Closeness		33.762	
		(11.62)***	
Dif _Betweenness			2.859
			(12.02)***
Past productivity ($q^{p}_{i;t,s}$)	0.578	0.612	0.598
	(101.32)***	(105.74)***	(106.65)***
Avg. co-authors' past productivity ($\bar{q}_{1i;t,s}$)	0.036	0.032	0.044
	(12.03)***	(11.28)***	(15.48)***
Degree of specialization ($H_{i;t,s}$)	−0.109	−0.142	−0.164
	(−9.00)***	(−11.21)***	(−13.43)***
Year fixed effects	Yes	Yes	Yes
Career seniority fixed effects	Yes	Yes	Yes
Granting university fixed effects	Yes	Yes	Yes
N	23,216	23,216	23,216
Pseudo R-sq	0.180	0.179	0.178

Panel B: Topic innovation

	(1) *Percentage of New Topics*	(2) *Percentage of New Topics*	(3) *Percentage of New Topics*
Degree	0.005		
	(3.22)***		
Closeness		14.124	
		(2.11)**	
Betweenness			1.517
			(3.40)***
Dif_Degree	0.003		
	(2.16)**		
Dif_Closeness		1.843	
		(0.24)	
Dif_Betweenness			1.218
			(2.45)**
Percentage of New Co-authors	0.097	0.098	0.097
	(8.75)***	(8.80)***	(8.72)***
New Co-author's New Topics	0.001	0.001	0.001
	(2.54)**	(2.52)**	(2.42)**
Gap	−0.008	−0.009	−0.009
	(−3.32)***	(−3.96)***	(−3.97)***
Year fixed effects	Yes	Yes	Yes
Career seniority fixed effects	Yes	Yes	Yes
Granting university fixed effects	Yes	Yes	Yes
Constant	0.589	0.596	0.608
	(29.40)***	(29.47)***	(32.10)***
N	8895	8895	8895
Adj. R-sq	0.054	0.054	0.054

This table presents results on the effect of co-author network centrality on the research output.
In panel A, we estimate the following model:

$$Productivity_{i;t} = \beta_0 + \beta_1 Centrality_{i;t,s} + \beta_2 Past\ Productivity_{i;t,s} + \beta_3 Avg.coauthors'\ past\ productivity_{i;t,s} + \beta_4 Degree\ of\ specialization_{i;t,s} + \beta_5 Dif\_Centrality_{i;t,s} + Year\ Fixed\ Effects + Career\ seniority\ fixed\ effects + Ph.D\ Granting\ university\ fixed\ effects$$

In panel B, we estimate the following model:

$$Percentage\ of\ New\ Topics_{i,p,q,t+1} = \beta_0 + \beta_1 Centrality_{i;t,s} + \beta_2 Percentage\ of\ New\ Co\text{-}author_{i,p,q} + \beta_3 New\ Co\_author's\ New\ Topics_{i,p,q} + \beta_4 Gap_{i,p,q} + \beta_5 Dif\_Centrality_{i;t,s} + Year\ Fixed\ Effects + Career\ seniority\ fixed\ effects + Ph.D\ Granting\ university\ fixed\ effects$$

In the two models, $Productivity_{i;t}$ is the 3-year future productivity of Author *i* in Year *t*. $Percentage\ of\ New\ Topics_{i,p,q,t+1}$ is percentage of new topics for Author *i's* Paper *p* published in Year *t* relative to Author *i's* most recent Paper *q*. $Centralityi;t,s$ represents the centrality measures for Author *i* during the period of Years *t* – 4 to *t*. We use *Degree, Closeness* and *Betweenness* to measure *Centrality* respectively. $Past\ Productivity_{i;t,s}$ is the productivity of Author *i* during the period of Years *t* – 4 to *t*. $Avg.\ co\text{-}authors'\ past\ productivity_{i;t,s}$ is the average of past productivity of all the co-authors of Author *i* during the period of Years *t* – 4 to *t*. $Degree\ of\ specialization_{i;t,s}$ is the Herfindahl Index of paper topics for papers published during the period of Years *t* – 4 to *t*. $Percentage\ of\ New\ Co\text{-}author_{i,p,q}$ is the percentage of new authors for Author *i's* Paper *p* relative to the author's most recent Paper *q*. $New\ Co\_author's\ New\ Topics_{i,p,q}$ is the number of topics the new co-authors in Paper *p* relative to Paper *q* has done while Author *i* has never done before Year *t*. $Gap_{i,p,q}$ measures the time gap between the publication year of Paper *p* and Paper *q*. $Dif\_Centrality_{i;t,s}$ is Author *i*'s co-authors' average *Centrality measures* during the period of Years *t* – 4 to *t*. All continuous variables are winsorized at the top and bottom 1% level. Year, career seniority and PhD granting university fixed effects are included and standard errors in parentheses are adjusted for author level clustering. *, **, *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.

Degree. *Dif_Closeness* is defined as the average co-authors' *Closeness* minus an author's *Closeness*. *Dif_Betweenness* is the average co-authors' *Betweenness* minus an author's *Betweenness*. If an author has no co-authors, *Dif_Degree*, *Dif_Closeness* and *Dif_Betweenness* are set to zero.

We include these variables in the regression analyses and results are reported in Table 13. In Panel A, Table 13, we report the results for productivity. The coefficients on centrality measures are all positive and significant. In addition, the coefficients on *Dif_Degree*, *Dif_Closeness* and *Dif_Betweenness* are all positive

and significant (0.008, $t = 12.50$ for *Dif_Degree*, 33.762, $t = 11.62$ for *Dif_Closeness* and 2.859, $t = 12.02$ for *Dif_Betweenness*). Thus, co-authors' centrality, relative to an author's own centrality, also have a positive impact on research productivity.

Panel B of Table 13 reports the results for topic innovation. The coefficients on the three centrality measures are all positive and significant. The coefficients on *Dif_Degree*, *Dif_Closeness*, and *Dif_Betweenness* are positive, but they are significant for *Dif_Degree* and *Dif_Betweenness* only (0.003, $t = 2.16$ for *Dif_Degree*, 1.843, $t = 0.24$ for *Dif_Closeness*, and 1.218, $t = 2.45$ for *Dif_Betweenness*). Overall, these results suggest that co-authors' centrality relative to an author's own centrality also generally positively affect topic innovation.

7. Conclusion

We establish the network centrality generated through research collaboration and examine the impact of centrality on individual researchers' output. Using papers published in the five top accounting journals (*JAR*, *TAR*, *JAE*, *CAR*, and *RAS*) from 1980 to 2016, we explore characteristics of the co-authorship network, research topic development and the impact of co-authorship network centrality on research output. We show that the co-authorship network in the accounting field meets the four features of the "small world" property. Specifically, each author does not have many co-authors compared with the number of authors in the network. There exists a giant component in the network within which any two authors can be linked, directly or indirectly. Further, it usually takes only a few steps to connect two authors in the network. Finally, the co-authorship in the network is highly overlapping. We further identify a group of authors that have very high co-authorship, and find that for these authors, their co-authors are less likely to work with each other. Therefore, the most connected authors play an important role in sustaining the network.

We use the LDA machine learning modeling to automatically label a research paper with multiple topics. Based on the LDA topic labels, we find that the number of topics covered each year relative to the number of published papers has decreased in recent years. In addition, the top-10 topics in each year are sticky. We also find that the overlaps of topics in the five journals are low, suggesting that these journals have their own topic specializations and/or tastes.

Finally, we examine the association between centrality in the co-authorship network and research output. We find that high centrality is associated with high future research productivity and topic innovation. We use an instrumental variable approach to address endogeneity associated with our centrality measures and find similar results. We execute several further analyses on the association between network features and research output. We find that author seniority enhances the positive impact of centrality on research productivity but not topic innovation. Isolated authors exhibit lower research productivity, but their do not lag in topic innovation. Finally, centrality of an author's co-authors also has an incrementally positively impact on his research output. Overall, we conclude that network centrality positively influence research output.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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State-owned enterprises in China: A review of 40 years of research and practice

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ABSTRACT

State-owned enterprises (SOEs) are important components of the Chinese economy. Although SOEs are generally considered inefficient in operations, China's economy, which relies heavily on SOEs, has been highly successful over the last four decades. This indicates the importance of SOEs in China's past and future economic success. Therefore, in this study, we review the literature on economic theories and 40 years of practice of Chinese SOEs and discuss implications for future research. Our review consists of four parts: the theories of SOEs and their reform, the performance and financing strategies of SOEs, corporate governance in SOEs, and corporate social responsibility in SOEs.

1. Introduction

State-owned enterprises (SOEs) play an increasingly important role in today's global economy. There were 27 SOEs in *Fortune Global 500* (FG500) in 2000, and this number increased to 102 in 2017, accounting for one fifth of the FG500 corporations. In 2017, the revenues of FG500 SOEs reached a total of $6.1 trillion, amounting to 22% of the total revenues of all FG500 corporations ($27.7 trillion) Chinese SOEs represent a significant portion of FG500 SOEs. In particular, in 2000, there were 27 FG500 SOEs, 9 were from China; in 2017, 75 of the 102 FG500 SOEs were from China. Fig. 1 shows the distribution of China's SOEs in relation to all SOEs in the FG500 list.

In addition to the 75 giant SOEs in FG500, there are more than 150,000 SOEs in China. China's SOE sector has grown significantly (in the number and total market capitalization of SOEs) since China's launch of

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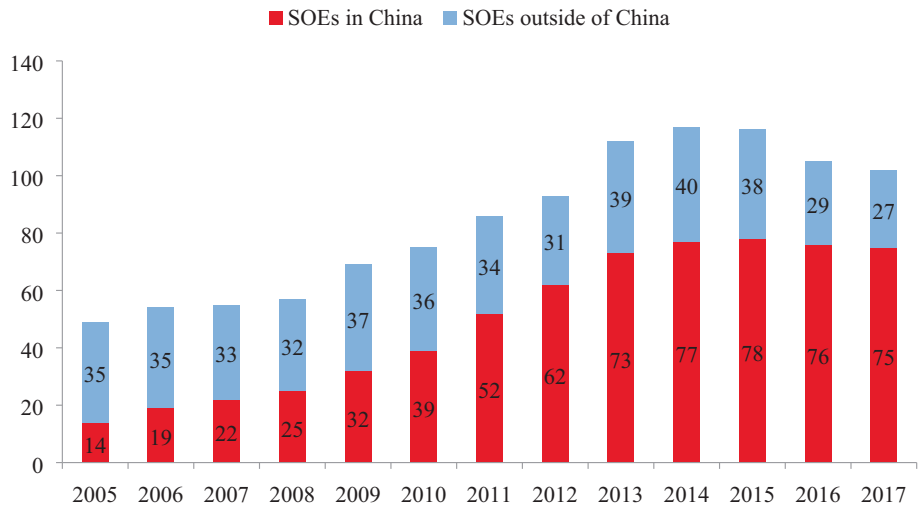

Fig. 1. SOEs in *Fortune Global 500*.

marketization reform in 1978. According to the disclosure of the State-owned Assets Supervision and Administration Commission of the State Council (SASAC), the assets of Chinese SOEs reached RMB151,711 billion (about US$22,310), and they sold more than RMB52,200 billion (about US$7,676) in goods and services in 2017.

These data suggest that China's SOEs are essential not only for the domestic market but also for the global market. In the field of academic research, voluminous studies on SOEs are based on a Chinese sample. According to Bruton et al. (2015), 39 papers on SOEs were published in the *Financial Times*'s list of 45 journals between 2000 and 2014, among which 30 papers used Chinese SOEs as a research sample. Existing research sometimes provides mixed evidence on China SOEs, probably due to lack of consensus on theories regarding China SOEs. Most important, the literature didn't provide clear answer on the question: If China's SOEs perform poorly, why has China achieved the fastest economic growth of the last 40 years by relying on its SOEs? Attempting to address this question, our study first describes the historical development of China's SOEs over the last 40 years, then reviews previous studies on the theories and empirical findings of China's SOEs to provide suggestions for future research.

We review the literature on theories and practices by organizing prior studies into three parts. The first part (Sections 2, 3, 4) describes the status and evolution of Chinese SOEs. We first describe the current status of the Chinese economy, led by the phenomenon of the "Chinese Puzzle," i.e., China's economy has relied heavily on SOEs, an economic organization considered to have lower production efficiency, yet has achieved outstanding economic growth. Second, we explain SOEs' operational inefficiency by detailing the theoretical developments regarding SOEs. For example, economic theories indicate that SOEs are public goods that would be overconsumed and carry heavy policy burdens, that SOEs naturally face agency problems between their controlling shareholder (i.e., the state) and their minority shareholders, and that SOEs' hierarchical structure will lead to greater information asymmetry between the decision maker (the state) and the executors of daily operations (managers), all leading to the economic conclusion of reduced operational efficiency. However, the Chinese government has effectively launched its SOE reform to overcome inefficiency. Thus, we present factual evidence of how SOEs have evolved historically to adapt to the Chinese economic system and its reform. Finally, we discuss the financial burden and financing policies of SOEs.

The second part of the review (Section 4) focuses on corporate governance in SOEs. We discuss the agency problem of SOEs, detailing different layers of this problem; we analyze the effectiveness of the compensation system, the independent director mechanism, the outside blockholder monitoring, and the external M&A market; we then review the literature on SOEs' information transparency to outside investors.

The third part of the review (Section 5) surveys studies examining how Chinese SOEs meet the expectations of their stakeholders through the lens of corporate social responsibility. We discuss how SOEs create jobs to

meet the needs of the government from a social welfare standpoint, their environmental protection efforts, and their philanthropic commitments.

2. The "China Puzzle and the role of SOEs in China's economy

2.1. Performance of China's SOEs and the "China Puzzle"

SOEs are shown to have lower economic performance than non-SOEs (e.g., Lin et al., 1998; Allen et al., 2005), largely because of their lower production efficiency. Borensztein and Ostry (1996) analyze the pre- and post-reform Chinese economy and find an increase in the per-worker total factor productivity (TFP), although it is unlikely to be sustainable. They suggest that government interventions, especially in SOEs, have led to lower productivity and employment growth rates in SOEs compared with non-SOEs.

Table 1 describes the status of Chinese SOEs. In the 20 years between 1997 and 2016, the number of SOEs first decreased and then increased after 2008, but overall decreased. However, the total assets managed by SOEs increased 11.39 times ((154,912–12,497)/12,497) in these two decades. Similarly, we can calculate the trends of other variables. Table 1 shows that SOEs' liabilities increased at the same pace as their assets (about 11 times), sales increased by 5.6 times, and net income increased by 31.34 times. These statistics demonstrate a significant improvement in SOEs' operational efficiency. Fig. 2 presents the ratio changes over time.

The "China Puzzle" refers to the fact that China lacks market-supporting institutions and is characterized by many government interventions, but its growth ranks among the top in the world. In other words, China's economic growth presents contradictory evidence against the law-finance-growth predictions that when the legal system does not support financial markets, economic growth is impeded. There are many factors contributing to the "China Puzzle," including the fact that China's economy relies heavily on the public sector. In the following sections, we discuss theoretical and empirical evidence of the advantages and disadvantages of SOEs.

2.2. Advantages of SOEs

Why are SOEs important for China's economy? If SOEs typically operate with low production efficiency (Lin et al., 1998; Firth et al., 2006), how can they help the Chinese economy rank at the top in terms of economic growth? The literature proposes three reasons why SOEs are advantageous to the extent that the government uses them to solve externalities that cannot be solved by the market.

First, government interventions in the market can benefit the economy by maximizing resource mobility to create capital-intensive industries. These industries are essential for the economy, but investing in them requires long gestation, imported equipment, and large lump-sum investments that cannot be achieved by the market alone (Lin et al., 1998; Lin and Tan, 1999). In other words, government interventions make functional operations possible in these capital-intensive industries and move the economy by providing infrastructure construction.

Second, the government sees SOEs as the second-best way to maintain social stability, without which the economy cannot function properly. Bai et al. (2000) show that SOEs are valuable for tasks other than profitability. For example, when social stability is low, SOEs are useful for hiring excess labor and bear people's retirement benefits, although they have reduced incentives for production (Shleifer and Vishny, 1994). Bai et al. (2009) also show that privatized firms have a reduced number of employees as a result of privatization and that the ratio of debt and financial expenses to sales decreases with non-state ownership. This result suggests that only SOEs are used to achieve social goals.

Finally, the government uses SOEs to maintain control over key elements of society, the "commanding heights" of state control advocated by Vladimir Lenin. Controlling a set of firms and outputs are consistent with the government's interests.

Table 1
SOE performance in China. This table presents the basic performance measures for SOEs and different ratios for the 1997–2016 period. The data come from the Ministry of Finance of China. Lev is measured as the ratio of total liabilities to total assets; ROA is the ratio of net income to total assets; ROE is the ratio of net income to shareholders' equity; ROS is the ratio of net income to sales.

Year	No. of SOEs (Thousand)	Total Assets (Billion)	Total Liabilities (Billion)	Sales (Billion)	Net Income (Billion)	Lev %	ROA %	ROE %	ROS %
1997	262	12,497.5	7881.06	6813.20	79.12	67.10	2.30	1.70	1.20
1998	238	13,478.0	8440.93	6468.51	21.37	65.50	2.10	0.40	0.30
1999	217	14,528.8	9147.49	6913.66	114.58	65.40	2.70	2.10	1.70
2000	191	16,006.8	10,209.24	7508.19	283.38	66.00	3.30	4.90	3.80
2001	174	16,671.0	10,527.33	7635.55	281.12	65.00	3.30	4.60	3.70
2002	159	18,021.9	11,367.58	8532.60	378.63	64.80	3.60	5.70	4.40
2003	146	19,971.0	12,871.89	10,016.09	476.94	65.90	3.50	6.70	3.00
2004	136	21,560.2	13,883.91	12,072.20	736.88	65.70	4.50	9.60	6.10
2005	126	24,256.0	15,517.32	14,072.66	957.99	65.10	5.00	11.00	6.80
2006	117	27,730.8	17,929.37	16,239.03	1219.35	67.40	5.50	12.40	7.50
2007	112	34,706.8	20,247.25	19,483.53	1744.18	68.70	6.40	12.10	9.00
2008	110	41,621.9	25,000.84	22,939.79	1333.52	61.60	4.60	8.00	6.00
2009	111	51,413.7	31,541.69	24,301.54	1560.68	62.80	4.20	7.90	6.60
2010	113	64,021.4	40,604.32	31,499.39	2142.82	63.40	4.60	9.20	7.00
2011	135	75,908.2	48,609.08	38,634.14	2466.98	64.00	4.60	9.00	6.60
2012	147	89,489.0	57,513.54	42,535.65	2427.73	64.30	4.10	7.60	5.90
2013	156	104,094.7	67,097.46	47,112.51	2557.39	64.50	3.80	6.90	5.60
2014	160	118,471.5	76,595.59	48,909.91	2644.40	64.70	3.50	6.30	5.50
2015	167	140,683.2	92,441.72	45,735.20	2497.04	65.70	2.90	5.20	5.60
2016	173	154,914.2	101,521.49	47,439.16	2555.87	65.50	2.70	4.80	5.50

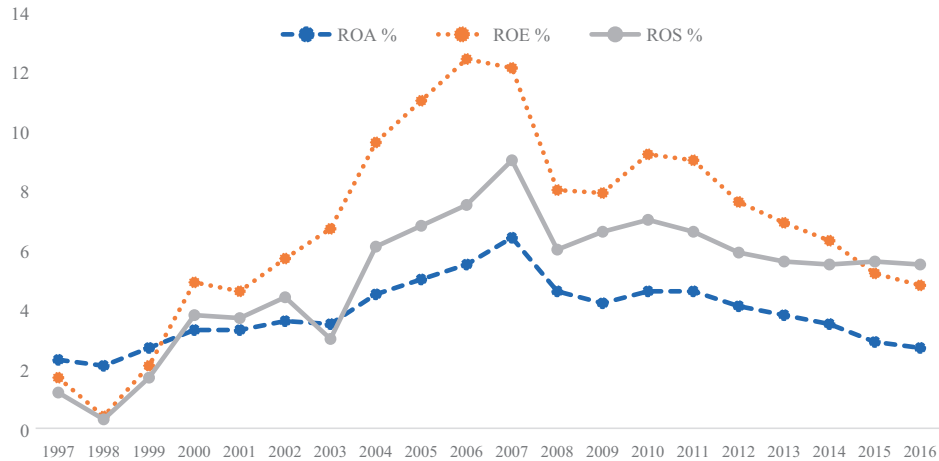

Fig. 2. Performance of SOEs.

2.3. Problems with SOEs that result in lower performance

The cost of SOEs undertaking multiple tasks is that their economic performance is lower than that of non-SOEs. Theories explaining this inferior performance are discussed below.

2.3.1. SOEs as public goods

A prominent issue causing SOEs' underperformance is the inherent defect of SOEs. SOEs are public goods subject to various externalities, impairing their operational efficiency. We will illustrate these externalities in two aspects: excludability and non-diminishability (Jefferson, 1998).

Excludability is a feature of public goods resulting from their undefined property rights, i.e., all parties accessible to public goods can consume them. The famous "tragedy of the commons" is a case in point – a common land is overconsumed by unregulated grazing. When resources are shared and have no defined ownership, anyone who has access to them will act independently according to their own interests (e.g., Tornell and Velasco, 1992). Conceptually, SOEs are "owned by the people", and such ambiguously defined property rights lead to the overconsumption of their assets by various parties, including the state, managers, and workers. The state extracts rents from SOEs with predatory taxes and other burdens, managers consume on-the-job perks, and workers shirk, leading to lower performance.

Non-diminishability indicates that the overconsumption of one person does not seriously affect the ability of others to extract value from public goods. In other words, although the state, managers, and workers consume assets from SOEs, they will not be constrained by other parties' consumption. This reduces the operational efficiency of SOEs. Even worse, the overconsumption of SOEs leads the state to control prices and tighten monetary policies, which reduces the productivity of the non-state sector, thereby undermining economic growth.

2.3.2. Policy burdens and soft budget constraint

The heavy policy burdens and the soft budget constraint also lead to lower performance among SOEs. Because of their special role in the economy, such as the need to maintain social stability, Chinese SOEs bear heavy policy burdens, including (a) high capital intensity (especially in strategically important industries), suggesting high financing costs, and (b) the costs related to retirement pensions, social welfare, and the hiring of redundant workers (Lin et al., 1998; Lin and Tan, 1999; Dong and Putterman, 2003). The soft budget constraint aggravates the problem of policy burdens (Lin et al., 1998; Lin and Tan, 1999). SOE managers often attribute their losses to the policy burdens imposed by the state, and the state cannot distinguish between the lack of effort or competence of SOE managers and the effect of policy burdens on firm performance. In turn, the state will bail out financially distressed SOEs through fiscal subsidies and tax cuts, effectively creating the

soft budget constraint. Therefore, the capital of SOEs is not constrained by a solid budgeting process. The soft budget constraint separates the incentives of SOE managers from firm performance, exacerbating the agency problem.

2.3.3. The agency problem in SOEs

The agency problem refers to the fact that when ownership and control are separated and the incentives of the economic agents operating the company deviate from those of the agents owning the company, firm value maximization is achieved in the first-best solution. In the Anglo-Saxon setting, the agency problem usually stems from the conflict of interest between managers and shareholders, while in the setting of Chinese SOEs, the agency problem refers to two layers of conflict of interest.

The first layer of the agency problem results from the conflict between the controlling shareholder and the minority shareholders. The presence of a controlling shareholder holding a dominant percentage of shares is a characteristic of Asian firms (Claessens et al., 2002). The controlling shareholder has well-entrenched incentives because it pays less than 100% of the company's ownership but controls it through voting rights. Therefore, the first level of the agency problem exists between the controlling shareholder and the minority shareholders (Claessens et al., 2000; Claessens et al., 2002). In the context of SOEs, the controlling shareholder is the government, which pursues multiple objectives other than value maximization, such as maintaining social stability by reducing unemployment and income polarization (Lin et al., 1998; Lin and Tan, 1999; Dong and Putterman, 2003).

The second layer of the agency problem exists between the managers and the controlling shareholder, as the literature shows in the Anglo-Saxon setting. In a market economy, the agency problem is solved through an efficient labor market (Fama, 1980),[1] which does not exist in China. More importantly, personnel decisions in SOEs are made by the state or local governments, resulting in labor contracts without an effective mechanism encouraging managers to pursue profitability (Bai and Xu, 2005; Chang and Wong, 2009). Instead, managers are incentivized to solve social problems, such as unemployment and social instability (Bai et al., 2000). Under this weak incentive structure encouraging CEOs to multitask, CEO compensation and turnover respond weakly to firm performance (Firth et al., 2006; Chang and Wong, 2009). Weak pay-for-performance and turnover-performance sensitivity are also seen as evidence of collusion between CEOs and the government (i.e., the controlling shareholder) (Wang and Xiao, 2011; Zhang et al., 2014).

2.3.4. Information asymmetry and the cost of hierarchy

Finally, SOEs are featured by its hierarchical structure, which hinders efficient information transfer between them and the government, resulting in lower operational efficiency. That is, information comes from the production floor and is used by top executives or the state, while agents in possession of information will use it to negotiate their benefits. Information asymmetry and the agent's tendency to conceal information to obtain private benefits (i.e., the moral hazard problem) generate costs for the state, especially when information has to be transmitted to the state (Groves et al., 1994; Huang et al., 2017). The greater the distance between the SOE and the overseeing government, the costlier the information transmission and the less effective the decision-making process.

3. The history of SOE reform in China

The Chinese government is aware of the advantages and disadvantages of SOEs in economic development. In this section, we discuss the historical development of SOEs in China and how the government has reformed SOEs to solve the disadvantages described in Section 2.

Before 1978, as in all socialist countries, China's economic system was a centralized socialist planning system. Each SOE was a production unit that responded to the production plans of the central government or local governments. Before the opening-up reform in 1978, China's SOEs had the following characteristics:

[1] In an efficient labor market, employers can directly design pay for performance contracts to motivate managers. Indirectly, the labor market valuation of the performance of managers can inform firms about the competence of their managers.

(1) they were state-owned and state-operated, which means that the state held both the ownership and the operating rights of SOEs (to better reflect this feature, these firms were named State-operated Enterprises at the time); (2) their production plans are developed by national planning agencies, and SOEs can only execute these plans; and (3) their strategic decisions, such as personnel, finance, production, and sales, were made by the government. Specifically, the Chinese government appointed SOE managers and developed salary standards for different industries and positions. The state also provided funds that SOEs needed for costs that are close to zero. SOEs planned their production according to predetermined plans issued by the government, without considering about setting product price and the demand of customers. All profits made by SOEs were remitted to the state and losses were covered by the state. Under this planned economic system, managers and workers had little incentive to promote production, thus SOEs had low operational efficiency.

It was apparent to the Chinese government that such inefficient SOE system could not help the government to overcome the economic distress caused by the Cultural Revolution between 1966 and 1976. Thus, China implemented its reform and opening-up in the late 1970s, which became a vital component of the national reform process. Over the last 40 years, the reform of SOEs has gone through stages illustrated as follows.

3.1. Stage 1: Expanding SOEs' operating rights under the planned economic system (1978–1984)

China's reform and opening-up was a tentative attempt to improve SOE performance in the late 1970s. During this period, the government first attempted to address SOEs' lack of enthusiasm for production. The most distinctive feature of this stage was to increase SOEs' decision-making rights in operations. This stage of reform started from October 1978, when the local government of the Sichuan Province chose six SOEs to conduct an experiment to increase their autonomy, letting them keep part of their profits and giving workers bonuses if they achieved their annual production goals. As a result, SOEs were allowed to engage in production beyond the state's mandatory plans and exporting SOEs started to retain some of their foreign exchanges. In 1983, the pilot reform was advanced to allow SOEs to pay taxes instead of remitting all profits to the state (*li gai shui*). Although the income tax rate was 55%, SOEs got to keep the rest of the profits.

At this stage of the reform, the state started to recognize SOEs as independent entities. Due to the growing autocracy, SOE managers became residual claimants, which greatly improved SOEs' enthusiasm for production and partially reduced the agency problem. The reform of the expansion of the autonomy of SOEs culminated in the publication of "Interim Ordinances on State-operated Enterprises" by the State Council in April 1983. The Ordinances defined for the first time an enterprise as a legal person with the right of independent production and operations. However, China's SOE reform at the time only expanded to a limited degree of operating autonomy, leaving the planned economy largely intact.

3.2. Stage 2: The contract responsibility system (CRS): Separation of ownership and operating rights based on public ownership (1984–1992)

In the early 1980s, the state took almost all important decisions, from personnel to production decisions, for SOEs. The integration of ownership and operations was accompanied by inefficient decisions; that is, the state did not have enough information and expertise to make good decisions.

In 1984, the third plenary session of the 12th Central Committee of the Communist Party of China (CPC) started to reform the urban economic system and clearly expressed the need to separate ownership and operating rights in SOEs. The policy was implemented with the Contract Responsibility System (*Cheng Bao Zhi,* hereinafter CRS) as the primary means. The CRS was a system in which managers were assigned the operating rights of SOEs by the government through employment contracts. In turn, they paid a predetermined amount of profits to the government and retained excess profits. At the end of 1988, 93% of the enterprises used the CRS system, and the duration of the government-manager contract was generally three to five years.

The CRS was the most striking feature of China's SOE reform in the 1980s. The system was considered to have improved the operating performance of the SOEs that used it. However, the CRS had obvious shortcomings. First, it created short-termism among managers. Because most contracts lasted three to five years, managers had little motivation to maintain fixed assets, invest in new projects, and upgrade production facilities. Second, it triggered tunneling behaviors. The initial intention of the CRS was to motivate managers by giving

them rights to residual profits, but they obtained more benefits by extracting resources from SOEs, resulting in significant erosion of state-owned assets. Third, the CRS was not a market mechanism in essence, which led to unsalable products produced by SOEs. Eventually, about 40% of the SOEs were losing money in the early 1990s.

3.3. Stage 3: Establishing a modern enterprise system based on the market economy (1992–2002)

China deepened its SOE reform after Deng Xiaoping, the chief architect of China's reform and opening-up, delivered a series of important speeches in 1992, promoting the role of the market in economic development. In the same year, the 14th National Congress of the CPC clearly stated that "*the goal of China's economic reform is to establish a socialist market economy*."

Although the CRS reform was seemingly successful, SOEs still suffered from the agency problem and a lack of market-supporting institutions to facilitate the separation of ownership and operations. This leads to vague property rights of SOEs. Consequently, the state launched a new round of reforms to establish a modern enterprise system, or corporatization. Corporatization entailed restructuring the internal governance system of SOEs while preserving state ownership (Aivazian et al., 2005). Unlike the previous two stages, which focused on the reform of operating rights, the corporatization of SOEs emphasized the reform of ownership rights. From then on, state-operated enterprises were called SOEs (state-owned enterprises).

Three milestones of the stage greatly promoted China's SOE reform. The first milestone was the establishment of the Shanghai and Shenzhen Stock Exchanges. The two exchanges provided platforms for listing and financing SOEs in the capital market. Today, more than 1000 SOEs are listed on both stock markets. The second milestone was the codification of Company Law, which came into effect in 1994 and laid a legal foundation for the establishment of a sound corporate governance structure for Chinese SOEs. Since then, the general meeting of shareholders, the board of directors, and the board of supervisors have become the three main bodies of Chinese companies. The third milestone was the codification of Securities Law (1999), the first economic law drafted by the supreme legislature of the state and not by a government department, which further boosted the development of China's securities market.

Although listed SOEs benefited from the corporatization reform, non-listed SOEs could not keep pace with this economic transition. When SOEs were in the spotlight, their operational inefficiency became visible. By the end of 1997, of the 16,784 large and medium-sized SOEs, 6599 reported negative earnings, with losses of RMB66.6 billion. To deal with this problem, Zhu Rongji, the newly appointed Prime Minister in 1998, stated that the government would spend three years helping most large and medium-sized unprofitable SOEs solve their problems and establishing a modern enterprise system. An important measure to eliminate redundant SOE workers resulted in 21 million workers being laid off throughout China, which largely solved the employee redundancy problem of SOEs. In 2000, the Chinese government stated that the three-year goal of SOE reform had been largely completed. In the same year, the profits generated by SOEs reached RMB230 billion. This achievement was noticeable in the public economy.

The enterprise reform was successful in that SOEs had improved their operational efficiency. However, during the reform where SOEs span off redundant assets, quality assets were captured by the non-state sector due to weak law enforcement. Such entrenchment activities became an increasingly prominent problem, causing social dissatisfaction. To address this issue, the Chinese government launched the fourth stage of its SOE reform, which began in 2002.

3.4. Stage 4: The reform of the state-owned assets management system (2003–2012)

After 2003, China's SOE reform entered a stage focusing on the reform of large and important SOEs. This round of the reform sought to solve the problem of undefined property rights. In other words, who are the owners of the SOEs? The report of the 16th National Congress of the CPC issued on November 2002 pointed out that the government needed to establish a state-owned assets management system, with which the central and local governments could assume the responsibilities of shareholders on behalf of the state, in terms of interests, rights, duties, and obligations. The report also clearly defined the roles of the central and local governments in managing different types of SOEs. For example, the central government should act as the owner

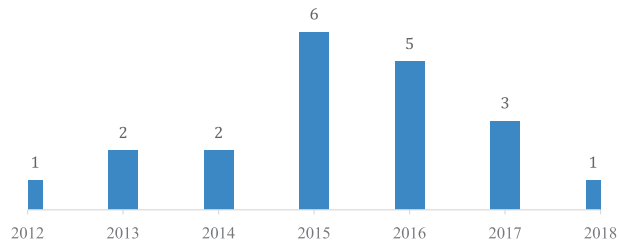

Fig. 3. Mergers of Central SOEs between 2012 and 2018.

for large SOEs in industries perceived to be the lifeline of the nation's economy and homeland security (such as industries in infrastructure constructions or natural resources productions), whereas local governments should act as the owners of smaller and less important SOEs.

Following this decision, in March 2003, China established the State-owned Assets Supervision and Administration Commission (SASAC) to fulfill the role of shareholder for large and important SOEs on behalf of the central government. SASAC is an agency reporting directly to the State Council acting as a shareholder of SOEs on behalf of the state. However, unlike the executive branch of the government, SASAC does not assume any public administrative function. At the time of its establishment, SASAC supervised 189 SOEs, called "central SOEs," which held RMB6.9 trillion (about US$1 trillion) in assets at the end of 2002.

SASAC launched the board reform of central SOEs in 2003 to increase the number of outside directors and improve their monitoring role in corporate operations. Before the board reform, the board of directors of central SOEs overlapped with their top management, which weakened its role in monitoring and advising the management team. The board reform requires all central SOEs' parent companies to hire outside directors to serve on corporate boards. According to the guidelines issued by SASAC,[2] outside directors must participate in strategy, funding, and investment decisions and select and evaluate SOE managers. By the end of 2018, 90% of the central SOEs had completed or were in the process of completing this board reform.

3.5. Stage 5: Extensive SOE reform (2012-present)

In November 2012, the 18th Congress of the CPC was convened. It was followed by an unprecedented anti-corruption campaign and the launch by the government of an increasingly comprehensive and thorough reform of SOEs. The core document guiding the reform, entitled "Guiding Opinions on Deepening the Reform of State-owned Enterprises," was published in 2015, along 22 supplementary files. The idea that SOE reform should be guided by one core policy document (the "one"), supplemented by supporting policies (the "N") is called the "one plus N" ("1 + N") policy system.

First, the "1 + N" policy system promotes the reform of SOEs based on their classification. SOEs are classified as commercial SOEs and public service SOEs. Commercial SOEs are further divided into perfect competitive sectors and strategic sectors (i.e., key industries related to national security and national economic lifelines). In this new classification system, the government can discriminatively allocate resources between different types of SOEs. In other words, the government can reduce its support to commercial SOEs and allow them to compete freely with the private sector while providing more resources to public service SOEs.

Second, the "1 + N" policy system aims at strengthening the leadership of the CPC in SOEs. After the 18th National Congress of the CPC, SOEs were mandated to incorporate the CPC's leadership role into their Articles of Association. For example, in an official document, the CPC mandated the board of directors to hear the opinions of the CPC committee of the company before deciding on important issues.

Third, the "1 + N" policy system seeks to reorganize central SOEs. SASAC facilitated the merger of 20 central SOEs during the 2012–2018 period (Fig. 3). China's goals for these mergers ranged from promoting the competitiveness of SOEs to fulfill the "One Belt, One Road" initiative to reducing surplus capacity and advancing

[2] In July 2004, SASAC published "On Establishing and Improving the Board of Director Trial in Central SOEs," clearly outlining the purpose of the board reform.

"supply-side reform" at home. During this dramatic wave of mergers, the number of central SOEs in China dropped from 189 in 2002 to 96 at the end of 2018.

4. Financing and payout policies of China's SOEs

4.1. Financing policies

Chinese companies can obtain financing from the financial market, the banking sector, and alternative financing channels (Allen et al., 2005). Overall, stock markets (i.e., the Shenzhen and Shanghai Stock Exchanges) are inefficient in resource allocation because stock prices cannot reflect firm-specific fundamentals. The banking sector is controlled by the government, so SOEs can obtain long-term loans with low creditworthiness requirements, resulting in a large number of non-performing loans. Alternative financing channels include the state budget, informal financing intermediaries, internal funds, foreign investments, corporate bonds, and trade credits (see Fig. 4).

4.1.1. State budget

For a while, China relied on a central planning system, in which the State allocated funds to most companies in the country. Since the reform, the state budget has become a small part of the funds obtained by SOEs. In the end of 2017, about 6% of the funds used by SOEs to finance their fixed asset investments came from the state.

4.1.2. Financial market

In 1993, the CPC Congress approved the "Decision of the CCP Central Committee on Issues Concerning the Establishment of a Socialist Market Economic Structure," which emphasized the reform of SOEs to restructure their ownership. As part of this plan, two stock exchanges were created in Shenzhen and Shanghai. Today, 1047 SOEs are listed on the Shanghai and Shenzhen Stock Exchanges, and they represent 52% of the market capitalization of these two stock exchanges.

SOEs list their stocks on the stock market through initial public offerings (IPOs) and increase their future equity through seasoned equity offerings (SEOs). SOEs have two types of stocks: non-tradable stocks held by the central or local governments and tradable stocks held by public investors. The IPO process followed a

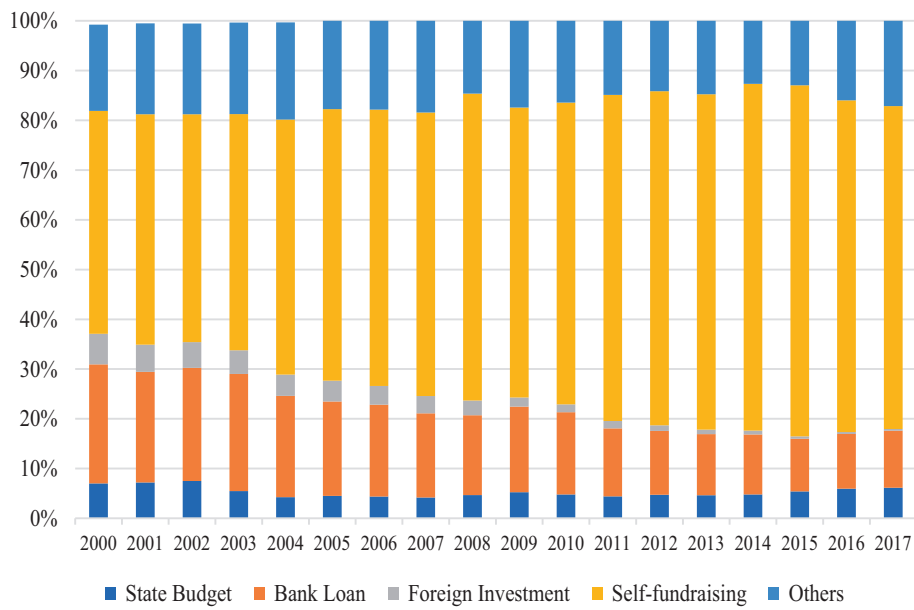

Fig. 4. SOE Financing Channels.

quota system between 1993 and 2000, in which the number of new shares to be issued was decided by the State Planning Committee, the Central Bank, and the CSRC (the China Securities Regulatory Commission). Then, quotas were allocated to each province or bureau with SOEs, which in turn recommended their SOEs for IPOs. The CSRC was responsible for screening SOE applicants for IPOs. The government favored SOEs for approval of rights offering (Green, 2003).

Market regulation policies affect SOEs' decisions to become public. Piotroski and Zhang (2014) show that the imminent political promotion of politicians accelerates the IPO process of SOEs under their jurisdiction because these politicians can be rewarded by the development of the market in the region.

To obtain equity financing, SOEs engage in earnings management activities. Aharony et al. (2000) show that depending on their relationship with the central government and where their stocks are listed, SOEs engage in earnings management ("financial packaging") during IPOs. These authors find that in general, firms with weaker ties to the central government engage in more financial packaging during their IPOs and experience a greater decline in earnings after their IPOs.

In terms of IPO performance, it appears that government involvement in the IPO process leads to IPO underpricing. Jones et al. (1999) show that because the government does not care about IPO returns and uses IPOs for political purposes, SOEs are usually more underpriced than non-SOEs. Chen et al. (2015) confirm that SOEs, especially central-government-owned SOEs, face greater IPO underpricing than non-SOEs.

4.1.3. Corporate bonds

The Chinese bond market has gradually grown. In the mid-1980s, non-governmental bonds were issued, but a third-party debt guarantee was required, and the coupon rate was set by the government. In 2006, a real credit market developed with the first bonds issued without a loan guarantor, indicating the development of a modern corporate bond market in China. At the end of 2017, outstanding bonds reached US$11 trillion (IMF, 2018).

Livingston et al. (2018) find that bonds issued by non-SOEs receive lower credit ratings, on average one-third of a notch lower, compared with those issued by central-government-owned SOEs. In addition, yields on non-SOE bonds are about 57 basis points higher than those issued by central-government-owned SOEs and 41 basis points higher than those issued by local-government-owned SOEs.

4.1.4. Bank loans

Bank loans are an important financing source for SOEs, largely because the big four banks are controlled by the state. The government owned 67% of the four largest commercial banks in China in 2017.[3] State-owned banks prefer to lend to SOEs and discriminate against private firms. Cull and Xu (2000) show that bank loans are more efficient than government transfers in terms of allocating resources to increase productivity. Brandt and Li (2003) argue that SOEs have preferential access to bank loans for several reasons. First, although non-SOEs are more profitable and grow faster, banks may sacrifice profitability and lend to SOEs because of their ideological preferences and the perks generated by loans. Second, state-owned banks may have better information about SOEs and are therefore more willing to lend to them. Third, SOEs are deemed less risky because they will be bailed out by the government in the event of exogenous economic shocks. Using survey data obtained from two Chinese banks, these authors separate these explanations and conclude that SOEs have easier access to long-term bank loans, mainly because bank managers enjoy private benefits from lending to SOEs, namely, building connections with local government officials and obtaining benefits from these political ties. Liu et al. (2018) also find that the Chinese government does not allocate resources equally between SOEs and non-SOEs in the economic stimulus package during a financial crisis. Instead, SOEs have easier access to bank loans.

4.2. Payout policies of China's SOEs

Investigating the dividend policy of SOEs and comparing it with that of non-SOEs, the literature illustrates that ownership is important in terms of dividend payout strategies. Bradford et al. (2013) show that SOEs pay

[3] LLS (2002) find that the government owns 99.45% of the 10 largest banks (Allen, 2005).

Table 2
SOE payout policies. This table presents the dividend policies of SOEs and non-SOEs, including cash dividends, stock dividends, and *Zhuanzeng*.

	Mean		
	SOEs	Non-SOEs	T-test
Cash Dividend to Earnings	0.3031	0.3218	−1.21
Stock Dividend Per Share	0.0132	0.0130	0.19
Zhuanzeng Per Share	0.0586	0.2038	−35.84***
Dividend Yield	0.0091	0.0063	18.24***

*, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

more cash dividends than non-SOEs and that the dividend payment increases with the length of the chains of control. In other words, the higher the number of layers between the SOE and the controlling shareholder, the more dividends the firm will pay.

There are several theories about the determinants of dividend payout. The first explanation is tunneling. Chen et al. (2009) propose that cash dividends are a way for the controlling shareholder to expropriate minority shareholders. These authors argue that firms obtain funds from IPOs and divert the proceeds to the controlling shareholder through cash dividends. Thus, the root of this problem is the differential pricing of tradable and non-tradable shares. The second explanation is the clientele and monitoring effect of investors. Firth et al. (2016) show that institutional investor ownership increases firms' dividend payout and that this effect holds in SOEs. The idea is that mutual funds prefer to pay dividends to reduce firms' free cash flow, which in turn curbs managers' empire-building incentives and mitigates the agency problem. The third explanation is information asymmetry. Lin et al. (2017) show that SOEs pay less dividends when information asymmetry is high, indicating that dividends are not used to signal or communicate with the market.

Statistics of payout policies for China's SOEs and non-SOEs are presented in Table 2. Both SOEs and non-SOEs pay about 30% of their earnings to their shareholders, presented in consolidated income statements, with no significant difference in statistics. Similarly, both SOEs and non-SOEs pay 0.013 stock dividends per share to shareholders.

Zhuanzeng (the conversion of additional paid-in capital into common shares) is also considered a form of payout in China. The difference between *Zhuanzeng* and stock dividends is that surplus reserve is converted into common shares through stock dividends, whereas additional paid-in capital is converted through *Zhuanzeng*. These two types of conversion do not affect equity value and simply dilute common shares and decrease stock prices. Table 2 shows that compared with non-SOEs, Chinese SOEs tend to make less conversion through *Zhuanzeng*.

The dividend yield (the ratio of a company's annual dividend to last year's share price) reflects the cash dividend return of a stock investment. Table 2 demonstrates that investors can only obtain a dividend yield of 0.91% each year from Chinese SOEs, but the ratio is still higher than that of non-SOEs.

5. Corporate governance in China's SOEs

5.1. The agency problem in China's SOEs

One prominent characteristic of China's SOEs is concentrated ownership, with the central or local governments acting as the controlling shareholder. Table 3 shows the ownership structure of China's SOEs and non-SOEs between 2003 and 2017. On average, China's central government or local governments hold 40.31% of equity directly as the largest shareholder and have secured controlling rights (about 41.86% of voting rights) as the ultimate owner through direct and indirect controlling links. The Chinese government uses a pyramidal structure to control not just a single firm, but a large number of corporations.

Table 3
Concentrated ownership structure of Chinese listed firms. This table presents the percentage of shares of the largest shareholder, the cash flow rights of the ultimate owner, and the control rights of the ultimate owner for China's SOEs and non-SOEs between 2003 and 2017.

	SOEs			Non-SOEs		
Year	Largest shareholder	Cash flow rights	Control rights	Largest shareholder	Cash flow rights	Control rights
2003	46.612	44.442	46.495	32.926	23.785	31.979
2004	45.837	42.296	45.842	33.956	20.447	31.824
2005	44.366	40.305	44.312	32.479	19.803	31.014
2006	39.441	36.127	40.121	31.794	20.230	30.765
2007	39.082	35.630	39.799	32.889	22.570	32.075
2008	38.918	35.502	39.887	33.847	23.664	32.482
2009	39.553	36.623	40.744	35.266	26.748	34.965
2010	39.507	36.551	40.688	36.842	31.228	37.953
2011	39.558	37.032	41.158	36.984	32.487	38.728
2012	39.744	37.581	41.715	37.159	33.108	39.327
2013	39.828	37.816	41.979	37.259	33.328	39.500
2014	39.592	37.959	41.991	38.456	25.620	32.293
2015	38.789	37.280	41.508	37.414	25.124	31.477
2016	38.259	37.181	41.434	37.937	25.588	31.441
2017	38.261	37.273	41.668	36.332	32.606	37.679
Total	40.306	37.829	41.856	36.483	28.225	35.037

Due to their concentrated ownership structure, China's SOEs have severe agency problems,[4] in which corporate insiders are the controlling shareholder and managers. On the one hand, concentrated ownership creates a conflict of interest between the controlling shareholder and the minority shareholders (Morck et al., 2005; Young et al., 2008). In China, SOEs are likely to incur significant agency costs when state shareholders (i.e., the government or politicians) tend to maximize social or political benefits instead of maximizing corporate profits (e.g., Fan et al., 2007). For example, China's central and local governments often request firms to absorb excess labor, sponsor public projects, and help jump-start local economies (Fan et al., 2017; Lin et al., 1998; Young, 2000). Prior literature provides strong evidence that this type of government intervention is the main obstacle to operational efficiency and investment in China's listed SOEs (Jiang et al., 2010). SOEs are also likely to incur significant agency costs due to managerial entrenchment when state shareholders have less incentive and ineffective mechanisms to motivate and monitor managers (Morck et al., 2005; Xu et al., 2006; Yang, 1997; Young et al., 2008). Previous studies show that SOE managers tend to overinvest for empire-building and consume excess benefits (Chen et al., 2005; Wang et al., 2014). Thus, China's SOEs suffer from this double agency problem. In this context, corporate governance seeks to mitigate the insider agency problem because of the divergence of interests between the controlling shareholder, minority shareholders, and top managers.

5.2. Is CEO compensation effective?

CEO incentive-based compensation is an important corporate governance mechanism aligning the interests of managers with those of shareholders in the diffused ownership structure. However, CEO compensation is not an effective mechanism for China's SOEs to mitigate the insider agency problem for several reasons. First, in concentrated ownership, the controlling shareholder is in charge of appointing/terminating the CEO and designing the CEO compensation scheme. In China, as the ultimate controlling owner, the government still has a significant and direct effect on the management of SOEs, especially the appointment and termination of top executives (Chen et al., 2013; Ke et al., 2012). Fan et al. (2007) show that the government strengthens its intervention in SOEs by appointing politically connected CEOs and other bureaucrats to the board of

[4] Under the concentrated ownership structure, corporate insiders tend to appropriate private benefits and thereby expropriate investors because they maximize their welfare as the owner rather than that of outside investors. Stulz (2005) describes this agency problem as "the agency problem of corporate insider discretion."

Table 4
Managerial compensation of Chinese listed firms. This table presents top management compensation for China's SOEs and non-SOEs between 2003 and 2017. Managers' compensation is calculated as the compensation of the top three managers divided by 3. Directors' compensation is calculated as the compensation of the top three directors divided by 3. Stock option dummy is an indicator variable equal to 1 if the firm grants stock options to its top managers during the year.

	Managers' compensation		Directors' compensation		Stock option dummy	Stock option percentage
Year	Mean	Median	Mean	Median		
Panel A: SOE sample						
2003	160,639	118,702	151,746	110,833	–	–
2004	196,940	146,214	171,212	124,896	–	–
2005	212,748	163,866	174,155	119,333	–	–
2006	265,083	200,000	214,577	141,000	0.02	3.89
2007	369,779	257,035	304,230	191,566	0.01	3.04
2008	405,227	288,000	325,305	221,966	0.04	2.84
2009	431,909	320,000	350,609	247,666	0.02	2.77
2010	519,991	383,933	418,771	292,328	0.02	2.69
2011	610,340	443,166	487,363	334,833	0.02	2.64
2012	621,358	476,083	523,277	379,484	0.03	1.92
2013	656,040	500,573	538,918	401,866	0.03	2.28
2014	701,194	514,333	566,614	409,966	0.05	2.26
2015	733,450	553,250	569,302	420,000	0.05	1.83
2016	777,300	574,150	599,206	445,633	0.04	2.48
2017	893,127	637,233	704,067	492,400	0.06	2.99
Total	522,802	366,100	421,018	281,400	0.03	2.54
Panel B: Non-SOE sample						
2003	168,374	118,700	163,079	110,356	–	–
2004	200,459	140,000	194,910	133,000	–	–
2005	213,727	148,366	208,751	133,200	–	–
2006	246,467	160,000	235,042	152,633	0.05	8.28
2007	390,511	196,666	376,177	190,100	0.03	4.72
2008	376,651	234,433	356,621	230,000	0.09	6.39
2009	416,941	262,433	388,546	248,366	0.05	4.47
2010	461,285	321,933	444,347	296,466	0.09	5.31
2011	497,496	368,500	477,864	345,266	0.15	5.19
2012	540,688	393,600	518,856	376,724	0.17	5.53
2013	596,301	417,433	569,448	396,300	0.22	5.20
2014	632,349	452,650	600,900	430,850	0.26	4.22
2015	709,644	491,266	674,199	474,800	0.29	4.36
2016	764,498	544,950	713,943	513,416	0.28	4.27
2017	820,553	594,016	778,953	560,000	0.31	4.73
Total	506,979	340,675	482,357	320,000	0.19	4.73

directors rather than electing directors with relevant professional backgrounds. Second, SOE managers are not only incentivized to increase economic performance but are more likely to fulfill the state's political and social goals in decision-making (Park et al., 2006). More importantly, SOE managers are government officials who will return to a government position when their term as a firm manager ends. Thus, their main incentive to do a good job as a firm manager is to get promoted to a high level government position (Jiang and Kim, 2015). Third, CEO compensation in SOEs has been highly regulated since the government began to seek to maintain social balance between managers and workers in a firm. For instance, "Regulation on Top Managers' Pay in SOEs" published in September 2009 serves to limit the cash compensation of top managers in SOEs. "Trial Measures for Implementing the Equity Incentive System by State-controlled Listed Companies

Table 5
Board directors and independent directors of Chinese listed firms. This table presents the characteristics of the board of directors of China's SOEs and non-SOEs between 2003 and 2017.

	SOE sample				Non-SOE sample			
	Directors		% Independent Directors		Directors		% Independent Directors	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
2003	9.98	9	32	33	9.73	9	33	33
2004	9.93	9	34	33	9.30	9	35	33
2005	9.83	9	34	33	9.11	9	35	33
2006	9.75	9	35	33	8.97	9	36	33
2007	9.74	9	36	33	8.95	9	36	33
2008	9.62	9	36	33	8.82	9	37	33
2009	9.54	9	36	33	8.74	9	37	33
2010	9.55	9	37	33	8.70	9	37	33
2011	9.52	9	37	33	8.63	9	37	33
2012	9.54	9	37	33	8.62	9	37	33
2013	9.49	9	37	33	8.48	9	38	33
2014	9.32	9	37	33	8.35	9	38	33
2015	9.19	9	37	36	8.27	9	38	36
2016	9.20	9	37	33	8.28	9	38	36
2017	9.16	9	37	36	8.24	9	38	36
Total	9.54	9	36	33	8.76	9	32	33

(Domestic)," published in 2006, regulates the incentive-based compensation of top managers in SOEs.[5] As a consequence, there is little managerial pay for performance sensitivity in China's SOEs (Kato and Long, 2006), even in SOEs cross-listed on the Hong Kong market (Ke et al., 2012). Chen et al. (2013) provide further evidence of weak compensation incentives for the management of China's SOEs. Their findings suggest that state-controlled Red Chip firms' stock option compensation plans were merely window dressing to satisfy foreign investors and were never fully implemented due to the unique managerial labor market of China's SOEs. Therefore, the managerial compensation scheme of SOEs cannot serve as a monitoring mechanism to moderate the insider agency problem. Information on the managerial compensation scheme of China's SOEs and non-SOEs between 2003 and 2017 is presented in Table 4.

5.3. Are independent directors effective?

The board of directors and its independence are often considered the most important internal corporate governance mechanism. In China, "The Code of Corporate Governance for Listed Companies in China" was published jointly on January 7, 2002 by the CSRC and the State Economic and Trade Commission. The Code of Corporate Governance requires Chinese listed firms to have a two-tier board structure (i.e., a board of directors and a board of supervisors). "The Guidelines for Introducing Independent Directors to the Board of Directors of Listed Companies" published in 2001 by the CSRC mandated the board of directors of all listed firms to be composed of at least one third of independent directors by June 30, 2003. Regulators in China have made it the primary and legally explicit responsibility of independent directors to monitor insiders (e.g., large controlling shareholders and managers) on behalf of minority shareholders. In Table 5, we provide information on the number of board directors and independent directors in SOEs and non-SOEs between 2003 and 2017.

[5] Since 2006, a series of regulations on the incentive-based compensation of top managers for SOEs has been implemented. For example, "Trial Measures for Implementing the Equity Incentive System by State-controlled Listed Companies (Domestic)" was jointly published by SASAC and the Ministry of Finance in September 2006; "Notice on the Issues related to the Launch of a Special Campaign to Strengthen Corporate Governance in Listed Companies" was published by the CSRC in March 2007; "Memorandum No. 1 & No. 2 on Issues related to Equity Incentives" was published in March 2008 and "Memorandum No. 3" in September 2008 by the Department of Listed Company Supervision of the CSRC; and "Notice on Issues related to the Regulation of the Implementation of the Equity Incentive System by the State-controlled Listed Companies" was jointly published by SASAC and the Ministry of Finance in October 2008.

Table 6
Blockholders' Ownership (%) of Chinese Listed Firms.

	SOEs sample			Non-SOEs sample		
	TOP1	TOP2-10	TOP2/TOP1	TOP1	TOP2-10	TOP2/TOP1
2003	46.750	15.495	53.673	32.819	25.460	9.929
2004	46.003	16.839	52.428	33.448	26.468	10.925
2005	44.427	17.418	40.688	32.158	25.713	11.477
2006	39.424	17.433	23.895	30.848	25.112	9.490
2007	38.993	17.276	21.822	31.753	24.057	9.616
2008	38.997	16.800	21.833	32.766	23.183	10.236
2009	39.568	16.844	20.541	32.888	23.220	10.306
2010	39.577	17.117	20.930	33.980	26.027	8.651
2011	39.596	17.123	20.783	34.165	26.905	8.012
2012	39.905	17.028	21.351	34.366	26.099	8.526
2013	40.007	17.184	21.867	34.250	24.851	8.315
2014	39.735	17.292	20.440	33.360	24.579	7.932
2015	38.981	18.765	15.034	32.396	26.118	6.877
2016	38.492	20.130	13.287	31.945	27.507	5.926
2017	38.550	20.820	13.273	32.220	28.969	5.513
Total	40.419	17.664	24.539	32.982	26.130	7.862

Do independent directors play a monitoring role in the insider agency problem in SOEs? Many will find this question difficult to answer. First, independent directors have less ability and incentives to restrict the controlling shareholder, as the power of governance is in the hands of the largest controlling shareholder in SOEs. Independent directors are not truly independent. For example, Zhu et al. (2015) find that independent directors are less likely to vote against the proposal of the board, especially in SOEs. Second, empirical evidence of the relationship between independent directors and firm performance is mixed.[6] A recent study by Liu et al. (2015) provides the first comprehensive and robust evidence of the relationship between board independence and firm performance in China after explicitly accounting for potential endogeneity problems. This study finds that board independence reduces tunneling through intercompany loans and improves investment efficiency, leading to better performance in SOEs. Therefore, independent directors may play a role in limiting managerial misbehavior in SOEs but have a less effective role in limiting the looting of controlling shareholders.

5.4. Are outside blockholders effective?

Non-controlling large shareholders play an important role in corporate governance in emerging markets, in which controlling shareholders' expropriation is a major concern (Sun et al., 2016). Non-controlling large shareholders have incentives to monitor insiders because of their high ownership stakes in SOEs. According to China's Code of Corporate Governance, listed firms must actively implement the cumulative voting system for the election of directors, especially when the controlling shareholder owns more than 30% of the shares. In this context, non-controlling large shareholders are likely to play an effective monitoring role through board representation in China (Zhu et al., 2015).

Several studies document the effectiveness of the monitoring role of non-controlling large shareholders. For example, Zhu et al. (2015) show that directors representing non-controlling shareholders are more likely to vote against the proposal of the board in low performing firms and in SOEs. Using data on the split share structure reform in China, Hope et al. (2017) find that both state outside blockholders and non-state outside blockholders have governance effects on SOEs by improving their performance. They also find that this performance improvement is stronger when firms have multiple outside blockholders. Table 6 presents basic information on outside blockholders for Chinese SOEs between 2003 and 2017. As shown in Table 6, the average shareholding of the 2 to 10 largest shareholders is about 18% for listed SOEs and about 26% for listed

[6] One possible reason is that most controlling shareholders simply hire the minimum number of independent directors (Jiang and Kim, 2015).

non-SOEs, which indicates that there are significant blockholders. The Herfindahl index of the top 10 largest shareholders (HHI_10) for SOEs is higher than for non-SOEs due to greater ownership of major shareholders. Since the split share structure reform in 2006, the ownership of blockholders in Chinese listed firms has remained stable.

5.5. Takeover market and China's split share structure reform

An effective takeover market is an important external corporate governance mechanism that can discipline managers and mitigate the agency problem (Lel and Miller, 2015; Cain et al., 2017). Indeed, the threat of a takeover gives additional incentives for the board to discipline managers and for the shareholders to discipline themselves to avoid losing control rights. However, there is no active market for corporate control in China. First, the concentrated ownership structure with up to 40% of the shares held by the largest shareholder in SOEs is a barrier to an active takeover market. Second, before 2005, the volume of non-tradable shares was also an obstacle to a market for corporate control because the presence of non-tradeable shares only allowed negotiated (friendly) takeovers. As argued by Hartzell et al. (2004), a negotiated takeover is difficult to interpret as a corporate governance mechanism, as insiders receive fortunes through these mergers. Third, government regulations constrain the takeover market. For example, the only payment method allowed for mergers prior to 2006 was cash.

In 2006, the split share structure reform was accompanied by the adoption of two regulations, "Measures for the Administration of the Share-trading Reform of Listed Companies" and "Measures for the Administration of the Takeover of Listed Companies" published by the CSRC in 2005 and 2008, respectively, which activated the creation of the market for corporate control. The reform effectively removed the legal and technical barriers to the transfer of state-owned shares to public investors. An increasing number of studies document the effects of China's split share reform on firm performance and other economic consequences. Liao et al. (2014) show that the split share reform has boosted SOEs' outputs, profits, and employment, but has not changed their operational efficiency and corporate governance. In addition, the split share structure reform has enhanced the governance role of outsider blockholders by directing their current threats to insiders, thereby improving firm performance (Hope et al., 2017).

5.6. Information transparency

Information transparency enables outside investors to protect themselves from insider expropriation. However, most studies (Fang et al., 2017; Chen et al., 2011) do not find that the quality of auditors improves the quality of information in China's SOEs. For example, Wang et al. (2008) show that Chinese SOEs tend to hire small auditors in the same regions compared with non-SOEs. Similarly, Chen et al. (2011) show that non-SOEs audited by Top 8 auditors have a lower level of earnings management, but not SOEs in China. In addition, controlling shareholders (the government and affiliated SOEs) have incentives to keep the information environment opaque. For example, Piotroski et al. (2015) find that SOEs have political incentives to suppress negative information in response to incentives created by political events that temporarily increase the cost of releasing bad news.

6. Chinese SOEs' participation in corporate social responsibility

Traditionally, SOEs are perceived as initiating and engaging in corporate social responsibility (CSR) activities (e.g., See, 2009) for two reasons. First, SOEs are special entities. They are not necessarily designed to maximize profits, but to fulfil social responsibilities, such as maintaining social stability, reducing unemployment, or promoting the government's prosocial goals (Luo and Zhang, 2009; Qian et al., 2015). In other words, SOEs can be considered "social organizations" with social roles and obligations. Although during economic transitions SOEs evolve from "social organizations" to "economic organizations," they cannot completely abandon their social obligations (Enderle, 2001). Second, the responsiveness of SOEs to government mandates is the primary driver of managerial decision-making (McWilliams and Siegel, 2001). Therefore, it

will supplement the government in assuming social responsibilities at all levels and responding to its social and political policies.

Carroll (1979) identifies four motivations for CSR activities: economic, legal, ethical, and discretionary (or philanthropic). While economic responsibility (for example, employment creation and fair remuneration for workers) is the foundation of the Chinese economy, the treatment of society/the environment with delicacy and friendliness are two other aspects of CSR that are favored and important for SOEs (Wang and Qian, 2011). In this section, we discuss CSR issues in China's SOEs in terms of employment creation, environmental protection, and corporate giving.

6.1. Employment creation as an example of social stability

Employment creation is the foundation of social responsibility (Carroll, 1979). Given the role of China's SOEs in maintaining social stability, sustaining employment or providing welfare to workers may well be the government's concern (Bai et al., 2006).

China's SOEs were wholly owned by the state until the early 1990s. During the Mao period (i.e., before 1977), the heavy-industry-oriented development strategy did not create enough job opportunities for urban residents. Due to the government's concern for social stability, political interference tended to dominate labor decisions (hiring, firing, and promotion). The absence of a well-functioning and independent social security system in the country required an employment creation strategy that met the cradle-to-grave needs of a large urban population. Although employee salaries only covered their daily consumption, SOEs provided them with lifelong employment and many other benefits and services for free, such as retirement pensions, housing, healthcare, and education expenses for their children. All of these expenses were covered by the state's fiscal appropriation.

When China's reform started in 1978, SOEs dominated China's industrial sectors in all areas. Labor mobility was non-existent. Following China's transition to a market economy, improved labor market mobility led to the rural-to-urban migration of more than 150 million workers. As entry restrictions imposed on non-SOEs were also gradually relaxed, China's SOEs started facing more competitive challenges due to the coexistence of different ownership types. While less regulated and less protected non-SOEs attracted young workers, China's SOEs were forced to create job opportunities by producing surplus products that society did not want. Lin et al. (1998) show that SOEs were not only prohibited from dismissing excess workers but were also forced to employ more workers.[7] As a result, 20% to 30% of the total labor supply in China's SOEs was redundant (Bai et al., 2006). While private firms could hire temporary workers, SOEs did not enjoy the same flexibility, as they relied mainly on permanent workers assigned as part of the central planning system of the government. This led to alternating cycles of labor shortages and surpluses in firms (Nee, 1992). In addition, China's SOEs suffered from aging facilities, aging workers, and the heavy burden of social services (Lee, 2001). Most aging workers in SOEs were uneducated, indicating an inferior workforce.

This heavy burden on China's SOEs with redundant and aging workers and many retired employees led to competition for the distribution of SOEs' retained earnings between the state and the labor force (Boisot and Child, 1988), which limited the operations of SOEs and resulted in low economic efficiency. In 1996, after 18 years of gradual transition, the share of SOEs in China's total industrial output dropped from 77.6% in 1978 to 28.8%. However, SOEs still employed 57.4% of urban workers and held 52.2% of total investment in industrial fixed assets (Lin et al., 1998). In a country where the main goal of SOEs is to maintain social stability, it is not surprising that SOEs lost to non-SOEs on all possible performance measures because of their heavy burden.

Since 1992, the layoff of many redundant workers has invariably started to promote SOEs' efficiency. Across the public sector, new employees are no longer hired for life. With the adoption of the modern enterprise system in the early 1990s, the internal work environment of SOEs has become increasingly dynamic and

[7] In mature markets, firms are free to make employment decisions and let the separate social security system take care of redundant workers. Therefore, labor surplus is normally non-existent.

Table 7
Employment and wages in China's public sector between 2000 and 2017.

Year	Total employment (million)	Total urban employment (million)	Total employment in urban units (million)	Total employment in urban state units (million)	Average annual employee salary in urban units (RMB)	Average annual employee salary in state units (RMB)
2017	776.40	424.62	176.438	60.64	74,318	81,114
2016	776.03	414.28	178.881	61.70	67,569	72,538
2015	774.51	404.10	180.625	62.08	62,029	65,296
2014	772.53	393.10	182.778	63.12	56,360	57,296
2013	769.77	382.40	181.084	63.65	51,483	52,657
2012	767.04	371.02	152.364	68.39	46,769	48,357
2011	764.20	359.14	144.133	67.04	41,799	43,483
2010	761.05	346.87	130.515	65.16	36,539	38,359
2009	758.28	333.22	125.73	64.20	32,244	34,130
2008	755.64	321.03	121.925	64.47	28,898	30,287
2007	75.321	309.53	120.244	64.24	24,721	26,100
2006	749.78	296.30	117.132	64.30	20,856	21,706
2005	746.47	283.89	114.04	64.88	18,200	18,978
2004	742.64	272.93	110.989	67.10	15,920	16,445
2003	737.36	262.30	109.697	68.76	13,969	14,358
2002	732.80	251.59	109.852	71.63	12,373	12,701
2001	727.97	241.23	111.658	76.40	10,834	11,045
2000	720.85	231.51	116.125	81.02	9333	9441

challenging, with extensive training and retraining programs organized to help employees adapt to the challenges of new work demands.

Despite efforts to reduce redundancy, statistics show that in 2017, the employment rate of SOEs[8] accounted for about 34.37% of total employment in urban units, even with China's total industrial output in the public sector reduced to 19.75%.[9] According to statistical data, the average annual salary of SOEs and non-SOEs has increased substantially since 2000, but the dynamics of salary growth of SOEs are more vigorous. The average annual salary of employees of SOEs is 8.38% higher than that of non-SOEs.[10] Of the 980,300 above-scale corporate entities in 16 industries surveyed by the State Statistics Bureau in 2017, the average annual salary of employees was RMB61,578. In contrast, the average annual salary of employees of SOEs was RMB78,549, the highest of all above-scale enterprises surveyed.[11] Table 7 provides detailed information on the evolution of China's employment and wages since 2000.[12]

6.2. SOEs' actions to protect the environment

While the market expects firms to fulfill its economic mission within the framework of legal requirements, firms are expected to do what is right, just, and fair to fulfill their ethical responsibility (Carroll, 2004). In addition to the important role played by Chinese SOEs in employment, as discussed above, the country has witnessed substantial growth in CSR-related activities (Zhang et al., 2010), as the Chinese government has strongly promoted the concept of CSR and encouraged corporations to actively engage in socially responsible activities, including environmental protection and corporate philanthropic giving.

Previous studies analyze how the spread of CSR norms and practices in China has driven and been fueled by regulators' attention to CSR (See, 2009; Moon and Shen, 2010; Wang and Qian, 2011). In a broader context, the Chinese government and the CPC have issued numerous pronouncements about the importance of all citizens and organizations increasing their social responsibility (e.g., the sixth plenary session of the 16th Party Central Committee, 2006) and about the national commitment to enhancing China's capacity for sustainable development (e.g., President Hu Jintao's report to the 17th National Congress of the CPC, 2007; President Xi Jinping's reports to the 18th and 19th National Congress of the CPC, 2012 and 2017). A number of CSR guidelines and initiatives have been published as a strategy for large companies to balance the social and environmental effects of rapid economic growth.[13] These administrative, regulatory, and legal documents emphasize the determination of government policies to promote the adoption of CSR by SOEs.

In China, disclosing environmental protection information is a mandatory requirement of regulators rather than a voluntary action of firms. Although mandatory CSR disclosure modifies firm behavior and generates positive externalities, with evidence proving that firms reporting mandatory CSR experience a decline in profitability, Chen et al. (2018) find that firms spending more on environmental protection are those of the most polluting industries, not SOEs in particular. Given that political connections motivate political rent-seeking in SOEs, corporations obtaining a "green image" and becoming a "green company" by providing environmental reports become the capital of executives' promotion. Firms run by former government officials are more likely to spend on CSR to seek private political benefits (Hung et al., 2012). For instance, Cheng et al. (2017) find that political connections can significantly increase the level of corporate environmental information disclosure (CEID), especially in highly polluting industries.

[8] Due to data availability, we use statistics for employment and employee salaries of state units to replace those of SOEs. However, state units may include not-for-profit organizations. We also assume that all state units are located in urban areas.

[9] Source: http://www.stats.gov.cn.

[10] In addition, SOEs still enjoy the benefits of resource allocation. SOEs' total investment in industrial fixed assets accounted for 38.5% if all domestic companies in the same year, while the number of SOEs only accounted for 5.02% of all above-scale industrial enterprises (Source: http://www.stats.gov.cn).

[11] Details are provided at http://www.stats.gov.cn/tjsj/zxfb/201805/t20180516_1599565.html.

[12] Source: http://www.stats.gov.cn.

[13] "Guidelines on Social Responsibility of Companies Listed on the Shenzhen Stock Exchange" issued by the Shenzhen Stock Exchange in 2006 and "Guidelines for Listed Companies to Reveal Environmental Information" issued by the Shanghai Stock Exchange in 2008 require listed companies to disclose CSR information using the stand-alone CSR report or their annual reports.

6.3. Corporate philanthropic activities of SOEs[14]

Corporate giving is considered as a strategic decision of firms. Engaging in corporate philanthropic activities can be opportunistic and potentially linked with a manager's pursuit of self-interest (McWilliams et al., 2006). From the government's perspective, SOEs' philanthropic contributions can promote the socially responsible public image of the government and reduce its financial burden. When the government fails to fund adequate public services, it encourages firms using financial resources to make philanthropic donations. Therefore, SOEs' contribution decisions are at least partially driven by the desire to fulfill their corporate and social obligations to the Chinese government (Luo and Zhang, 2009), especially because SOEs have strong political attachments and connections.

Corporate philanthropic giving in China has grown rapidly.[15] According to statistics, philanthropic donations from China's listed companies in 2017 totaled about RMB7.2 billion (about US$1billion), up 14.71% from the previous year, of which RMB3,776 billion came from SOEs. The total contributions of SOEs in 2017 represented 2.49% of their total assets (RMB151,711 billion in 2017).

Deciding whether to give, how much to give, and what to give is a discretionary judgment and choice of firms (Carroll, 1979). Many factors driving China's growth in philanthropic giving have been studied. As CSR information disclosure is mandated in China, the controlling shareholders of SOEs are reluctant to donate their assets or resources to charitable organizations (Tan and Tang, 2016). Given that Chinese firms engaging in corporate giving activities do not receive equal benefits from these activities (Wang and Qian, 2011), corporate giving from SOEs may not reflect their general concerns about different stakeholders or their responses to them (Qian et al., 2015). Previous research shows that SOEs in China can effectively balance multiple stakeholders in terms of legitimacy building with the government while still seeking to maximize shareholder profits (Bruton et al., 2015).

See (2009) argues that SOEs only engage in CSR based on the benefits they can extract. Similarly, Du et al. (2014) state that "SOEs have passive, involuntary attitudes toward philanthropic giving." (pp.238) Evidence from other studies shows that SOEs engaging in corporate giving are less associated with corporate financial transparency, corporate misconduct, or tunneling than their non-SOE counterparts (Du et al., 2014; Qian et al., 2015). In addition, using data from the CSRC web pages, Li and Zhang (2010) show that SOEs donate less than private firms.

7. Conclusions and future studies

China's SOE reform has been central to China's economic reform over the last 40 years. Therefore, many studies examine and explain SOEs' performance, financial behavior, corporate governance, and social responsibility. The literature on the theories of SOEs is well developed, and the reform of Chinese SOEs is based on these theories and an empirical approach in practice. However, current research reaches no consensus on what the best practices are for Chinese SOEs. For example, given their externalities, why do SOEs perform well and support China's rapid economic development? How can the SOE system be linked with the Chinese political system to become efficient? Future research should build on current evidence of the inefficiency of state ownership and focus on constructive suggestions on how to improve SOE efficiency based on the political ecosystem of China.

A remarkable feature of SOEs is their corporate governance, which is a nexus of formal and informal institutions, contracts, and corporate policies to address conflicting objectives between insiders and outsiders. Concentrated ownership increases the complexity of agency problems in Chinese SOEs. Unlike those in the western companies, insiders in Chinese SOEs are the controlling shareholders and managers. Evidence is

[14] As early as 1999, the "Public Welfare Donation Law" was published during the tenth plenary session of the 9th Standing Committee of the National People's Congress to encourage and normalize philanthropic giving and receiving of Chinese companies. In 2009, SASAC published "Notice on Reinforcing Corporate Giving in Central SOEs," setting specific rules for the scope, scale, approval, and procedure of corporate giving for central SOEs.

[15] China's total philanthropic giving was RMB139,294 billion in 2016, accounting for 0.19% of GDP, compared to 2.1% in the US and 0.52% in the UK (http://www.gongyishibao.com/html/gongyizixun/12735.html).

mixed regarding whether and how different types of corporate governance mechanisms (e.g., laws, regulations, contracts, corporate policies) contribute to corporate valux maximization. We deemed the following questions interesting. First, it would add insights to the existing literature to investigate the roles of SOEs' managers and board members in the labor market, since individuals, including managers and board members, make decisions based on their knowledge and incentives (Brickley and Zimmerman, 2010), which depends on the efficiency of the labor market. Second, existing sevidence regarding how corporate governance mechanisms interact is scarce, which can be supplemented by future research. Third, the functioning of corporate governance mechanisms still depends on the quantity and quality of information. Using new data technologies, such as big data, future research should analyze the effect of new data and information dissemination technologies on the functioning of corporate governance mechanisms.

The analysis of CSR activities in China's SOEs allows us to understand the current state of research and practice and to further explore research questions in this area. First, in recent decades, the CSR practices of Chinese SOEs have been considered as a burden and as discretionary activities required by the government, leading to inefficient practices. The Chinese government is the primary resource allocator of the economy, and is expected to build a harmonious society through initiatives in promoting employment and employee benefits, training and education, environmental protection, and poverty alleviation. The Chinese SOEs respond to the orders and recommendations of the government. Although Friedman (1970) argues that the social responsibility of a business is to increase profit, other researchers view that integrating social responsibility and profit maximization facilitates social changes (Mulligan, 1986). Over the last two decades, studies have addressed important questions about the creation of goodwill, reputation, image, or status, collectively and loosely termed "social evaluations." Therefore, future research can contribute to the literature by examining how organizations seek and benefit from social evaluations (George et al., 2016; Wang et al., 2016). While the Chinese government strongly encourages CSR practices, CSR is likely to go beyond companies doing the right thing. To some extent, the CSR practices of Chinese SOEs shift their production and profitability responsibilities to help maintain social stability. With the spread of CSR norms and practices in the country, the number of NGOs in China is increasing, creating a demand for improving business reputation (Moon and Shen, 2010). As a result, Chinese SOEs must work effectively with many stakeholders (Bruton et al., 2015) to meet the CSR requirements set by the government to avoid reputational damage and conflicts of interest. Therefore, future research should focus on the pressures, incentives, strategies, and economic consequences of CSR decisions made by SOEs in China.

Finally, the theories and practice regarding the Chinese SOEs and the "China puzzle" seem to suggest a new explanation of the Chinese SOEs – the social enterprise theory. Social enterprises refer to a prime example of hybrid organizations in Western countries; they were created to achieve social goals, yet through business methods (Brakman Reise, 2013). Therefore, they are different from for-profit and not-for-profit organizations, and can be defined as organizations that integrate both social logic and financial logic (Battilana and Dorado, 2010).

Chinese SOEs are companies fitting the social enterprise concept in that they are set to balance the demand of multiple stakeholders effectively (Bruton et al., 2015). More important, China's institution provides a better supporting ecosystem for SOEs to reinforce the creation of social value when pursuing value maximization. SOEs could sacrifice profits and efficiency to fulfill social roles when necessary. Such a characteristic enables the Chinese government to focus on developing social welfare with supporting economic infrastructure, and thus makes the "China puzzle" feasible. We believe using the perspective of social enterprise to explain the Chinese SOEs will enrich future studies regarding SOEs.

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Peer effect in the initial recognition of goodwill

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ABSTRACT

This study investigates the peer effect in the initial recognition of goodwill. We find that firms imitate their peers in the initial recognition of goodwill. The higher the tendency for imitation, the higher the proportion of goodwill recognized. Imitation behavior in the initial recognition of goodwill cannot be explained by information acquisition or rivalry motivations. Instead, we find evidence that managers' opportunistic motivations explain the peer effect in the initial recognition of goodwill and the overestimation of goodwill arising from imitation tendencies. Executive overconfidence weakens the peer effect but exacerbates the overestimation of goodwill caused by imitation tendencies. Finally, the higher the imitation tendency, the greater the probability and amount of goodwill impairment in the future. This further confirms that the peer effect leads to overestimation of goodwill. The findings of this study enrich the literature on goodwill and provide insightful empirical evidence for regulating goodwill accounting. The results show that the conservatism principle should be reinforced in the initial recognition of goodwill.

1. Introduction

With the rapid development of China's economy, mergers and acquisitions (M&As) of listed firms in China have increased dramatically in recent years. M&A transactions are expected to optimize resource allocation and bring economies of scale. While large-scale M&A transactions inject vitality into the capital market, they can also be dangerous: the M&A failure rate is between 70% and 90% (Christensen et al., 2011). One reason for the failure of M&As is their high premium. However, this high premium results in huge goodwill, which becomes a reservoir for M&A risk due to the discretion inherent in the subsequent measurement of goodwill.

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China's goodwill accounting has gone through two stages since 1993, when China restored double-entry bookkeeping system. Before 2006, goodwill was recognized as an intangible asset and amortized within a certain period according to the Chinese Accounting Standards for Business Enterprises (hereinafter, CAS). Since 2007, goodwill has been recognized as a separate asset and is no longer amortized but subject to an annual impairment test. According to CAS 20 – Business Combinations, goodwill is initially recognized as the purchase price (fair value of consideration paid) minus the fair value of the identifiable net assets acquired. After the acquisition, a goodwill impairment test is conducted annually by comparing the carrying value and recoverable amount of goodwill.[1]

However, discretion arises in both the initial and subsequent measurement of goodwill. Goodwill can be used to mask irrational M&A decisions and managers' opportunistic behavior. M&A transactions with high premiums and high goodwill are frequently failures. For example, J&R Optimum Energy acquired a lithium battery firm named Watermark for 5.2 billion yuan in 2015, generating goodwill of more than 4.6 billion yuan. Two years later, the goodwill was impaired due to the poor performance of the acquired business.

Since 2008, the amount of goodwill recognized by China's A-share listed firms has grown rapidly, from 53.2 billion yuan in 2008 to 1307.6 billion yuan in 2018, and goodwill impairment risk continues to accumulate. In November 2018, the China Securities Regulatory Commission (hereinafter, CSRC) issued "Accounting Supervision Risk Warning Notice No. 8 – Goodwill Impairment," reminding auditors and asset evaluation agencies of the risks in the initial recognition and subsequent impairment of goodwill. On January 31, 2019, hundreds of listed firms announced loss warnings, most of which were due to vast impairment of goodwill expenses. Goodwill accounting arouses great concern from regulators and capital markets.

Goodwill accounting has also attracted the attention of academia. Discussions focus on its initial recognition and measurement, impairment, and disclosure. However, relevant empirical evidence is still relatively scarce, especially on the initial recognition of goodwill due to the difficulty of obtaining data. The literature finds that acquirers exploit overpriced shares to make more acquisitions, resulting in increasing goodwill (Gu and Lev, 2011). Transaction characteristics are found to be associated with the initial recognition of goodwill. For example, high premiums lead to high goodwill (Bugeja and Loyeung, 2015), share payment is positively related to goodwill (Xie and Zhang, 2013), industry similarity between the acquire and the acquiree is negatively related to goodwill (Zhang and Zhang, 2016), and goodwill is positively correlated with earnings-based bonuses (Shalev et al., 2013). The irrational decision-making of executives is also associated with the growth of goodwill. For example, Li et al. (2018) find that the higher the degree of executive overconfidence, the greater the increase in goodwill. In addition, external appraisers constrain managerial discretion in the initial recognition of goodwill (Zhang and Zhang, 2016).

Uncertainty is common in economic activities. The accounting recognition and measurement of transactions or events with uncertainty requires estimation. Theoretically, accounting estimates are based on objective facts or possible states, using scientific methods. However, due to the high degree of discretion, accounting estimates have become an important tool for corporate financial reporting strategy selection. The fair value of the consideration to be paid or received in a business combination and the fair value of the net assets acquired must be estimated. These estimates determine the amount of initial goodwill recognized, making the subjectivity inherent in estimating goodwill greater than that in most other assets (Ramana and Watts, 2012). The merger premium generated in a business combination can either be recorded as a fair value adjustment that is subsequently amortized or as goodwill that is subsequently subject to impairment tests. The existing research has scarcely investigated the allocation of merger premium between fair value adjustment and goodwill.

In this study, we explore the initial recognition of goodwill in business combinations, focusing on the allocation of the merger premium between goodwill and fair value adjustment. The portion of the M&A premium allocated to fair value adjustment must be amortized periodically in subsequent periods, whereas the portion allocated to goodwill is only subject to an annual impairment test. Compared with periodic amortization, the fair-value-based impairment test is more discretionary. Therefore, executives are more inclined to allocate

[1] Referring to CAS 8 – Assets Impairment.

merger premium to goodwill, leading to an overestimation of goodwill. This is consistent with the traditional opportunistic accounting policy choice theory. We further propose that listed firms refer to their peers' practices in the initial recognition of goodwill, thus providing an excuse for their tendency to overestimate goodwill. The findings in this study corroborate this prediction. We find that firms imitate their peers in the initial recognition of goodwill and that the higher the tendency for imitation, the higher the proportion of goodwill recognized.

The identification of causal relationships between individuals and groups is a major obstacle to studying the peer effect (Manski, 1993). First, recognition of the peer effect requires evidence that there are channels of social interaction between peers. Fortunately, in financial analysis and corporate pricing decisions, the communication of information between individuals and groups does not depend on physical social relationships because the information referenced is publicly available. For example, the calculation of goodwill in business combinations is disclosed in the periodic report of the listed firms. Second, some common behaviors may be caused by endogenous factors and have nothing to do with social communication. To overcome this difficulty, we control the variables of multiple dimensions in the regression analysis, including transaction characteristics, corporate characteristics of the acquirer and acquiree, internal and external corporate governance factors, and industry and year fixed effects. Finally, it is challenging to distinguish between the effect of groups on individuals and the reflective effect of individuals on groups. To alleviate the reflective effect, we use the lagged mean goodwill of other listed firms in the same industry as the main explanatory variable, which partially excludes the individual's reflection on the group.

Lieberman and Asaba (2006) divide imitation behavior between enterprises into two mechanisms: information-based imitation and rivalry-based imitation. As reference to industry practice is an accounting convention, there may be natural motivation for information acquisition in the peer effect in the initial recognition of goodwill. If the motivation for information acquisition is dominant, we will find that the greater the information asymmetry, the greater the peer effect in the initial recognition of goodwill. We use whether an acquirer and acquiree are in the same industry and whether they are in the same region as proxies of information asymmetry but find that the degree of information asymmetry has no effect on the peer effect. Therefore, the information acquisition motivation does not dominate the peer effect in the initial recognition of goodwill. Rivalry-based imitation is less likely because goodwill has a negative effect on future firm performance (Paugam et al., 2015). However, goodwill has an incentive effect on M&As (Gu and Lev, 2011) because it is not subject to compulsory amortization. The incentive effect may be followed by rivals. To check for possible rivalry-based imitation, we look at the degree of industry competition of the acquirer and its effect on imitation in goodwill recognition. The results show no effect, which excludes rivalry-based motivation. In addition, we examine the influence of irrational decision-making on the peer effect in the initial recognition of goodwill—that is, overconfidence. We find that overconfidence can relieve the peer effect, but it exaggerates the overestimation of goodwill caused by imitation.

To further verify the opportunistic motivation of the peer effect in the initial recognition of goodwill, we investigate the effect of internal and external governance mechanisms on the peer effect. First, for ownership characteristics, we find that the higher the largest shareholder's ownership, the more obvious the peer effect, but the presence of foreign investors can suppress the peer effect. Furthermore, management ownership, institutional investor ownership, and foreign investor ownership can alleviate the overestimation of goodwill caused by the peer effect. Second, a high proportion of independent directors and high reputation auditors facilitate the peer effect in the initial recognition of goodwill, which possibly shows their strong dependence on industry benchmarks. A high proportion of independent directors increases the goodwill estimation caused by imitation, but auditors with a good reputation suppress it. In addition, CEO duality fosters the high goodwill estimation caused by imitation, but more analysts following restrains it. Finally, we find that the higher the imitation tendency, the greater the possibility and level of future goodwill impairment. These findings are consistent with the opportunistic explanation of the peer effect in the initial recognition of goodwill.

This study contributes in the following aspects. First, it enriches the research on the determinants of the initial recognition of goodwill. Evidence on the factors influencing the initial recognition of goodwill is scarce, and there is no literature that considers the peer effect. We do so using manually collected data on the allocation of premiums in business combinations. Second, our study investigates accounting policy choices from the perspective of behavioral finance. The uncertainty and discretion in the initial recognition of goodwill

provide an opportunity for the study of behavioral motivation. At present, the peer effect research in corporate finance centers on the effects of institutional investors and managers on investment and financing decision-making. We introduce the peer effect into accounting choice decisions. The research context of this study also provides a natural opportunity to test the peer effect. Third, this study provides empirical evidence for regulators and capital market participants. We find that there is a peer effect caused by opportunistic motivation in the initial recognition of goodwill and that this effect can lead to negative accounting results. The results provide evidence for strengthening the regulation of goodwill accounting. Because imitation tendencies in the initial recognition of goodwill lead to the overestimation of goodwill, accountants should rely more on the conservatism principle in exercising judgment and estimating goodwill.

The rest of this paper is organized as follows: Section 2 presents the theoretical analysis and hypothesis development, Section 3 introduces the research design, Section 4 presents the empirical results, Section 5 reports the robustness tests, and Section 6 concludes the paper.

2. Theoretical analysis and hypothesis development

The peer effect refers to the phenomenon that individual behavior is affected by that of the group, as reflected in the individual's imitation of group behavior. Findings on the peer effect in corporate finance are plentiful. Studies find peer effects in investment decisions (Foucault and Fresard, 2014; Chen and Ma, 2017), financing decisions (Leary and Roberts, 2014), M&A decisions (Wang et al., 2016), capital budget (Graham and Harvey, 2001), capital structure (Lu et al., 2017; Zhong and Zhang, 2017), risk aversion (Ahern et al., 2014), stock split (Kaustia and Rantala, 2015), and executive compensation (Zhao, 2016).

In the face of information uncertainty, individuals will pay much to obtain accurate information. It is a relatively better choice to make decisions by imitating peers (Conlisk, 1980). Lieberman and Asaba (2006) classify the motivations for firm imitation behavior into two categories: information-based and rivalry-based. According to information-based theories, firms follow others that are perceived as having superior information. Under rivalry-based theories, firms imitate others to maintain competitive parity or limit rivalry. Financial decision-making often relies on industry information for reference and verification, which is typical information-based imitation.

Economically, goodwill is the discount of expected future excess profitability (Ohlson, 1995). In business combinations, the valuation of the target includes a goodwill component that reflects the target's future excess profitability. There is information asymmetry between the acquirer and acquiree in business combinations. In addition, there is uncertainty about the future economic situation and the target firm's operation. Therefore, discretion is used in the valuation of goodwill and the target. In the face of information asymmetry and uncertainty, learning and imitating the goodwill valuation of similar transactions has become an important method, leading to the peer effect in the recognition of goodwill. At the same time, according to current accounting standards, goodwill is recognized as a separate asset and no longer compulsorily amortized. Compared with compulsory amortization, an impairment test of goodwill has less adverse effects on post-acquisition income. This treatment encourages M&A activities and promotes the pace of enterprise expansion (Gu and Lev, 2011). If this strategy is imitated by rivals, it will generate rivalry-based imitation, which also produces the peer effect.

Based on the above analysis, we propose the peer effect hypothesis in the initial recognition of goodwill:

Hypothesis 1: There is a peer effect in the initial recognition of goodwill; that is, listed firms imitate the allocation ratio of other listed firms in the same industry when they allocate a merger premium to goodwill.

In financial statements, goodwill is "residual value" (Miller, 1973), which is the remainder of the fair value of the consideration paid minus the fair value of the net assets acquired. In practice, the fair value of the consideration paid is allocated to three items: the book value of the net assets acquired, the fair value adjustment, and goodwill. The sum of the fair value adjustment and goodwill is called the acquisition premium. According to CAS 20 – Business Combinations, the fair value adjustment is determined based on the evaluation value (i.e., fair value) of the net assets of the acquiree on the acquisition date. The consideration paid is also measured at fair value and may include cash and other assets paid, stocks issued, liabilities assumed, and any contingent considerations. Discretion is inherent in estimating both the fair value of the net assets acquired and that of the consideration paid. Given the fair value of the consideration paid and the book value of the assets acquired, the allocation of acquisition premium between the fair value adjustment and goodwill is a trade-off.

Theoretically, both reflect their fair values on the acquisition date. However, subsequent accounting treatments of the two items take different approaches. The fair value adjustment is amortized over the useful life of the corresponding assets or liabilities. Goodwill has no definite useful life, and its economic value does not necessarily decrease; its carrying value is written down only when it is impaired. Compared with periodic amortization, the impairment test is more discretionary. Therefore, executives are more inclined to factor an acquisition premium into goodwill, which leads to the overstatement of goodwill. This also results in a higher risk of subsequent goodwill impairment.

In addition to transaction characteristics, the opportunistic behavior of managers determines the allocation of acquisition premiums to goodwill. For example, Shalev et al. (2013) find that when a CEO compensation package relies more on earnings-based bonuses, they are more likely to allocate to goodwill because goodwill is not amortized compulsorily. The greater the allocation to goodwill, the less negative the effect on subsequent accounting profits will be if goodwill is not impaired. Whether goodwill is impaired is a judgment, and managers have a certain degree of discretion. The overestimation of goodwill caused by opportunistic behavior will be imitated by peers in the presence of the peer effect. Opportunistic managers tend to adopt the goodwill allocation ratio of their peers when that ratio is consistent with their allocation level to prove that their goodwill valuation is reasonable. Therefore, we expect that opportunistic behavior produces a peer effect in the initial recognition of goodwill and that the peer effect is directional; that is, there is a tendency to overestimate goodwill. Based on the above analysis, we propose the second hypothesis as follows:

Hypothesis 2: When determining the proportion of goodwill, the stronger the imitation tendency, the greater the possibility that goodwill is overestimated.

3. Research design

3.1. Sample selection and data sources

CAS 20 – Business Combinations, issued in 2006, stipulates that goodwill is no longer included in intangible assets but is treated as a separate asset and no longer subject to periodic amortization.[2] Since then, goodwill has been reported separately on the balance sheet. However, in the early years, the number of listed firms that had and reported goodwill were few. Considering the distribution of samples and changes in goodwill accounting standards, we take the M&A events of A-share listed firms in the Wind M&As database between 2010 and 2017 as our initial research sample. We then exclude the following deals: (1) backdoor listings; (2) those in the financial and insurance industry; (3) those labeled as unfinished; and (4) those by firms that suffered from losses in two or three consecutive fiscal years (ST firms and *ST firms). We obtain 1122 observations after this screening. Because most of the target firms are unlisted, we hand-collect their financial data and the transaction characteristics data. The financial data of the acquiring firms are drawn from the China Security Market and Accounting Research (CSMAR) and Wind databases. All of the continuous variables are winsorized at 1% and 99% to eliminate the influence of outliers on the empirical results.

3.2. Empirical model and variable definitions

We construct the following model to test Hypothesis 1:

$$GW_{i,t} = \alpha_0 + \alpha_1 Peer_{i,t-1} + \alpha_2 Controls_{i,t-1} + \varepsilon \quad (1)$$

where the dependent variable $GW_{i,t}$ is the initial goodwill recognition ratio, which is the proportion of the acquisition premium assigned to goodwill on the acquisition date. It is calculated as the initial recognized amount of goodwill divided by the total acquisition premium. The acquisition premium is the difference between the fair value of the consideration paid and the book value of the net assets acquired. The main independent variable $Peer_{i,t-1}$ is the mean initial goodwill allocation ratio in the M&A transactions of other listed firms in the same industry in the previous year.

[2] Before 2007, goodwill was part of intangible assets and subject to amortization.

In studying the peer effect, it is difficult to distinguish the influence of the group on the individual and the individual's reflective influence on the group. To overcome this difficulty, we use the lagged allocation ratio (previous year) of the group (except the sample firm), which is not affected by the current period behavior of the sample firm (individual). Another challenge in studying the peer effect is that endogenous factors lead to some common behaviors between individuals and groups, and such common behaviors have nothing to do with social communication. To eliminate possible endogenous effects on the imitation behavior between individuals and groups, we control as many factors as possible, including transaction characteristics, acquirer firm characteristics, target firm characteristics, and industry and year fixed effects ($Controls_{i,t-1}$). Specifically, acquirer firm characteristics include agency cost (*Mfee*), firm size (*Size*), debt levels (*Lev*), operating performance (*ROA*), and owner type (*State*). Target firm characteristics include firm size (*SizeT*), debt levels (*LevT*), and operating performance (*ROAT*). The transaction characteristics include whether a transaction is a major asset restructuring (*Major*),[3] whether it is between related parties (*Related*), and the transaction payment type (*Payment*). See Table 1 for detailed variable descriptions and definitions.

We construct the following model to test Hypothesis 2:

$$GW_{i,t} = \beta_0 + \beta_1 PP_{i,t} + \beta_2 Controls_{i,t-1} + \varepsilon \quad (2)$$

where the dependent variable $GW_{i,t}$ is the ratio of goodwill to acquisition premium on the acquisition date. The independent variable $PP_{i,t}$ is the degree of imitation tendency in the initial recognition of goodwill. $PP_{i,t}$ is measured as the negative of $|GW_{i,t}\text{-}Peer_{i,t-1}|$, which is the absolute value of the difference between the initial goodwill recognition ratio of sample firms ($GW_{i,t}$) and the initial goodwill recognition ratio of other firms in the same industry in the previous year ($Peer_{i,t-1}$). To make the results more intuitive, we take the negative of the absolute values. The larger the $PP_{i,t-1}$, the higher the imitation tendency. The control variables ($Controls_{i,t-1}$) are the same as those in Eq. (1), and the variables are defined in Table 1.

4. Empirical analysis

4.1. Descriptive analysis

Table 2 presents the descriptive statistics for the main variables. The mean of the initial goodwill recognition ratio ($GW_{i,t}$) is 0.853, and the mean of the initial goodwill recognition ratio of peer firms ($Peer_{i,t-1}$) is 0.847. Therefore, most of the M&A premium is recognized as goodwill and only a small part (about 15%) is included in the fair value adjustment. The proportion of major asset restructurings, related M&As, different industry M&As, and different region M&As are 31.4%, 29.9%, 52.9%, and 70.2%, respectively. The average proportion of cash payment in M&A transactions is 68.1%. Compared with acquirers, target firms are smaller and have higher leverage and stronger operating performance.

Table 3 reports the Pearson correlation coefficients for the main variables. As shown, the correlation coefficient between the initial goodwill recognition ratio ($GW_{i,t}$) for sample firms and the average of that of peer firms ($Peer_{i,t-1}$) is 0.379, and the correlation is significant at the 1% level. The significant coefficient indicates the peer effect in the initial recognition of goodwill. That is, listed firms imitate their peers in the initial recognition of goodwill. The correlation coefficient of the initial goodwill recognition ratio ($GW_{i,t}$) with the imitation tendency ($PP_{i,t}$) is 0.362 and is significant at the 1% level. Therefore, firms that are apt to imitate their peers allocate a higher proportion of the acquisition premium to goodwill. The results of the correlation coefficient test support Hypotheses 1 and 2. However, in corporate valuation and financial analysis, reference to the industry is a way to verify information. The imitation motivation must be verified by regression analysis controlling various factors.

[3] Major asset restructuring refers to transactions in which the purchased or sold assets represent more than 50% of total assets in the latest audited consolidated financial statements; or the purchased or sold assets generating revenue in the latest fiscal year represent more than 50% of revenue reported in the consolidated financial statement for the same period; or the purchased or sold net assets represent more than 50% of net assets in the latest audited consolidated financial statements and are more than 50,000,000 RMB.

Table 1
Variable definitions and descriptions.

Type	Name	Definition and description
Panel A: Main variables		
Dependent variable	*GW*	The initial goodwill allocation ratio, calculated as the initially recognized amount of goodwill divided by the acquisition premium on the acquisition date
Explanatory variables	*Peer*	The initial goodwill allocation ratio of peers, calculated as the mean of the initial goodwill recognition ratio in the previous year's M&A transactions of other listed firms (excluding the sample firm) in the same industry
	PP	The degree of imitation in the initial recognition of goodwill, calculated as the negative of the absolute value of the difference between the initial goodwill allocation ratio of sample firms ($GW_{i,t}$) and the mean initial goodwill recognition ratio of other firms in the same industry in the previous year ($Peer_{i,t-1}$)
Panel B: Control variables		
Acquirer characteristics	*Mfee*	Agency cost, calculated as administrative expenses divided by operating income
	Size	Firm size, the natural logarithm of total assets.
	Lev	Leverage, calculated as total liabilities divided by total assets
	ROA	Profitability, calculated as net income divided by average total assets
	State	A dummy variable that equals 1 if the controlling shareholder is state-owned and 0 otherwise
	HHI	Industry concentration, calculated as the sum of the square of the ratio of each firm's core income to their industry's total core income
Target characteristics	*SizeT*	Target firm size, the natural logarithm of total assets
	LevT	Target firm leverage, total liabilities divided by total assets
	ROAT	Target firm profitability, net income divided by total assets balance
Transaction characteristics	*Major*	A dummy variable that equals 1 if the deal is a major asset restructuring and 0 otherwise
	Related	A dummy variable that equals 1 if the deal is a related transaction and 0 otherwise
	Payment	The amount paid in cash divided by the total amount of the transaction
	IndDiff	A dummy variable that equals 1 if the acquirer and acquiree belong to different industries and 0 otherwise
	Distance	A dummy variable that equals 1 if the acquirer and acquiree are registered in different provinces and 0 otherwise
Fixed effects	*Bind*	The industry of the acquirer
	Tind	The industry of the acquiree.
	Year	Year of acquisition
Panel C: Moderating variables		
Ownership characteristics	*Top1*	The number of shares held by the largest shareholder divided by the total number of shares
	MShare	The number of shares held by management divided by the total number of shares
	IShare	The number of shares held by institutional investors divided by the total number of shares
	Foreign	A dummy variable that equals 1 if there are foreign investors and 0 otherwise
Corporate governance	*BoardInd*	A dummy variable that equals 1 if the proportion of independent directors on the board of directors is higher than the median of the year and industry and 0 otherwise
	Dual	A dummy variable that equals 1 if the CEO and board chair are the same person and 0 otherwise
External supervision	*Auditor*	A dummy variable that equals 1 if the annual ranking of the acquirer's accounting firm is in the top four and 0 otherwise. The rankings are based on the "Comprehensive Evaluation of Accounting Firms" issued by the Chinese Institute of Certified Public Accountants
	Analyst	The natural logarithm of the number of analysts following the acquirer
Management overconfidence	*MShareInc*	A dummy variable that equals 1 if the number of shares held by management increased not as the result of a share split, rights issue, or stock dividends and 0 otherwise
	OverConf	A dummy variable that equals 1 if the performance forecast is a profit increase or loss reduction but actual net profit is less than predicted and 0 otherwise

Table 2
Descriptive statistics.

Variable	Obs	Mean	Std. Dev	Median	Min	Max
$GW_{i,t}$	1122	0.853	0.395	0.971	−0.953	2.391
$Peer_{i,t-1}$	1122	0.847	0.158	0.878	0.141	1.210
$PP_{i,t}$	1122	−0.215	0.296	−0.116	−1.833	0
$Mfee_{i,t-1}$	1122	0.127	0.088	0.107	0.017	0.489
$Size_{i,t-1}$	1122	21.620	0.964	21.550	19.540	24.880
$Lev_{i,t-1}$	1122	0.367	0.194	0.340	0.058	0.886
$ROA_{i,t-1}$	1122	0.054	0.055	0.050	−0.116	0.242
$State_{i,t}$	1122	0.126	0.332	0	0	1
$HHI_{i,t-1}$	1122	0.054	0.075	0.009	0.008	0.351
$SizeT_{i,t-1}$	1122	18.360	1.794	18.530	13.180	22.520
$LevT_{i,t-1}$	1122	0.536	0.436	0.503	0	3.028
$ROAT_{i,t-1}$	1122	0.061	0.211	0.059	−0.826	0.660
$Major_{i,t}$	1122	0.314	0.464	0	0	1
$Related_{i,t}$	1122	0.299	0.458	0	0	1
$Payment_{i,t}$	1122	0.681	0.380	1	0	1
$IndDiff_{i,t}$	1122	0.529	0.499	1	0	1
$Distance_{i,t}$	1122	0.702	0.457	1	0	1
$Top1_{i,t-1}$	1122	0.324	0.134	0.304	0.051	0.894
$MShare_{i,t-1}$	1108	0.242	0.222	0.225	0	0.671
$IShare_{i,t-1}$	1122	0.094	0.112	0.048	0	0.605
$Foreign_{i,t-1}$	1122	0.081	0.273	0	0	1
$BoardInd_{i,t-1}$	1122	0.471	0.499	0	0	1
$Dual_{i,t-1}$	1117	0.371	0.483	0	0	1
$Auditor_{i,t}$	1122	0.274	0.446	0	0	1
$Analyst_{i,t-1}$	951	1.796	0.983	1.946	0	3.829
$MShareInc_{i,t-1}$	1122	0.142	0.349	0	0	1
$OverConf_{i,t-1}$	815	0.125	0.331	0	0	1

4.2. Empirical results for the baseline model

Table 4 presents the basic regression results. The coefficient on the main explanatory variable $Peer_{i,t-1}$ in column (1) is 0.760 and is significant at the 1% level, showing a strong peer effect in the initial recognition of goodwill. Specifically, the higher the proportion of goodwill allocated by peer firms, the higher proportion of acquisition premium allocated to goodwill by sample firms. Economically, a one-standard-deviation increase in the proportion of peers' goodwill allocation leads to a 12.01% (0.760 × 0.158) increase in the proportion of goodwill recognized by sample firms. Therefore, listed firms have strong incentive to learn from and imitate their peers in the initial recognition of goodwill. In column (2), the main explanatory variable is imitation tendency ($PP_{i,t}$). The larger the value of $PP_{i,t}$, the more likely it is that the initial recognition of goodwill is aligned with their peers. The coefficient on $PP_{i,t}$ is 0.417 and significant at the 1% level. That is, the higher the tendency for imitation, the higher the proportion of initial goodwill recognition. Economically, a one-standard-deviation increase in imitation tendency results in a 12.34% (0.417 × 0.296) increase in initial goodwill recognition. The peer effect in the initial recognition of goodwill leads to systemic overestimation of goodwill. The results in Table 4 support both Hypotheses 1 and 2.

4.3. Motivation analysis: Information-based imitation or rivalry-based imitation?

Lieberman and Asaba (2006) argue that there are two main motivations for firms to imitate their peers: information acquisition and maintaining competitive parity. In the process of the initial recognition of goodwill, reference to industry and market benchmarks is a commonly used accounting estimation method, consistent with the information acquisition motivation of corporate imitation. If the peer effect on the initial recognition of goodwill is motivated by information acquisition only, the peer effect will be more significant

Table 3
Pearson correlation coefficients.

	GW	*Peer*	*PP*	*Mfee*	*Size*	*Lev*	*ROA*	*State*	*HHI*	*SizeT*	*LevT*	*ROAT*	*Major*	*Related*	*Payment*	*IndDiff*
Peer	0.379***	1														
PP	0.362***	0.318***	1													
Mfee	0.082***	0.139***	0.113***	1												
Size	−0.198***	−0.254***	−0.230***	−0.395***	1											
Lev	−0.177***	−0.240***	−0.159***	−0.311***	0.551***	1										
ROA	0.143***	0.149***	0.045	−0.080***	−0.032	−0.358***	1									
State	−0.174***	−0.201***	−0.154***	−0.150***	0.376***	0.264***	−0.119***	1								
HHI	0.076**	0.201***	0.170***	0.207***	−0.107***	−0.050*	0.087***	−0.054*	1							
SizeT	−0.096***	−0.167***	−0.089***	−0.173***	0.284***	0.242***	−0.180***	0.219***	−0.095***	1						
LevT	−0.022	−0.009	0.016	0.020	−0.024	0.009	−0.002	−0.016	0.030	−0.062**	1					
ROAT	0.114***	0.137***	0.144***	0.030	−0.061**	−0.064**	0.010	−0.023	0.100***	0.198***	−0.285***	1				
Major	0.086***	0.077**	0.178***	0.119***	−0.219***	0.015	−0.158***	−0.048	0.134***	0.317***	0.034	0.183***	1			
Related	0.036	0.034	0.034	0.089***	−0.105***	0.056*	−0.114***	0.040	0.049	0.217***	0.018	0.066**	0.489***	1		
Payment	−0.080***	−0.138***	−0.174***	−0.069**	0.163***	0.032	0.135***	0.010	−0.063**	−0.224***	−0.007	−0.159***	−0.520***	−0.436***	1	
IndDiff	0.018	−0.018	−0.016	−0.058*	0.030	0.042	−0.102***	−0.078***	−0.186***	−0.085***	−0.039	−0.030	−0.046	−0.037	0.044	1
Distance	0.063**	0.051*	0.043	−0.005	0.026	0.002	0.010	0.023	0.016	0.018	−0.0220	0.085***	0.041	0	−0.013	0.006

Table 4
Peer effect in goodwill recognition.

Dependent variable	$GW_{i,t}$	$GW_{i,t}$
$Peer_{i,t-1}$	0.760***	
	(8.10)	
$PP_{i,t}$		0.417***
		(10.74)
$State_{i,t}$	−0.081**	−0.081**
	(−2.20)	(−2.25)
$Major_{i,t}$	0.041	0.011
	(1.29)	(0.33)
$Related_{i,t}$	0.008	0.020
	(0.30)	(0.70)
$Payment_{i,t}$	−0.007	−0.003
	(−0.21)	(−0.09)
$Mfee_{i,t-1}$	−0.031	−0.004
	(−0.21)	(−0.03)
$Size_{i,t-1}$	−0.025	−0.016
	(−1.51)	(−0.94)
$Lev_{i,t-1}$	−0.010	−0.004
	(−0.13)	(−0.06)
$ROA_{i,t-1}$	0.726***	0.817***
	(3.09)	(3.57)
$SizeT_{i,t-1}$	−0.002	−0.002
	(−0.33)	(−0.33)
$LevT_{i,t-1}$	−0.007	−0.010
	(−0.26)	(−0.41)
$ROAT_{i,t-1}$	0.103*	0.081
	(1.80)	(1.44)
_cons	0.920*	1.978***
	(1.89)	(4.42)
Year	*Yes*	*Yes*
Bind&Tind	*Yes*	*Yes*
N	1122	1122
adj. R^2	0.164	0.198

Note: The *t*-statistics are reported in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.

in M&As with higher information asymmetry. We use two variables to measure the degree of information asymmetry in M&As. Referring to Kohers and Ang (2000), Datar et al. (2001), and Barbopoulos and Sudarsanam (2012), we use whether an acquirer and acquiree are in the same industry ($IndDiff_{i,t}$) as the first measure of information asymmetry. The indicator variable $IndDiff_{i,t}$ equals 0 if the acquirer and the acquiree are in the same industry and 1 otherwise. When the two parties are in different industries, M&A valuation and goodwill estimation are subject to greater information asymmetry.

The closer an investor is to a firm, the easier it is to obtain firm-related information (Loughran, 2008). In contract, the further an investor is from a firm, the higher the degree of information asymmetry (Cai and Jiang, 2013). Therefore, we use whether an acquirer and acquiree are in the same region ($Distance_{i,t}$) as the second measure of information asymmetry; $Distance_{i,t}$ is an indicator variable that equals 0 if the acquirer and acquiree are in the same province and 1 otherwise. When the two are in different provinces, the degree of information asymmetry is higher.

If the information acquisition motivation leads to the peer effect in the initial recognition of goodwill, we will find a more significant peer effect in M&As between different industries and different provinces. Table 5 reports the estimation results of the motivation analysis. In columns (1) and (2) of Table 5, we introduce $IndDiff_{i,t}$ and $Distance_{i,t}$ as explanatory variables, respectively, and include their interactions with $Peer_{i,t}$. If the coefficients of $Peer_{i,t-1} \times IndDiff_{i,t}$ and $Peer_{i,t-1} \times Distance_{i,t}$ are significantly positive, it indicates that

Table 5
Motivation analysis of peer effect.

Dependent variable	$GW_{i,t}$ (1)	$GW_{i,t}$ (2)	$GW_{i,t}$ (3)
$Peer_{i,t-1}$	0.868***	0.739***	0.825***
	(7.27)	(5.45)	(6.62)
$Peer_{i,t-1} \times IndDiff_{i,t}$	−0.216		
	(−1.46)		
$Peer_{i,t-1} \times Distance_{i,t}$		0.025	
		(0.17)	
$Peer_{i,t-1} \times HHI_{i,t-1}$			−1.247
			(−0.78)
$IndDiff_{i,t}$	0.193		
	(1.50)		
$Distance_{i,t}$		0.011	
		(0.08)	
$HHI_{i,t-1}$			1.108
			(0.77)
$State_{i,t}$	−0.081**	−0.082**	−0.083**
	(−2.19)	(−2.23)	(−2.24)
$Major_{i,t}$	0.038	0.039	0.042
	(1.18)	(1.23)	(1.31)
$Related_{i,t}$	0.009	0.009	0.011
	(0.33)	(0.33)	(0.40)
$Payment_{i,t}$	−0.009	−0.007	−0.006
	(−0.26)	(−0.20)	(−0.17)
$Mfee_{i,t-1}$	−0.036	−0.037	−0.022
	(−0.25)	(−0.25)	(−0.15)
$Size_{i,t-1}$	−0.025	−0.026	−0.025
	(−1.50)	(−1.54)	(−1.46)
$Lev_{i,t-1}$	−0.018	−0.010	−0.011
	(−0.24)	(−0.13)	(−0.14)
$ROA_{i,t-1}$	0.723***	0.718***	0.722***
	(3.07)	(3.05)	(3.06)
$SizeT_{i,t-1}$	−0.001	−0.002	−0.003
	(−0.18)	(−0.28)	(−0.37)
$LevT_{i,t-1}$	−0.007	−0.007	−0.006
	(−0.28)	(−0.26)	(−0.23)
$ROAT_{i,t-1}$	0.103*	0.097*	0.106*
	(1.80)	(1.70)	(1.84)
_cons	0.764	0.893*	0.867*
	(1.53)	(1.82)	(1.75)
Year	*Yes*	*Yes*	*Yes*
Bind&Tind	*Yes*	*Yes*	*Yes*
N	1122	1122	1122
adj. R^2	0.164	0.163	0.162

Note: The *t*-statistics are reported in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.

information asymmetry leads to a stronger peer effect. However, as reported in columns (1) and (2), the coefficients of the intersections are not significant, so the information acquisition motivation alone cannot explain the peer effect in the initial recognition of goodwill.

The more competitive the industry in which a firm operates, the stronger the firm's sense of competition. The rivalry motivation for corporate imitation can be explored by testing whether high industry competition results in a stronger peer effect. We use industry concentration ($HHI_{i,t-1}$) to characterize the degree of competition in an industry and examine whether there is a rivalry motivation using the coefficient of the interaction

of $Peer_{i,t-1}$ and $HHI_{i,t-1}$. The results in column (3) show that the coefficient of the interaction of $Peer_{i,t-1}$ and $HHI_{i,t-1}$ is not significant; therefore, a rivalry motivation cannot be supported.

4.4. Management overconfidence and the initial recognition of goodwill

Management overconfidence is one reason for M&As, and M&As induced by overconfidence result in higher goodwill (Li et al., 2018). The peer effect is a phenomenon in which individual decision-making is influenced by group decision-making. Overconfidence is a source of irrational decision-making. Managers who are overconfident rely more on their own judgment, and their decision-making is less affected by their peers. To validate this prediction, we include management overconfidence and the interaction of management overconfidence and the peer effect in the regression analysis. Specifically, referring to Malmendier and Tate (2005a,b) and Lin et al. (2005), we use two variables to measure management overconfidence. The first considers the situation in which executives increase their holdings of firm stock, $MShareInc_{i,t-1}$. If the number of shares held by management increases and the reason for the increase is not a share split, a rights issue, or stock dividends, $MShareInc_{i,t-1}$ equals 1 and 0 otherwise. The second is a failure to meet optimistic profit forecasts, $OverConf_{i,t-1}$. If a listed firm's performance forecast is a profit increase or loss reduction, but actual net profit at the end of the period is less than predicted, $OverConf_{i,t-1}$ equals 1 and 0 otherwise. Table 6 reports the effect of overconfidence on the initial recognition of goodwill. The coefficients on $MShareInc_{i,t-1}$ and $OverConf_{i,t-1}$ in columns (1) and (4), respectively, are positive, indicating that management overconfidence is positively correlated with the ratio of goodwill recognition. However, in columns (1) and (2), the coefficients on the interactions are significantly negative, indicating that management overconfidence can reduce the peer effect on the initial recognition of goodwill, which is in line with our expectations. In columns (3) and (4), the coefficients on the interactions are significantly positive, indicating that although management overconfidence can mitigate the peer effect, the imitation tendency, if any, still leads to higher goodwill when management is overconfident.

4.5. Management opportunism and the peer effect in the initial recognition of goodwill

The above results show that the information acquisition motivation, the rivalry motivation, and management overconfidence do not explain the peer effect in the initial recognition of goodwill. Under the principal-agent theory, management or internal controllers use accounting policy choice to maximize their own interests. For example, Shalev et al. (2013) find that CEOs with compensation packages that rely heavily on accounting profit are more motivated to over-allocate purchase price to goodwill. Management opportunism leads to the overestimation of goodwill and such behavior induces the peer effect if imitated by peers. Under the information acquisition hypothesis, the peer effect in the initial recognition of goodwill does not lead to systemic overestimation of goodwill. Taking advantage of the accounting treatment of goodwill over that of fair value adjustment, opportunists favor goodwill in the allocation of acquisition premiums. Therefore, our Hypothesis 2 predicts that the peer effect in the initial recognition of goodwill leads to an overestimation of goodwill. In this section, we introduce corporate governance variables as moderators to test whether good corporate governance mechanisms can suppress the peer effect in the initial recognition of goodwill and the overestimation of goodwill thus caused. These tests can further verify that the peer effect is induced by opportunistic behavior.

First, we examine the effects of ownership characteristics. We measure ownership characteristics in four dimensions: largest shareholder ownership ratio ($Top1_{i,t-1}$), management ownership ratio ($MShare_{i,t-1}$), institutional investor ownership ratio ($IShare_{i,t-1}$), and whether there are foreign investors ($Foreign_{i,t-1}$). The largest shareholder ownership ratio proxies for the second type of agency problem (the conflict of interest between a controlling shareholder and minority shareholders). The management ownership ratio proxies for the first type of agency problem (the conflict of interest between shareholders and managers). Institutional investors and foreign investors play a watchdog role, monitoring the controlling shareholder and management. The results of the effect of ownership characteristics on the peer effect in the initial recognition of goodwill are reported in Table 7. As shown, the coefficient on $Top1_{i,t-1}$ is significantly positive, and the coefficient on $Foreign_{i,t-1}$ is significantly negative. The results indicate that the more serious the conflict of interest

Table 6
Executive overconfidence and the initial recognition of goodwill.

Dependent variable	$GW_{i,t}$ (1)	$GW_{i,t}$ (2)	$GW_{i,t}$ (3)	$GW_{i,t}$ (4)
$Peer_{i,t-1}$	0.810***	0.969***		
	(8.40)	(8.27)		
$Peer_{i,t-1} \times MShareInc_{i,t-1}$	−0.482**			
	(−1.99)			
$Peer_{i,t-1} \times OverConf_{i,t-1}$		−0.493*		
		(−1.66)		
$PP_{i,t}$			0.380***	0.376***
			(9.03)	(7.67)
$PP_{i,t} \times MShareInc_{i,t-1}$			0.220**	
			(2.24)	
$PP_{i,t} \times OverConf_{i,t-1}$				0.490***
				(4.48)
$MShareInc_{i,t-1}$	0.392*		0.040	
	(1.82)		(1.06)	
$OverConf_{i,t-1}$		0.359		0.076*
		(1.36)		(1.78)
$State_{i,t}$	−0.083**	−0.099**	−0.083**	−0.113**
	(−2.24)	(−2.08)	(−2.30)	(−2.47)
$Major_{i,t}$	0.041	0.050	0.009	0.007
	(1.28)	(1.37)	(0.30)	(0.19)
$Related_{i,t}$	0.008	0.014	0.015	0.015
	(0.28)	(0.43)	(0.53)	(0.50)
$Payment_{i,t}$	−0.008	0.073*	−0.006	0.072*
	(−0.22)	(1.75)	(−0.16)	(1.80)
$Mfee_{i,t-1}$	−0.044	−0.052	0.002	−0.073
	(−0.30)	(−0.31)	(0.01)	(−0.46)
$Size_{i,t-1}$	−0.026	−0.043**	−0.017	−0.039**
	(−1.53)	(−2.20)	(−1.01)	(−2.04)
$Lev_{i,t-1}$	0.000	0.043	0.002	0.066
	(0.00)	(0.49)	(0.02)	(0.78)
$ROA_{i,t-1}$	0.736***	0.772***	0.825***	0.951***
	(3.14)	(2.95)	(3.60)	(3.78)
$SizeT_{i,t-1}$	−0.002	0.006	−0.002	0.008
	(−0.27)	(0.67)	(−0.30)	(1.02)
$LevT_{i,t-1}$	−0.006	−0.006	−0.010	−0.008
	(−0.24)	(−0.20)	(−0.39)	(−0.29)
$ROAT_{i,t-1}$	0.096*	0.056	0.088	0.023
	(1.67)	(0.92)	(1.57)	(0.38)
_cons	0.842*	1.559***	1.991***	1.892***
	(1.73)	(2.81)	(4.46)	(3.56)
Year	*Yes*	*Yes*	*Yes*	*Yes*
Bind&Tind	*Yes*	*Yes*	*Yes*	*Yes*
N	1122	815	1122	815
adj. R^2	0.166	0.150	0.201	0.208

Note: The *t*-statistics are reported in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.

between a controlling shareholder and minority shareholders, the more likely the firm is to imitate its peers in goodwill allocation. Nevertheless, the presence of foreign investors inhibits firms from imitating their peers.

Next, we examine the moderating effect of ownership characteristics on the overestimation of goodwill generated by imitation tendencies, and the results are reported in Table 8. As shown, the coefficient on $PP_{i,t}$*$Top1_{i,t-1}$ is not significant, indicating that although a higher proportion of largest shareholder ownership leads to a more serious peer effect, imitation behavior does not induce the overestimation of goodwill. The coefficients on $PP_{i,t}$*$Mshare_{i,t-1}$, $PP_{i,t}$*$Ishare_{i,t-1}$, and $PP_{i,t}$*$Foreign_{i,t-1}$ are all negative, indicating that

Table 7
Ownership characteristics and the peer effect on the initial recognition of goodwill.

Dependent variable	$GW_{i,t}$ (1)	$GW_{i,t}$ (2)	$GW_{i,t}$ (3)	$GW_{i,t}$ (4)
$Peer_{i,t-1}$	0.168	0.765***	0.785***	0.831***
	(0.80)	(6.72)	(6.92)	(8.58)
$Peer_{i,t-1} \times Top1_{i,t-1}$	1.732***			
	(3.08)			
$Peer_{i,t-1} \times MShare_{i,t-1}$		−0.657		
		(−1.59)		
$Peer_{i,t-1} \times IShare_{i,t-1}$			−0.491	
			(−0.67)	
$Peer_{i,t-1} \times Foreign_{i,t-1}$				−0.751***
				(−2.74)
$Top1_{i,t-1}$	−1.555***			
	(−3.26)			
$MShare_{i,t-1}$		0.613*		
		(1.70)		
$IShare_{i,t-1}$			0.614	
			(0.93)	
$Foreign_{i,t-1}$				0.670***
				(2.83)
$State_{i,t}$	−0.067*	−0.055	−0.078**	−0.071*
	(−1.82)	(−1.46)	(−2.10)	(−1.92)
$Major_{i,t}$	0.044	0.041	0.047	0.043
	(1.39)	(1.27)	(1.46)	(1.36)
$Related_{i,t}$	0.012	0.020	0.010	0.007
	(0.41)	(0.70)	(0.36)	(0.25)
$Payment_{i,t}$	−0.008	0.001	−0.004	−0.003
	(−0.21)	(0.04)	(−0.12)	(−0.08)
$Mfee_{i,t-1}$	−0.029	−0.032	−0.050	−0.041
	(−0.20)	(−0.22)	(−0.34)	(−0.28)
$Size_{i,t-1}$	−0.024	−0.017	−0.025	−0.028*
	(−1.43)	(−1.01)	(−1.47)	(−1.65)
$Lev_{i,t-1}$	−0.008	−0.018	−0.012	−0.004
	(−0.10)	(−0.23)	(−0.16)	(−0.06)
$ROA_{i,t-1}$	0.775***	0.689***	0.633***	0.708***
	(3.30)	(2.94)	(2.62)	(2.99)
$SizeT_{i,t-1}$	−0.004	−0.003	−0.003	−0.003
	(−0.53)	(−0.39)	(−0.39)	(−0.37)
$LevT_{i,t-1}$	−0.010	−0.004	−0.006	−0.005
	(−0.38)	(−0.15)	(−0.22)	(−0.20)
$ROAT_{i,t-1}$	0.106*	0.117**	0.101*	0.107*
	(1.87)	(2.05)	(1.77)	(1.87)
_cons	1.459***	0.704	0.892*	0.872*
	(2.85)	(1.42)	(1.82)	(1.79)
Year	*Yes*	*Yes*	*Yes*	*Yes*
Bind&Tind	*Yes*	*Yes*	*Yes*	*Yes*
N	1122	1108	1122	1122
adj. R^2	0.171	0.147	0.165	0.168

Note: The *t*-statistics are reported in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.

management ownership, institutional investor ownership, and the presence of foreign investors can restrain the overvaluation of goodwill caused by the peer effect. These results are generally consistent with the opportunistic motivation of the peer effect in the initial recognition of goodwill.

We also examine the effect of other corporate governance mechanisms, including board independence ($BoardInd_{i,t-1}$), CEO duality ($Dual_{i,t-1}$), auditor reputation ($Auditor_{i,t}$), and analysts following ($Analyst_{i,}$

Table 8
Ownership characteristics, imitation tendency, and the initial recognition of goodwill.

Dependent variable	$GW_{i,t}$ (1)	$GW_{i,t}$ (2)	$GW_{i,t}$ (3)	$GW_{i,t}$ (4)
$PP_{i,t}$	0.314***	0.523***	0.569***	0.477***
	(3.24)	(10.30)	(12.14)	(12.16)
$PP_{i,t}$*$Top1_{i,t-1}$	0.303			
	(1.14)			
$PP_{i,t}$*$Mshare_{i,t-1}$		−0.678***		
		(−3.98)		
$PP_{i,t}$*$Ishare_{i,t-1}$			−1.902***	
			(−5.78)	
$PP_{i,t}$*$Foreign_{i,t-1}$				−0.917***
				(−6.50)
$Top1_{i,t-1}$	−0.068			
	(−0.66)			
$MShare_{i,t-1}$		−0.074		
		(−1.17)		
$IShare_{i,t-1}$			−0.110	
			(−0.96)	
$Foreign_{i,t-1}$				−0.164***
				(−3.41)
$State_{i,t}$	−0.077**	−0.040	−0.070**	−0.070**
	(−2.14)	(−1.08)	(−1.98)	(−1.96)
$Major_{i,t}$	0.011	0.013	0.010	0.014
	(0.36)	(0.40)	(0.31)	(0.44)
$Related_{i,t}$	0.021	0.030	0.016	0.009
	(0.76)	(1.07)	(0.60)	(0.31)
$Payment_{i,t}$	0.001	0.009	−0.004	−0.006
	(0.03)	(0.25)	(−0.11)	(−0.17)
$Mfee_{i,t-1}$	−0.016	−0.005	−0.010	0.023
	(−0.11)	(−0.04)	(−0.07)	(0.16)
$Size_{i,t-1}$	−0.016	−0.008	−0.018	−0.019
	(−0.95)	(−0.50)	(−1.13)	(−1.18)
$Lev_{i,t-1}$	−0.002	−0.022	−0.004	0.020
	(−0.02)	(−0.29)	(−0.06)	(0.26)
$ROA_{i,t-1}$	0.859***	0.751***	0.686***	0.791***
	(3.74)	(3.31)	(2.95)	(3.48)
$SizeT_{i,t-1}$	−0.002	−0.001	−0.001	−0.004
	(−0.24)	(−0.17)	(−0.11)	(−0.56)
$LevT_{i,t-1}$	−0.010	−0.006	−0.008	−0.014
	(−0.39)	(−0.25)	(−0.33)	(−0.57)
$ROAT_{i,t-1}$	0.076	0.098*	0.087	0.092*
	(1.37)	(1.77)	(1.57)	(1.67)
_cons	1.999***	1.763***	2.051***	2.100***
	(4.47)	(3.93)	(4.66)	(4.77)
Year	*Yes*	*Yes*	*Yes*	*Yes*
Bind&Tind	*Yes*	*Yes*	*Yes*	*Yes*
N	1122	1108	1122	1122
adj. R^2	0.200	0.195	0.224	0.227

Note: The *t*-statistics are reported in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.

$_{t-1}$). Variable definitions are given in Table 1, and the empirical results are presented in Table 9. As shown, the coefficients on $Peer_{i,t-1} \times BoardInd_{i,t-1}$ and $Peer_{i,t-1} \times Auditor_{i,t}$ are significantly positive, whereas the other two interaction coefficients are not significant. High board independence and high auditor reputation result in a greater tendency for imitation in the initial recognition of goodwill. One explanation for the higher imitation

Table 9
Corporate governance and the peer effect on the initial recognition of goodwill.

Dependent variable	$GW_{i,t}$ (1)	$GW_{i,t}$ (2)	$GW_{i,t}$ (3)	$GW_{i,t}$ (4)
$Peer_{i,t-1}$	0.508***	0.705***	0.655***	0.556***
	(4.47)	(6.54)	(6.21)	(3.33)
$Peer_{i,t-1} \times BoardInd_{i,t-1}$	0.553***			
	(3.80)			
$Peer_{i,t-1} \times Dual_{i,t-1}$		0.204		
		(1.25)		
$Peer_{i,t-1} \times Auditor_{i,t}$			0.322**	
			(2.12)	
$Peer_{i,t-1} \times Analyst_{i,t-1}$				0.109
				(1.37)
$BoardInd_{i,t-1}$	−0.530***			
	(−4.22)			
$Dual_{i,t-1}$		−0.177		
		(−1.25)		
$Auditor_{i,t}$			−0.261**	
			(−1.98)	
$Analyst_{i,t-1}$				−0.085
				(−1.22)
$State_{i,t}$	−0.080**	−0.089**	−0.080**	−0.069*
	(−2.18)	(−2.35)	(−2.17)	(−1.66)
$Major_{i,t}$	0.050	0.039	0.039	0.038
	(1.56)	(1.19)	(1.23)	(1.07)
$Related_{i,t}$	0.008	0.007	0.008	0.012
	(0.27)	(0.24)	(0.28)	(0.38)
$Payment_{i,t}$	0.001	−0.005	−0.009	0.010
	(0.03)	(−0.13)	(−0.24)	(0.26)
$Mfee_{i,t-1}$	−0.015	−0.017	−0.035	−0.147
	(−0.10)	(−0.11)	(−0.23)	(−0.86)
$Size_{i,t-1}$	−0.024	−0.025	−0.026	−0.038*
	(−1.43)	(−1.44)	(−1.57)	(−1.88)
$Lev_{i,t-1}$	−0.014	−0.013	−0.009	−0.009
	(−0.18)	(−0.16)	(−0.12)	(−0.10)
$ROA_{i,t-1}$	0.703***	0.738***	0.688***	0.697**
	(3.01)	(3.13)	(2.91)	(2.48)
$SizeT_{i,t-1}$	−0.002	−0.002	−0.002	0.001
	(−0.21)	(−0.21)	(−0.32)	(0.14)
$LevT_{i,t-1}$	−0.008	−0.007	−0.006	0.014
	(−0.33)	(−0.25)	(−0.22)	(0.49)
$ROAT_{i,t-1}$	0.097*	0.099*	0.102*	0.096
	(1.71)	(1.73)	(1.79)	(1.58)
_cons	1.086**	0.945*	0.997**	1.268**
	(2.24)	(1.91)	(2.04)	(2.31)
Year	*Yes*	*Yes*	*Yes*	*Yes*
Bind&Tind	*Yes*	*Yes*	*Yes*	*Yes*
N	1122	1117	1122	951
adj. R^2	0.179	0.165	0.166	0.156

Note: The *t*-statistics are reported in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.

tendency is that independent directors and auditors are more dependent on industry benchmarks in making decisions to reflect their independence.

Next, we examine the moderating effect of corporate governance characteristics on the overestimation of goodwill caused by imitation tendencies, and the results are shown in Table 10. The coefficients on $PP_{i,t}$*$BoardInd_{i,t-1}$ and $PP_{i,t}$*$Dual_{i,t-1}$ are significantly positive, revealing that a high proportion of independent

Table 10
Corporate governance, the peer effect and overestimation of goodwill.

Dependent variable	$GW_{i,t}$ (1)	$GW_{i,t}$ (2)	$GW_{i,t}$ (3)	$GW_{i,t}$ (4)
$PP_{i,t}$	0.158***	0.340***	0.544***	0.637***
	(3.09)	(7.39)	(11.56)	(7.29)
$PP_{i,t}$*$BoardInd_{i,t-1}$	0.533***			
	(7.46)			
$PP_{i,t}$*$Dual_{i,t-1}$		0.246***		
		(3.14)		
$PP_{i,t}$*$Auditor_{i,t}$			−0.352***	
			(−4.65)	
$PP_{i,t}$*$Analyst_{i,t-1}$				−0.151***
				(−3.50)
$BoardInd_{i,t-1}$	0.050*			
	(1.93)			
$Dual_{i,t-1}$		0.039		
		(1.39)		
$Auditor_{i,t}$			−0.048	
			(−1.63)	
$Analyst_{i,t-1}$				−0.019
				(−1.15)
$State_{i,t}$	−0.087**	−0.094**	−0.082**	−0.061
	(−2.49)	(−2.57)	(−2.29)	(−1.50)
$Major_{i,t}$	0.014	0.008	0.011	0.017
	(0.47)	(0.25)	(0.37)	(0.49)
$Related_{i,t}$	0.032	0.020	0.025	0.008
	(1.19)	(0.70)	(0.90)	(0.25)
$Payment_{i,t}$	0.010	0.000	0.000	0.016
	(0.29)	(0.00)	(0.01)	(0.42)
$Mfee_{i,t-1}$	0.041	0.031	−0.052	−0.087
	(0.29)	(0.22)	(−0.36)	(−0.52)
$Size_{i,t-1}$	−0.012	−0.013	−0.014	−0.040**
	(−0.74)	(−0.78)	(−0.83)	(−2.01)
$Lev_{i,t-1}$	−0.014	−0.006	−0.019	0.014
	(−0.19)	(−0.08)	(−0.25)	(0.16)
$ROA_{i,t-1}$	0.764***	0.833***	0.750***	0.835***
	(3.42)	(3.64)	(3.28)	(3.04)
$SizeT_{i,t-1}$	−0.002	−0.003	−0.004	0.002
	(−0.24)	(−0.36)	(−0.53)	(0.19)
$LevT_{i,t-1}$	−0.023	−0.013	−0.009	0.007
	(−0.90)	(−0.49)	(−0.36)	(0.26)
$ROAT_{i,t-1}$	0.057	0.079	0.079	0.071
	(1.04)	(1.41)	(1.43)	(1.19)
_cons	1.709***	1.885***	1.879***	2.234***
	(3.92)	(4.20)	(4.24)	(4.50)
Year	Yes	Yes	Yes	Yes
Bind&Tind	Yes	Yes	Yes	Yes
N	1122	1117	1122	951
adj. R^2	0.242	0.205	0.213	0.187

Note: The *t*-statistics are reported in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.

directors and CEO duality both exacerbate the overestimation of goodwill caused by imitation tendencies. The coefficients on $PP_{i,t}$*$Auditor_{i,t}$ and $PP_{i,t}$*$Analyst_{i,t-1}$ are both significantly negative, indicating that high reputation auditors and analysts following suppress the overestimation of goodwill caused by imitation tendencies. Therefore, internal governance mechanisms exaggerate the overestimation of goodwill, but external governance mechanisms relieve such overestimation. In general, the results based on the moderating effect

of internal and external corporate governance mechanisms are consistent with the opportunistic motivation of the peer effect.

4.6. Imitation tendency and future goodwill impairment

We find that listed firms with a high degree of imitation tendency overestimate goodwill. To further verify that higher goodwill is overvalued, we use the imitation tendency to predict future goodwill impairment. If a high imitation tendency leads to a higher probability of future goodwill impairment and a higher amount of goodwill impairment, the high goodwill caused by the peer effect is overestimated in its initial recognition. To test whether the degree of imitation tendency affects the impairment of goodwill, we construct two variables to measure the impairment of goodwill: the presence of goodwill impairment (*GWI_dum*) and the amount of goodwill impairment (*GWI*). *GWI_dum* examines whether a listed firm reports goodwill impairment in the periods following initial goodwill recognition. The indicator variable *GWI_dum* equals 1 if a firm recognizes goodwill impairment and 0 otherwise. *GWI* is the natural logarithm of the amount of goodwill impairment and takes 0 if a firm does not recognize goodwill impairment. *GWI_dum* and *GWI* are calculated for the four years following initial goodwill recognition. The results are reported in Table 11, in which the dependent variable in Panel A is the presence of goodwill impairment (*GWI_dum*), and in Panel B, it is the amount of goodwill impairment (*GWI*). As Table 11 shows, the degree of imitation tendency is positively correlated with future goodwill impairment. In particular, the probability and amount of goodwill impairment in 3 out of 4 years subsequent to initial recognition are significantly correlated with the imitation tendency. This result further validates the opportunistic motivation of the peer effect in the initial recognition of goodwill. The higher the merger premium allocated to goodwill, the more likely goodwill is to be impaired in the future.

5. Robustness tests

To buttress our empirical results, we conduct a series of robustness tests and report the results as follows.[4]

5.1. Excluding leading industry

Industry distribution in our study shows that the information technology industry accounts for 27.44% of the sample, the largest proportion of any of the industries represented. To exclude the possibility of a dominating industry effect, we exclude the information technology industry from the sample and rerun the empirical tests. The results remain consistent.

5.2. Adding more control variables

To further control possible omitted variable problems, we include all moderating variables in the regression model, and the results remain consistent.

5.3. Controlling policy shocks

CSRC revised the ‘‘Measures for the Administration of the Material Asset Restructurings of Listed Companies” in 2014. The main revisions include relaxing the review system, improving the market-based pricing mechanism for issuing shares to purchase assets, improving the definition of backdoor listing, enriching the payment instruments in M&As, eliminating the threshold on the purchase of assets by issuing shares to unrelated third parties and mandatory requirements for profit forecast compensation, enriching the performance guarantee system for tender offer, and specifying a deferential review system. The new measures emphasize in-process and post transaction monitoring, to ensure the parties perform their duties. To alleviate the effect of

[4] To save space, the tables are omitted here.

Table 11
Imitation tendency and future goodwill impairment.

Panel A	GWI_dum_{t+1}	GWI_dum_{t+2}	GWI_dum_{t+3}	GWI_dum_{t+4}
$PP_{i,t}$	0.089*	0.048	0.097***	0.057**
	(1.80)	(1.02)	(2.60)	(2.28)
$State_{i,t}$	−0.103**	−0.014	−0.035	−0.001
	(−2.25)	(−0.33)	(−1.03)	(−0.04)
$Major_{i,t}$	−0.070*	0.043	0.053*	0.016
	(−1.86)	(1.20)	(1.86)	(0.85)
$Related_{i,t}$	−0.019	−0.053	−0.053**	−0.042**
	(−0.54)	(−1.56)	(−1.98)	(−2.33)
$Payment_{i,t}$	−0.006	−0.018	−0.039	−0.046**
	(−0.12)	(−0.41)	(−1.13)	(−2.01)
$Mfee_{i,t}$	0.665***	0.704***	0.388**	−0.018
	(2.93)	(3.27)	(2.26)	(−0.15)
$Size_{i,t}$	0.043**	0.036*	0.036**	0.001
	(2.03)	(1.82)	(2.29)	(0.12)
$Lev_{i,t}$	0.079	0.082	0.017	0.043
	(0.78)	(0.86)	(0.23)	(0.85)
$ROA_{i,t}$	−0.357	−0.345	0.017	0.189
	(−1.00)	(−1.02)	(0.06)	(1.05)
_cons	−0.187	−0.985*	−1.038**	−0.103
	(−0.32)	(−1.78)	(−2.34)	(−0.35)
Year	Yes	Yes	Yes	Yes
Bind&Tind	Yes	Yes	Yes	Yes
N	1122	1122	1122	1122
adj. R^2	0.079	0.225	0.418	0.567
Panel B	GWI_{t+1}	GWI_{t+2}	GWI_{t+3}	GWI_{t+4}
$PP_{i,t}$	1.393*	1.228	1.751***	1.093**
	(1.67)	(1.50)	(2.60)	(2.35)
$State_{i,t}$	−1.705**	−0.408	−0.738	−0.062
	(−2.22)	(−0.54)	(−1.19)	(−0.15)
$Major_{i,t}$	−1.001	1.122*	1.276**	0.310
	(−1.57)	(1.79)	(2.48)	(0.87)
$Related_{i,t}$	−0.410	−0.872	−0.887*	−0.779**
	(−0.68)	(−1.48)	(−1.83)	(−2.33)
$Payment_{i,t}$	−0.173	−0.358	−0.835	−1.008**
	(−0.23)	(−0.48)	(−1.35)	(−2.35)
$Mfee_{i,t}$	11.619***	10.443***	7.025**	−0.743
	(3.04)	(2.78)	(2.27)	(−0.35)
$Size_{i,t}$	0.872**	0.842**	0.695**	0.042
	(2.46)	(2.42)	(2.43)	(0.21)
$Lev_{i,t}$	1.582	0.570	0.480	0.686
	(0.93)	(0.34)	(0.35)	(0.73)
$ROA_{i,t}$	−6.806	−6.426	0.862	2.895
	(−1.13)	(−1.09)	(0.18)	(0.86)
_cons	−3.917	−21.786**	−18.775**	−2.654
	(−0.40)	(−2.25)	(−2.35)	(−0.48)
Year	Yes	Yes	Yes	Yes
Bind&Tind	Yes	Yes	Yes	Yes
N	1122	1122	1122	1122
adj. R^2	0.085	0.240	0.418	0.563

Note: The *t*-statistics are reported in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.

the new "Measures for the Administration of the Material Asset Restructurings of Listed Companies," we use the sample from 2015 and beyond to rerun the empirical tests, and the results remain the same.

6. Conclusions

Using the M&As of A-share listed firms, this study examines the peer effect on the initial recognition of goodwill. We find evidence that supports a peer effect on the initial recognition of goodwill. When a firm allocates an acquisition premium, it imitates the treatment of other listed firms in the same industry. This imitation behavior leads to a systemic overestimation of goodwill. We examine the information acquisition and rivalry motivations in peer effect theory. However, these motivations are not supported in the peer effect on the initial recognition of goodwill. We propose that managerial opportunistic behavior produces a peer effect in allocating acquisition premiums, and this hypothesis is verified in our study. We further find that listed firms with a high degree of the second type of agency problem (high ownership by the largest shareholder) are more likely to imitate their peers in the initial recognition of goodwill, but the presence of foreign investors inhibits this imitation. The lower the first type of agency problem, the higher the institutional investor ownership, and the existence of foreign investors can alleviate the overestimation of goodwill caused by the peer effect. In the initial recognition of goodwill, when the proportion of independent directors on the board of directors is higher, there is a stronger imitation tendency, and this imitation tendency promotes the overestimation of goodwill. Therefore, independent directors do not perform their appropriate supervisory and advisory functions in goodwill accounting selection. Although firms audited by high reputation auditors show a higher peer imitation tendency, the high reputation of auditors can restrain the overestimation of goodwill caused by the peer effect. High reputation auditors make more objective professional judgments in referring to industry practice. In addition, CEO duality exacerbates the overestimation of goodwill caused by imitation tendencies. Listed firms with more analysts following have a lower degree of goodwill overestimation caused by imitation tendencies. Executive overconfidence can suppress the peer effect, but it encourages the overestimation of goodwill caused by imitation tendencies. Finally, the higher the imitation tendency in the initial recognition of goodwill, the greater the possibility of future goodwill impairment and the greater the degree of impairment.

The results of this study indicate that there is opportunistic motivation in the initial recognition of goodwill and that this opportunistic behavior is imitated. Market methods in accounting estimation and conformity with industry practice in accounting policy choice disguise such opportunistic motivation. In November 2018, the CSRC issued "Accounting Supervision Risk Warning Notice No. 8 – Goodwill Impairment." This notice enumerates irregularities in the initial recognition of goodwill including: merger cost measurement error (such as not considering or not correctly considering contingent considerations that should be included in the cost of the acquisition) and under-identification of identifiable assets and liabilities (such as contract rights, customer relations, pending litigations, guarantees) that are owned by the acquiree but not recognized in the financial statements.[5] These problems call for more standardization and more scientific and professional input into the initial recognition of goodwill. The results of this study echo the regulations and reveal that the conservatism principle should be reinforced in the initial recognition of goodwill to avoid overestimation and reduce future goodwill impairment.

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[5] Please refer to the CSRC website for the text of the notice: http://www.csrc.gov.cn/pub/newsite/kjb/kjbzcgf/xsjzj/sjpgjggz/201811/t20181116_346845.html.

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The effect of affiliated analysts on stock recommendations: Evidence from share pledges in China

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ABSTRACT

We use the share pledge context in China to examine how affiliated analysts whose securities companies are pledgees of share pledge firms issue stock recommendations on these listed firms. We find that their recommendations are more optimistic than those of non-affiliated analysts, and they are more likely to issue Buy and Add recommendations, suggesting that they issue optimistic rating reports for share pledge firms due to their conflicts of interest. We also find a dynamic adjustment in the stock recommendation behavior of these analysts, and their probability after issuing optimistic stock recommendations is significantly reduced before and after the years that the affiliation relationship between them and share pledge firms both began and ended. These affiliated analysts continue to issue optimistic stock recommendations after visiting the share pledge firms if they work in the same location as the firms, or if they are star analysts among New Fortune's "top five analysts," and when the information transparency of the share pledge firms is higher. In addition, the optimistic stock recommendation behavior of affiliated analysts is more significant in our sample of firms with high share pledge ratios and downward stock price pressure. The earnings forecast quality of affiliated analysts is also found to be lower, and they are less inclined to downgrade stock recommendations for these share pledge firms. Buy recommendations issued by both non-affiliated and affiliated analysts can bring cumulative excess returns in the short event window, but those issued by affiliated analysts are significantly negative in the long-term event window, and significantly lower than those issued by non-affiliated analysts. Overall, our study shows that affiliated analysts issue optimistic rating reports on share pledge firms due to conflicts of interest, which leads to decision-making bias in investors and thus decreases the stock

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price crash risk of the firms. Our findings further reveal the economic consequences of share pledging and extend our understanding of the behavior of analysts in a conflict of interest situation from the share pledge perspective.

1. Introduction

The *Guidelines on Share Pledge Repo Transaction, Registration and Settlement*, which came into effect in May 2013, enable securities companies to engage in share pledges in China's capital market. According to Wind statistics, 45 percent of these listed firms have shareholders who pledged their shares as collateral to raise funds from securities companies. These companies have become the most important pledgees after financial institutions such as banks and trusts. The strategies used by controlling shareholders to avoid losing control rights during the share pledge period, such as share repurchase, information disclosure strategies, earnings management, tax avoidance, and cash holding policies, have been extensively discussed (Chan et al., 2015; Huang and Xue, 2016; Wang et al., 2018; Qian and Zhang, 2018), but limited evidence has been given for the effect and economic consequences of Share Pledge Repo Transactions. The research has mainly focused on pledgors or pledges from the perspectives of share pledge firms and not from those of the pledgees. The implementation of the Share Pledge Repo Transaction provides a useful context in which this unresolved issue can be examined. When securities companies engage in share pledges, the affiliated analysts as the information intermediaries issue research reports for these share pledge firms in the capital market. In this situation, the influence on the stock recommendation behavior of these analysts is a concern. Do affiliated analysts use their connections to obtain more private information and disclose conservative rating reports? Or is there a conflict of interest between affiliated analysts and share pledge firms, so that the analysts issue optimistic rating reports to help share pledge firms avoid the risk of stock price crashes? The evidence on this topic is currently limited. In this study, we provide empirical evidence on the relationship between affiliated analysts' stock recommendation behavior and share pledge firms.

Analysts are important information intermediaries in the capital market, and they thus have professional advantages and can extensively mine information. The rating reports they issue inform investors' decision-making, which improves the efficiency of information transmission and stock price sensitivity. When compiling their reports, analysts process public and private information that investors can use to make decisions. Firm-level information is an important source for analysts, so the quality of their rating reports is directly determined by their understanding and mastery of the firms' information. Share pledging as an activity conducted by shareholders can provide them with financing convenience, but also means the firm may risk losing control. To avoid the risk of a stock price crash, the share pledge firm may increase its risk-taking (Anderson and Puleo, 2015) and thus withhold bad news and increase information opacity. If affiliated analysts' securities companies accept the pledged shares of shareholders, can this connection between the analysts and the firms whose shares are pledged help the analysts gain more information about the firms and thus decrease their stock recommendation deviation? The *Guidance of Information Barrier System of Securities Companies* requires securities companies to establish information barrier systems against advisory service businesses, underwriting, investment banking, and research, but in practice, brokers have not effectively established these isolation measures, and their affiliated departments can still share information (Cao and Zhu, 2011). In addition, affiliated analysts gain advanced information about target firms, as research department analysts must provide industry, liquidity, profitability, and other information about the firms when assessing the Share Pledge Repo Transaction business, which to an extent helps alleviate information asymmetry. Thus, this information superiority means that affiliated analysts can issue more conservative stock recommendations for share pledge firms.

However, the independence of analysts can be questionable. They may have a close personal relationship with listed firms and may thus issue optimistic rating reports to gain more private information, which is

beneficial to managers (Francis and Philbrick, 1993; Das et al., 1998; Lim, 2001). Analysts may also selectively release optimistic rating reports on listed firms due to conflicts of interest in areas such as investment banking, sub-warehouse commissioning, and proprietary businesses (O'Brien et al., 2005; Mola and Guidolin, 2009). Control rights can provide controlling shareholders with dividends and other private benefits (Johnson et al., 2000). These potential benefits lead to shareholders of listed firms having control rights preferences. When controlling shareholders use their shares as collateral to obtain short-term loans, they are subject to margin calls, as the stock prices may fall below the desired level (Chan et al., 2015). When the market value of pledged shares drops below the maintenance requirement stated in the pledge contract, the pledgees can sell the shares. This forced sale can be very costly to controlling shareholders as they may lose their control rights. Thus, under external pressure, affiliated analysts are motivated to consider the listed firms and issue optimistic rating reports. These contribute to the market value management of share pledge firms and can lead to more private information from listed firms in the future. Share pledge business is also the basis of cooperation between securities companies and listed firms, which is conducive to the expansion of other securities businesses. The limited market resources make the securities companies face the pressure of competition, and the desire of securities companies to extend their businesses can lead affiliated analysts to issue optimistic rating reports on share pledge firms. Thus, the notion of conflicts of interest indicates that stock recommendations issued by these analysts for share pledge firms are more optimistic.

On the basis of the above analysis, we examine whether the relationship between securities companies and target share pledge firms can affect affiliated analysts' stock recommendation behavior. If so, can the behavior of affiliated analysts be explained by information superiority or by conflicts of interest?

Using A-share listed firms in China capital market from 2013 to 2017, we find that the stock recommendations of affiliated analysts on share pledge firms are more optimistic than those of non-affiliated analysts, and the affiliated analysts are more likely to issue Buy and Add recommendations, which suggests that they have issued optimistic rating reports on share pledge firms. We also find a dynamic adjustment of the stock recommendation behavior of affiliated analysts. The probability that affiliated analysts will issue optimistic stock recommendations is significantly reduced before and after the years in which the affiliation relationship between securities companies and share pledge firms began and ended. Thus, our findings support the hypothesis of conflicts of interest.

However, these findings may be due to information asymmetry between affiliated analysts and share pledge firms. To ensure this is not the case, we use the following methods to measure information asymmetry and examine whether affiliated analysts with more private information about share pledge firms can reduce the optimism of stock recommendations. First, site visits are found to be an important information acquisition activity for analysts, as they can communicate and interact with the managers face to face, which can enable them to acquire more private information about listed firms. Thus, corporate site visits can help affiliated analysts alleviate the information asymmetry with share pledge firms and improve the quality of their rating reports (Cheng et al., 2016). Second, according to new theories of economic geography, geographic proximity affects the efficiency of information transmission between different firms. The proximity between analysts and listed firms can affect the cost of the analysts' access to information of listed firms. Geographically proximate analysts possess an information advantage over others, and their earnings forecasts are thus more accurate (Malloy, 2005; Bae et al., 2008; O'Brien and Tan, 2015). Therefore, if the workplaces of affiliated analysts are located in the same provinces as the share pledge firms, they have better access to private information about the firms and issue more accurate earnings forecasts. Third, star analysts who have a better grasp of useful information from public or private domains can provide more accurate rating reports. They can also remain independent under the constraint of the reputation mechanism and can avoid the pressure from share pledge firms to improve the quality of their rating reports (Stickel, 1992; Jackson, 2005). Last, the information environment provided by listed firms determines the difficulty analysts face in obtaining information from them. The higher the information transparency of share pledge firms, the easier it is for affiliated analysts to acquire such information, and thus the information asymmetry between affiliated analysts and listed firms is reduced. We find that even if affiliated analysts have visited these share pledge firms, work in the same location as them, or are star analysts listed as one of the "top five analysts" by New Fortune, or if the information transparency of the firms is high, the analysts' stock recommendation behavior remains optimistic. This also supports our conflict of interest hypothesis.

Although we have eliminated the possibility of information asymmetry, our finding that affiliated analysts issue optimistic stock recommendations when their securities companies engage in share pledges and are pledgees of the share pledge firms could be due to the connections between securities companies' other business involvements and these firms, as this could affect the stock recommendation behavior of affiliated analysts. To eliminate any interference from the additional connections of affiliated analysts, we remove from our data share pledge firms that have relationships with affiliated analysts via the investment banking, sub-warehouse commissions, and proprietary businesses of securities companies (O'Brien et al., 2005; Bessler and Stanzel, 2009; Cao and Zhu, 2011). After eliminating the sample with these conflicts of interest, our findings are still valid. Our tests show that the information asymmetry between affiliated analysts with share pledge firms and the connections between other businesses of securities companies with share pledge firms does not influence our conclusion, and that the interest conflict caused by share pledge financing affects the independence of affiliated analysts, and leads to their optimistic stock recommendations for the firms.

Based on this, we further examine the stock recommendation behavior of affiliated analysts in different scenarios. First, we divide the sample into high ratio vs. low ratio groups of pledged shares and expect to find that the influences of affiliated analysts' stock recommendation behavior in the two groups differ. The controlling shareholders who pledge most of their shares to securities companies are usually subject to more pressure from margin calls, as the stock prices may fall below the desired level and the shares that they hold cannot meet the demand to make up the drop in stock price (Chan et al., 2015). We expect the stock recommendation behavior of affiliated analysts to be more optimistic and radical in the high-share pledge ratio sample than in the low ratio sample. Our empirical results show that affiliated analysts are positively associated with the likelihood of stock recommendations for the high-share pledge ratio firms. Second, we test the effect of downward stock price pressure on affiliated analysts' stock recommendation behavior. The share pledge firms are faced with the threat of maintaining the stock price under downward pressure in China's capital market, which can prompt affiliated analysts to issue optimistic rating reports and help share pledge firms effectively manage the market value. We follow the stock market cycle measurement method of Kao et al. (1998), and define an upward trend as when the monthly average stock returns in the past 12 months are greater than 0, as the stock price is increasing, and an average of less than 0 as a downward trend, as the price is decreasing. We expect the stock recommendation behavior of affiliated analysts to be more optimistic when the stock price is following a downward trend. We also find that the association between affiliated analysts and the likelihood of stock recommendation is stronger when the stock price displays a downward rather than an upward trend.

Stock recommendations only include five categories: "Sell," "Reduce," "Neutral," "Add," and "Buy." The recommendation behavior of affiliated analysts cannot be quantitatively explained from this, as the level of subjectivity is too high. Further analyses show that if the earnings forecast quality is low, the bias of earnings forecasts is higher and the accuracy lower. From both quantitative and qualitative perspectives, our results show that affiliated analysts issue optimistic rating reports for share pledge firms.

We also examine the economic consequences of affiliated analysts' optimistic stock recommendations. We find that their optimistic behavior makes them more likely to upgrade or maintain rather than downgrade their stock recommendations for share pledge firms. The Buy recommendations issued by non-affiliated and affiliated analysts can lead to cumulative excess returns in the short event window. However, the cumulative excess returns of Buy recommendations issued by affiliated analysts are significantly negative in the long-term event window and significantly lower than those issued by non-affiliated analysts. This finding shows that investors do not recognize the optimistic behavior of affiliated analysts in the short event window, and that analysts' independence can only be identified after long-term market correction. Thus, the stock recommendations of affiliated analysts can significantly reduce the stock price crash risk of share pledge firms.

Our study makes several contributions to the literature. First, we contribute to share pledge research from the perspective of the Share Pledge Repo Transaction. The literature regards the share pledge as homogeneous, and most studies compare the differences between share pledge and non-share pledge firms (Chan et al., 2015; Qian and Zhang, 2018), thus ignoring the heterogeneity of share pledges. The implementation of the Share Pledge Repo Transaction provides us with a context through which we can overcome previous difficulties, and with a new perspective for understanding the heterogeneity of share pledges.

Second, we extend the research into share pledges from the perspective of the pledgee. The literature has extensively examined the effect of share pledges on the pledgor and corporate behavior at the firm level, such

as share repurchasing, information disclosure strategies, earnings management, tax avoidance, and cash holding policies (Chan et al., 2015; Huang and Xue, 2016; Wang et al., 2018; Singh, 2017). However, few studies have examined the effect of share pledges on pledgees' behavior. We examine this effect on analysts' behavior through the context of securities companies that conduct Share Pledge Repo Transactions and thus become pledgees. Our study thus extends the research into the economic consequences of share pledges and enriches the literature about share pledge from the perspective of the pledgee.

Last, we provide an interpretation of the conflicts of interest of analysts and thus extend the literature on analyst independence, which has previously been examined through the relationships of investment banking, sub-warehouse commissions, and the proprietary business of securities companies (Michaely and Womack, 1999; O'Brien et al., 2005; Bessler and Stanzel, 2009; Cao and Zhu, 2011; Xue, 2017). By examining the behavior of affiliated analysts from the perspective of share pledge financing, we provide new evidence that the conflict of interest between analysts and listed firms can affect analyst independence. Our finding increases the understanding of analysts' behavior from the perspective of share pledges.

Our study also has significance for regulators. Our findings show that the information barrier system among securities companies is not effectively implemented in practice, and the Share Pledge Repo Transaction has become a new cause of conflicts of interest for securities companies, as it affects the independence of their affiliated analysts. Thus, our conclusions are also of value to regulators of Share Pledge Repo Transactions and securities companies. Our findings also support the evidence of Xie et al. (2016), who found that the share pledges of controlling shareholders increase the risk of stock price crashes, but they did not identify the channel through which share pledges affect such a risk. Our study shows that investors fail to identify the optimistic stock recommendations of affiliated analysts for share pledge firms in a short event window, which affects their investment decisions, thus to some extent decreasing the stock price crash risk of share pledge firms.

The remainder of this paper is organized as follows. Section 2 provides a literature review and presents our hypotheses. We describe our data and model in Section 3. The empirical results and robustness tests are provided in Section 4. Section 5 provides further analysis. Section 6 concludes the paper.

2. Literature review and hypothesis development

2.1. Literature review

2.1.1. Related literature on the economic consequences of share pledge

Share pledging is a type of debt financing method in which shareholders pledge their shares to banks, trusts, or other financial institutions and obtain loans, which helps them obtain financing rapidly, on the premise of retaining control rights. However, share pledges separate the control rights and cash flow rights of shareholders, and increase the agency conflict between the controlling shareholder and other shareholders and the risk-taking of the share pledge firms (Anderson and Puleo, 2015). Shareholders are also subject to margin calls, as stock prices may fall below the desired level, thus increasing the financial pressure from insiders who may use the controlled resources of listed firms to save themselves (Chan et al., 2015). The behaviors of controlling shareholders who pledge their shares thus affect both the interests of external shareholders and the value of the firms (Dou et al., 2017; Singh, 2017).

In addition, controlling shareholders can risk losing their control rights through share pledges. If during the share pledge period, stock prices drop below the mandatory liquidation level, controlling shareholders must provide additional collateral or terminate the pledged shares early; otherwise, the pledgees are forced to sell the pledged shares and controlling shareholders can lose their control rights. Controlling shareholders are motivated by the risk of a stock price crash to influence information disclosure decisions by listed firms, to release good news, and to withhold bad news (Qian and Zhang, 2018). The motivation of controlling shareholders also drives the income smoothing and earnings management of share pledge firms (Huang and Xue, 2016). However, as these firms are supervised by creditors, they prefer real earnings management over accrual earnings management. Although the firms may use performance methods to avoid the risk of stock price crashes, they are more likely to use market value management methods, such as high stock dividends and stock repurchasing, to stabilize stock prices (Chan et al., 2015), and their motivation to address the stock price crash risk by holding cash also significantly increases.

However, these risk avoidance activities can lead to a decrease in information quality and accounting conservatism, and to prevent highly uncertain R&D investment activities from affecting their pledged shares, controlling shareholders will inhibit the innovation investment of share pledge firms (Li et al., 2018). The activities can also damage the interests of minority shareholders and affect the value of listed firms. Rational auditors will, as information authenticators, increase their audit input, charge higher risk premiums, and be more likely to issue non-standard audit reports (Zhai et al., 2017).

2.1.2. Related literature on the stock recommendation behavior of analysts

Analysts are important information intermediaries in the capital market and rely on their professional knowledge and ability to issue rating reports on listed firms through information collection, processing, and sorting. This increases the information transparency of listed firms and improves the allocation efficiency of the capital market. Although some access public information, most analysts use information from listed firms, which determines the quality of their rating reports. Thus, issuing preferential rating reports for listed firms benefits both parties, which can be achieved by analysts conducting conference calls or site visits with managers of the listed firms, as this provides them with superior private information about earnings (Mayew et al., 2013; Cheng et al., 2016).

Affiliated analysts have been found to be more likely to issue optimistic stock recommendations when driven by conflicts of interest (O'Brien et al., 2005; Bessler and Stanzel, 2009). They will upgrade Buy and Add recommendations significantly faster and are slower to downgrade Sell and Reduce recommendations (O'Brien et al., 2005). However, investors are more negative in their responses to optimistic stock recommendations issued by affiliated analysts (Michaely and Womack, 1999). Xue (2017) found that affiliated analysts with information superiority issue optimistic stock recommendations because of the conflict of interest between these analysts and listed firms, but non-affiliated analysts are less likely to issue optimistic stock recommendations. Gu et al. (2013) found that affiliated analysts are more inclined to issue optimistic stock recommendations to support the stocks held by institutional investors as they can gain higher commission fees. Affiliated analysts also issue optimistic recommendations for the stocks owned by their proprietary business, but the excess return for investors in their stocks is lower (Cao and Zhu, 2011).

2.2. Hypotheses

Although share pledging is a type of debt financing activity, it is closely related to the capital market because shares of listed firms are pledged. During the share pledge period, if the stock price drops below the mandatory liquidation level, the controlling shareholder must provide additional collateral or terminate the pledged shares early, or the shares must be sold, and the controlling shareholders can lose their control rights. Thus, share pledging increases the risk-taking of the share pledge firms (Anderson and Puleo, 2015). To avoid losing control rights, share pledge firms with controlling shareholders typically disclose strategic information, manipulate earnings, and engage in market value management activities. Qian and Zhang (2018) found that if controlling shareholders use the advantages of control rights, they create an entrenchment effect during the period of the share pledge, which affects the information disclosure behavior of share pledge firms, and they are motivated to issue good news and withhold bad news. This results in a decrease of information disclosure quality and an increase in the probability of information disclosure violations. Huang and Xue (2016) found that the share pledges of controlling shareholders increase the level of earnings management of their firms, but external creditors' supervision makes the firms more likely to conceal their real earnings management activities than to engage in accrual earnings management activities. Share pledge companies are also more likely to dynamically adjust their accounting policies for R&D expenditure projects and capitalize such projects that should have been expensed, to manipulate earnings (Xie et al., 2017). The information used becomes more opaque through these activities.

Listed firms can provide both financial and nonfinancial information to analysts who issue stock recommendations. These analysts also use other information about macro-economies, capital markets, investor sentiment, and market indexes, which unlike firms' financial information cannot be directly quantified. Stock recommendations only have the five categories of "Sell," "Reduce," "Neutral," "Add," and "Buy," so directly quantifying them is difficult, as they are highly subjective. Thus, the information collected from listed firms

directly determines the quality of the rating reports issued by analysts. However, market value management behavior reduces the information quality and increases the information opacity of share pledge firms, which to an extent hinders analysts in accessing the information of listed firms. In addition, firms only release good news and withhold bad news during the period of the share pledge so that analysts cannot reveal any bad news in time, resulting in earnings forecast bias. Securities companies that accept the pledged shares of shareholders can contribute to the development of the relationship between affiliated analysts and share pledge firms, which can help affiliated analysts break through the information barrier and enhance their ability to obtain firm information. Although the *Guidance of Information Barrier System of Securities Companies* requires securities companies to establish information barrier systems in their advisory services, underwriting, investment banking, and research, brokers have not as yet established effective isolation measures among these businesses in practice, and the firewall systems in securities companies have not been effectively implemented, so the affiliated departments can still share information (Cao and Zhu, 2011). Therefore, unlike non-affiliated analysts, affiliated analysts can use the channel provided by securities companies that accept the pledged shares of shareholders to alleviate the information asymmetry between them and the firms, thus improving the quality of their rating reports.

Sell-side analysts seek career promotions to improve their reputations and increase their compensation, and so being selected as a star analyst is important for them, and the quality of the rating reports they provide can help determine whether they should be selected. Analysts concerned about their reputation and their future careers are thus motivated to provide more accurate rating reports (Hong and Kubik, 2003) through various information channels to gain competitive advantages in the selection of star analysts. Thus, based on the hypothesis of information superiority, we assume that the association between affiliated analysts and stock recommendation is negative, and that the rating reports issued by affiliated analysts are more accurate than that of non-affiliated analysts.

H1: The stock recommendations issued by affiliated analysts are more conservative than those of non-affiliated analysts.

However, the investment rating activities of affiliated analysts can suffer from independence problems caused by conflicts of interest with listed firms. The information sources that analysts rely on for their rating reports are not only public, as they can also establish private relationships with the managers of listed firms. To maintain these relationships and gain more information in the future, analysts may issue optimistic reports to satisfy the needs of the listed firms and their managers (Francis and Philbrick, 1993; Das et al., 1998; Lim, 2001). Francis and Philbrick (1993) found that analysts are more likely to issue optimistic reports to improve their relationships with managers of listed firms, which may have been damaged due to the early issuance of adverse rating reports. Ke and Yu (2006) found that rating reports that comply with managers' requirements can provide analysts with more opportunities to ask questions in conference calls and help them gain more private information. In addition, the more optimistic the rating reports issued by analysts, the more private information they can obtain (Chen and Matsumoto, 2006; Mayew, 2008; Mayew et al., 2013). Zhao et al. (2013) found that there is demand on the stock prices of listed firms involved in IPO and SEO processes and that analysts who cooperate with them issue optimistic rating reports. They are rewarded with more private information from the firms, enabling them to issue more accurate rating reports in the future.

Control rights are important for controlling shareholders, as such rights can provide opportunities for more private interests, so they will try their best to prevent the stock price from falling below the mandatory liquidation level in an attempt to prevent the loss of their control rights. The pressure of maintaining the stock price motivates controlling shareholders to collude with affiliated analysts and encourage them to issue optimistic rating reports. The analysts are also more inclined to issue optimistic rating reports to meet the stock price demand and to obtain more private information about the listed firms in the future.

In addition, affiliated analysts also face conflicts of interest with securities companies, which are responsible for reducing the risk of share pledge payment. Due to the special status of controlling shareholders, the shares they hold are generally restricted and can only be sold under special conditions. Therefore, the liquidity of pledged shares by controlling shareholders is relatively lower. Even if there is a risk of the stock price dropping below the mandatory liquidation level, they must be disposed of through lawsuits, auctions, or OTC transactions. The *Guideline of the CSRC on the Reduction of Shares Held by Shareholders, Directors, Supervisors and Senior Executives* also requires the new regulation on the reduction of controlling shareholders' shares to be

implemented if the shares of controlling shareholders are sold due to the implementation of the share pledge agreement. This new rule means that the number of controlling shareholders' shares that can be sold in the capital market is far lower than the number for mandatory liquidation. Thus, securities companies that want to force the selling of shares that are subject to mandatory liquidation are more cautious due to concerns about financial security and customer relationships. If a large number of shares are sold in the capital market, the stock price will fall, and selling more will result in the price dropping more, which leads to systematic financial risks. The behavior of forced selling will damage the interests of securities companies, shareholders, listed firms, and other stakeholders. Thus, in practice securities companies generally continue to hold the pledged shares whose stock prices drop below the mandatory liquidation level and write down impairment, instead of conducting direct forced selling of shares. The potential risk of share pledging is essentially transferred to financial institutions such as securities companies. To avoid the loss caused by share pledges, securities companies are motivated to require their affiliated analysts to issue optimistic rating reports to manage the market value of share pledge firms and meet the demands of the stock price.

In addition, the internal conflicts of interest in securities companies prompt affiliated analysts to issue biased rating reports. Although the risk in the share pledge business is generally higher and the return lower, the share pledge financing business of securities companies is booming, mainly because it is the key to cooperation between securities companies and listed firms, and thus conducive to the expansion of investment banking, M&A, asset management, brokerage businesses, and other activities of securities companies. The lack of internal firewall systems in securities companies means that the independence of the analysts' research conflicts with the profit-creating businesses of securities companies such as underwriting, M&A, asset management, and brokerage. The limited resources of the securities market means that these companies face the pressure of competition. To maintain the relationship between securities companies and share pledge firms, affiliated analysts issue optimistic rating reports for share pledge firms at the request of the securities companies that wish to extend their business. Thus, they issue more optimistic reports due to the internal pressure to build a stable customer relationship and obtaining more business resources (Lin and McNichols, 1998; Mola and Guidolin, 2009; Ljungqvist et al., 2009). The affiliated analysts then face double the conflicts of interest from the internal securities companies reducing the risk of share pledge repayment and extending their business resources. Thus, based on the conflict of interest hypothesis, we assume that the stock recommendations issued by affiliated analysts for share pledge firms are more optimistic.

H2: The stock recommendations issued by affiliated analysts are more optimistic than those of non-affiliated analysts.

3. Research design

3.1. Data and sample selection

Our sample consists of all of the firms listed in the Shanghai and Shenzhen Stock Exchanges over the period of 2013 to 2017. The *Guidelines on Share Pledge Repo Transaction, Registration and Settlement*, which came into effect in May 2013, allow securities companies to engage in share pledging in China's capital market. In our study, securities companies constitute the pledgees and we must match them with their affiliated analysts, so the starting year of our sample is 2013. The data are at the analyst level. However, one analyst may issue more than one rating report for a listed firm in one year. We retain only the latest rating reports and drop other data because analysts will update their reports based on the information obtained over time, and only the latest reports fully reflect the behavior of analysts. After excluding financial firms and firms with missing financial information, our final sample consists of 122,110 analyst-firm-year observations.

The share pledge data in our study are derived from the Wind database, and the analyst data from the RESSET database. The data for analysts' site visits are hand-collected from the information disclosure platform of the Shenzhen Stock Exchange, and other data are obtained from the China Stock Market and Accounting Research (CSMAR) database. All continuous variables are Winsorized at the 1% and 99% levels.

3.2. Model

We examine the stock recommendation behavior of affiliated analysts in a (order) probit model in Equation (1).

$$\begin{aligned} Rec = {} & \alpha + \beta_1 Affiliated\_Analyst + \beta_2 Analyst\_Num + \beta_3 Institution + \beta_4 Age \\ & + \beta_5 Size + \beta_6 Lev + \beta_7 ROA + \beta_8 MB + \beta_9 Turnover + \beta_{10} Experience \\ & + \beta_{11} Brokersize + \beta_{12} Day + Brokerfixedeffect + Yearfixedeffect + \varepsilon \end{aligned} \quad (1)$$

Rec is the placeholder for the two explanatory variables capturing stock recommendations. The stock recommendations are divided into the five categories of Sell, Reduce, Neutral, Add, and Buy. We define the indicator variable Rec_1 and assign the values of Rec_1 as 5, 4, 3, 2, and 1, to represent the stock recommendations of Buy, Add, Neutral, Reduce, and Sell, respectively. The larger the Rec_1 value, the more optimistic the stock recommendations. We then combine the Buy and Add rating reports into a positive rating reports category, and the Neutral, Reduce, and Sell reports into a negative rating reports category. We use the indicator variable Rec_2, which takes the value of 1 if a rating report is positive and 0 otherwise.

Affiliated_Analyst is an explanatory variable that equals 1 if shares of a listed firm are pledged by controlling shareholder to securities companies, and their analysts issue rating reports on the firms, and 0 otherwise. For example, the controlling shareholder of Orient Landscape (Stock Code 002310), Ms. Qiaonv He, pledged 17.83 million shares, accounting for 1.60% of the shares she held, to the Industrial Securities company using the Share Pledge Repo Transaction in April 2017. Jie Meng, an analyst for the Industrial Securities company, issued a rating report for Orient Landscape on October 26, 2017, and the stock recommendation was to Buy. Thus, Jie Meng is connected to Orient Landscape through the Share Pledge Repo Transaction business of the Industrial Securities company. We define Jie Meng as an affiliated analyst during the period of the share pledge by the controlling shareholder of Orient Landscape. Our data show that 26.9% of analysts were affiliated between 2013 and 2017. Table 1 summarizes the sample of affiliated analysts and reports the sample distribution of stock recommendation by year.

To eliminate the interference from any information asymmetry between affiliated analysts with share pledge firms, we use site visits, geographic proximity, star analysts, and information environment to measure such asymmetry, and we examine whether affiliated analysts with more private information about share pledge firms provide less optimistic stock recommendations. If an analyst visits a listed firm, the value of *Visiting* is 1, and 0 otherwise. If the workplaces of affiliated analysts are located in the same provinces as the share pledge companies, they have easier access to private information and issue more accurate earnings forecasts. The value of *Location* is thus 1, and 0 otherwise. If analysts are listed as star analysts, the value of *Star* is 1 and

Table 1
Sample distribution.

Panel A: Distribution of Affiliated Analysts by year

Year	Full Sample	No. of Affiliated Analysts	%
2013	29,648	2703	9.1
2014	25,759	6036	23.4
2015	26,494	8438	31.9
2016	19,306	7366	38.2
2017	20,903	8258	39.5
Total	122,110	32,801	26.9

Panel B: Distribution of Stock Recommendations by year

Year	Buy	Add	Neutral	Reduce	Sell
2013	10,092	17,622	1860	15	59
2014	10,606	13,781	1280	13	79
2015	14,185	11,412	820	9	68
2016	10,350	8553	359	3	41
2017	12,110	8539	252	0	2
Total	57,343	59,907	4571	40	249

0 otherwise. We also use the earnings quality, calculated by the DD model (Dechow and Dichev, 2002), as the proxy variable of information transparency (*AQ*).

We use control variables previously identified in the stock recommendations literature (Lin and McNichols, 1998; Michaely and Womack, 1999; Barber et al., 2006; O'Brien and Tan, 2015). We include the natural logarithm of the firm's total assets at the end of year *t* (*Size*) to capture the effects of size. Firm age (*Age*) captures the maturity level of the firm, and we use the natural logarithm of the number of years since the firm has been publicly traded. *Lev* captures the financial leverage of the firm and is measured as the ratio of total debt to total assets. *ROA* proxies for the financial performance, calculated as the income before extraordinary items scaled by total assets at year t. Market value-to-Book value (*MB*) captures the growth of the firm and we use the ratio of market value to book value of equity as the measurement. *Turnover* captures the turnover rate of stock in the capital market and is measured as the ratio of the trading shares to tradable shares. *Analyst_Num* proxies for the demand from information intermediaries and is measured as the logarithm of the number of analysts who provide earnings forecasts for year *t* plus 1. We include institutional ownership (*Institution*), measured as the ratio of shares by investors to total shares, to capture the demand for information by investors. *Brokersize* is a variable that captures the effects of the size of securities companies and is measured by the natural logarithm of the size. *Experience* proxies for the work experience of analysts and is calculated as the relative work experience of all analysts. *Day* captures the analyst forecast days and is measured by the natural logarithm of the days between the date the rating report was issued and the date the annual report was released. We also include the broker and year fixed effects to remove the influences of broker and year on the estimation of the coefficients on the affiliated analyst variable. All of the variables are defined in Table 2.

Table 2
Variable definitions.

Variable	Definition
Rec_1	A discrete numeric value variable equal to 5, 4, 3, 2, or 1, which represents that the stock recommendation is Buy, Add, Neutral, Reduce, or Sell, respectively
Rec_2	A dummy variable equal to 1 for an analyst that issues a Buy or Add rating report and 0 indicates that the stock recommendation is Neutral, Reduce, or Sell
CAR(−2, +2)	The cumulative excess return in a short-term window (−2, +2)
CAR(+3, +60)	The cumulative excess return in a long-term window (+3, +60)
Affiliated_Analyst	A dummy variable that equals 1 if a firm's shares are pledged by a controlling shareholder to securities companies and their analyst issues a rating report on the share pledge firm, and 0 otherwise
Visiting	A dummy variable that equals 1 if an analyst visits the listed firm, and 0 otherwise
Location	A dummy variable that equals 1 if an analyst's workplace is located in the same province as the share pledge company, and 0 otherwise
Star	A dummy variable that equals 1 if an analyst is listed as a star analyst, and 0 otherwise
AQ	The earnings quality calculated by the DD model
Analyst_Num	The log (1+ the number of analysts who issue earnings forecasts for the firm at year t)
Institution	The ratio of total shares held by institutional investors
Age	The natural logarithm of the number of years from the beginning of year t since the firm's A-shares were publicly traded in the Chinese exchanges
Size	The natural logarithm of total assets
Lev	The ratio of total debt to total assets
ROA	Income before extraordinary items divided by total assets
MB	The ratio of the market value of equity to the book value of equity
Turnover	The ratio of total trading volume scaled by total tradable shares
Brokersize	The natural logarithm of securities companies' size
Experience	The relative work experience among all analysts
Day	The natural logarithm of the days between the date the rating report was issued and the date the annual report was released

4. Empirical results

4.1. Descriptive statistics

Table 3 provides the descriptive statistics for our variables. Panel A reports the summary statistics. Among the rating reports issued by analysts, 96.0% have the value of 1 for the Rec_2 variable, and the mean value of Rec_1 is 4.425, suggesting that 96.0% of stock recommendations in rating reports are Buy and Add in our sample, which shows that analysts are more likely to issue Buy and Add stock recommendations rather than negative rating reports such as Sell or Reduce.

The cumulative abnormal return (*CAR*) of stock recommendations issued by analysts in a short-term window [-2, +2] is 0.011, and the *CAR* value in a long-term window [+3, +60] is −0.060, which indicates that the rating reports can bring abnormal positive returns in the short-term window, but the returns in the long-term window are significantly negative.

We find that 26.9% of sample have the value of 1 for the *Affiliated_Analyst* variable, which is thus the percentage of affiliated analysts in our sample, suggesting sufficient variation in our explanatory variables for the empirical tests. Of the listed firms in the Shenzhen Stock Exchange, 71.2% are visited by analysts. The workplaces of 11.0% of analysts are located in the same province as their share pledge firms. In the New Fortune selection, 19.6% of analysts are selected as star analysts.

Panel B presents the results of our univariate tests. The sample is divided into the two sub-samples of affiliated and non-affiliated analysts. The mean and median values of the main test variables in the two groups are

Table 3
Descriptive statistics.

Panel A: summary statistics

Variable	N	Mean	Min	25th	Median	75th	Max	Std
Rec_1	122,110	4.425	1	4	4	5	5	0.588
Rec_2	122,110	0.960	0	1	1	1	1	0.195
CAR(−2, +2)	107,913	0.011	−0.483	−0.031	0.003	0.044	0.634	0.078
CAR(+3, +60)	107,884	−0.060	−2.674	−0.243	−0.048	0.131	1.712	0.335
Affiliated_Analyst	122,110	0.269	0	0	0	1	1	0.442
Visiting	80,699	0.712	0	0	1	1	1	0.448
Local	122,110	0.110	0	0	0	0	1	0.320
Star	122,110	0.196	0	0	0	0	1	0.389
AQ	122,110	0.060	0.001	0.020	0.043	0.080	0.290	0.057
Size	122,110	22.771	20.488	21.792	22.540	23.478	26.999	1.357
Lev	122,110	0.428	0.069	0.270	0.421	0.580	0.848	0.198
ROA	122,110	0.063	−0.060	0.032	0.056	0.089	0.211	0.048
Age	122,110	2.174	0.693	1.609	2.197	2.773	3.178	0.645
MB	122,110	2.445	0.182	1.070	1.938	3.224	9.757	1.955
Turnover	122,110	4.567	0.458	2.174	3.672	6.025	16.007	3.232
Return	122,110	0.319	−0.488	−0.089	0.198	0.579	2.485	0.569
Brokersize	122,110	3.628	1.609	3.258	3.738	4.043	4.682	0.631
Experience	122,110	−0.183	−2.794	−1.654	−0.650	1.289	3.339	1.715
Day	122,110	5.361	4.369	5.030	5.357	5.778	6.116	0.425
Institution	122,110	0.080	0.004	0.032	0.059	0.095	0.570	0.087
Analyst_Num	122,110	2.561	1.099	2.197	2.639	2.944	3.526	0.540

Panel B: univariate tests

Variable	Affiliated analysts group			Non-affiliated analysts group			T-value	Z-value
	N	Mean	Median	N	Mean	Median		
Rec_1	32,801	4.499	5	89,309	4.439	4	26.60***	24.43***
Rec_2	32,801	0.981	1	89,309	0.953	1	22.35***	22.31***

This table presents the descriptive statistics. Panel A reports the summary statistics of all variables. Panel B presents the results of univariate tests. The t-statistics (z-statistics) are based on difference tests of mean value (median value) in the affiliated vs. non-affiliated analyst groups. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels.

given and the differences are calculated and tested. The mean value of stock recommendations issued by affiliated analysts is 4.499, and that of those issued by non-affiliated analysts is 4.439, suggesting that stock recommendations are significantly higher at the 1% level in the affiliated analysts group than in the non-affiliated analysts group. In our sub-sample, 98.1% of stock recommendations in the rating reports issued by affiliated analysts are Buy and Add, compared to only 95.3% of those issued by non-affiliated analysts. Thus, a significant difference between the two groups is found at the 1% level. The results of our univariate tests show that the stock recommendations issued by affiliated analysts are more optimistic than those of non-affiliated analysts.

4.2. Results

4.2.1. The effect of affiliated analysts on stock recommendations

Table 4 reports the estimation results of Equation (1). The affiliated analyst variable is significantly positively associated with the two stock recommendation variables. In column (1), the coefficient on *Affiliated_Analyst* is 0.101 with a z statistic of 4.35, and thus strongly significantly positive in a two-tailed test at the 1% level. Column (2) shows that the coefficient on *Affiliated_Analyst* is 0.220, with a z statistic of 4.30, which is significantly positively associated with stock recommendation at the 1% level. The marginal effect of affiliated analysts

Table 4
The effect of affiliated analysts on stock recommendations.

	(1)	(2) Full sample	(3)	(4) Sub-sample 1	(5)	(6) Sub-sample 2
	Rec_1	Rec_2	Rec_1	Rec_2	Rec_1	Rec_2
Affiliated_Analyst	0.101***	0.220***	0.088***	0.189***	0.122***	0.249***
	(4.35)	(4.30)	(2.94)	(3.14)	(4.61)	(4.41)
Size	0.006	−0.074***	0.027	−0.063	0.014	−0.057**
	(0.40)	(−2.68)	(1.01)	(−1.29)	(0.83)	(−1.97)
Lev	0.436***	0.742***	0.246**	0.443*	0.392***	0.658***
	(5.14)	(4.40)	(2.22)	(1.75)	(4.12)	(3.42)
ROA	4.131***	7.874***	3.321***	5.951***	4.355***	8.485***
	(12.31)	(11.20)	(7.58)	(6.21)	(11.38)	(10.21)
Age	−0.057**	−0.096**	−0.049	−0.022	−0.059**	−0.106**
	(−2.54)	(−2.13)	(−1.58)	(−0.38)	(−2.35)	(−2.04)
MB	−0.034***	−0.050***	−0.021	−0.024	−0.043***	−0.069***
	(−3.71)	(−2.70)	(−1.60)	(−0.78)	(−4.62)	(−3.71)
Turnover	0.007*	0.018**	−0.001	0.007	0.010**	0.027***
	(1.76)	(2.04)	(−0.15)	(0.64)	(2.18)	(2.68)
Return	0.186***	0.268***	0.113***	0.186**	0.189***	0.265***
	(9.33)	(5.71)	(4.06)	(2.57)	(8.49)	(5.19)
Brokersize	0.284***	0.221***	0.248***	0.233*	0.283***	0.237**
	(7.68)	(2.62)	(4.30)	(1.86)	(6.91)	(2.44)
Experience	−0.008*	−0.006	−0.008	−0.018	−0.006	−0.001
	(−1.92)	(−0.67)	(−1.23)	(−1.33)	(−1.34)	(−0.08)
Day	−0.226***	−0.231***	−0.220***	−0.187***	−0.219***	−0.243***
	(−13.60)	(−6.91)	(−9.31)	(−3.49)	(−11.46)	(−6.29)
Institution	0.172	0.168	1.141***	2.552***	0.092	−0.025
	(1.03)	(0.55)	(3.64)	(3.72)	(0.54)	(−0.08)
Analyst_Num	0.194***	0.318***	0.141***	0.262***	0.203***	0.344***
	(8.25)	(7.41)	(4.30)	(4.25)	(7.83)	(7.04)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Broker fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	122,110	122,110	59,675	59,675	95,236	95,236
Pseudo R^2	0.190	0.340	0.202	0.352	0.191	0.349

This table reports the effects of affiliated analysts on stock recommendations. Z-statistics computed with robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

is an increase in the likelihood of a Buy or Add stock recommendation of 7.7%. Given the average rate of 26.9% for affiliated analysts, their effects are economically significant. These results show that affiliated analysts are more likely to issue optimistic rating reports to help share pledge firms implement market value management and maintain stock price. Our finding supports the hypothesis of conflicts of interest.

To further examine the relationship between affiliated analysts and stock recommendations, we divided our sample into two sub-samples. The first consists of listed firms in which the shares are pledged by controlling shareholders and affiliated analysts are defined as those with affiliated securities companies that are pledgees of share pledge firms, so the value of *Affiliated_Analyst* then equals 1, and 0 otherwise. The second sub-sample consists of non-share pledge firms and share pledge firms that have relationships with listed firms. The definition of affiliated analyst is the same as the variable definition of *Affiliated_Analyst* in Table 2. Columns (3) to (6) in Table 4 show that the coefficients of *Affiliated_Analyst* are all significantly positive and significant at a 1% level in both sub-samples. These results show that the stock recommendations of affiliated analysts are more optimistic when these affiliated securities companies are pledgees of share pledge firms. The findings further confirm that the affiliated analysts lose their independence due to conflicts of interest and issue optimistic rating reports for share pledge firms.

4.2.2. The effect of the dynamic adjustment behavior of affiliated analysts on stock recommendations

The above findings suggest that affiliated analysts issue more optimistic rating reports for share pledged firms. If this is caused by the conflict of interest behavior of affiliated analysts, will their optimistic behavior regarding stock recommendations be weakened before (after) the relationship formed (dissolved) between them and share pledge firms? We provide more evidence for our conflict of interest hypothesis by examining the dynamic adjustment behavior of affiliated analysts in terms of stock recommendations.

We use a sample in which the shares of listed firms are only pledged once by controlling shareholders between 2013 and 2017 as the experimental group, and non-share pledge firms as the control group. We define two variables, *Pre* and *Post,* in Eq. (1). The variable of *Pre* represents the year before the relationship between affiliated analysts and share pledge firms was formed, and *Post* represents the year after the relationship between affiliated analysts and share pledge firms dissolved. Table 5 reports the results of the dynamic adjustment behavior of affiliated analysts on stock recommendations. In column (1), the coefficient on *Affiliated_Analyst* is 0.097 with a z statistic of 3.17, and is significant at the 1% level. The coefficient on *Pre* is positive, but it fails to pass the significance test. This shows that the rating reports issued by the analysts without interference from outside pressure are more objective before the year that the relationship was formed. The coefficient on *Post* is positive, but also fails to pass the significance test. This suggests that these affiliated analysts are less likely to issue optimistic rating reports after the year that the relationship dissolved. We obtain the same finding when we use Rec_2, our other measurement of stock recommendation, which suggests that there is a dynamic adjustment of the stock recommendation behavior of affiliated analysts, and they are faced with less conflict of interest before the year that the relationship was formed and after the year that it was dissolved. Thus, we provide more evidence for the conflict of interest hypothesis.

4.3. Exclusivity testing

4.3.1. Eliminating the influence of information asymmetry

Our above findings may be due to information asymmetry between affiliated analysts and share pledge firms. In this section, we use the following methods to measure the information asymmetry and examine whether affiliated analysts who have more private information about share pledge firms produce less optimistic stock recommendations.

First, site visits are an important method of acquiring information for analysts, as they can communicate and interact with managers face to face, which can enable them to obtain more private information about listed firms. Thus, corporate site visits can help affiliated analysts alleviate the information asymmetry with share pledge firms and improve the quality of their rating reports (Cheng et al., 2016).

In 2009, the Shenzhen Stock Exchange stated that listed firms must disclose information about analysts' site visits. We use these data to examine whether affiliated analysts who have more private information about share pledge firms produce less optimistic stock recommendations after visiting the firms. The results of

Table 5
Dynamic adjustment behavior of affiliated analysts in stock recommendations.

	(1) Rec_1	(2) Rec_2
Pre	0.022	0.016
	(0.59)	(0.20)
Affiliated_Analyst	0.097***	0.205***
	(3.17)	(2.86)
Post	0.049	0.082
	(1.47)	(1.15)
Size	0.001	−0.094***
	(0.07)	(−2.75)
Lev	0.428***	0.612***
	(4.37)	(2.80)
ROA	4.140***	8.551***
	(10.50)	(9.46)
Age	−0.052*	−0.085
	(−1.79)	(−1.36)
MB	−0.022**	−0.046**
	(−2.18)	(−2.00)
Turnover	0.006	0.021*
	(1.32)	(1.86)
Return	0.143***	0.180***
	(5.67)	(2.94)
Brokersize	0.117**	0.198
	(2.08)	(1.49)
Experience	−0.007	−0.022*
	(−1.28)	(−1.81)
Day	−0.211***	−0.186***
	(−9.69)	(−4.16)
Institution	0.172	0.217
	(0.78)	(0.56)
Analyst_Num	0.188***	0.286***
	(6.50)	(4.72)
Year fixed effects	Yes	Yes
Broker fixed effects	Yes	Yes
N	68,193	68,193
Pseudo R^2	0.195	0.373

This table reports the results of the dynamic adjustment behavior of affiliated analyst on stock recommendations. The Z-statistics computed with robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

column (1) and (2) in Table 6 show that the coefficients on *Affiliated_Analyst*Visiting* are non-significant, suggesting that affiliated analysts who have visited share pledge firms do not issue less optimistic stock recommendations for them. Thus, affiliated analysts cannot improve the quality of their rating reports although the site visits can help them obtain more private information, and thus the hypothesis of information asymmetry does not hold.

Second, according to the new theory of economic geography, geographic proximity affects the efficiency of information transmission between companies. The proximity of analysts and firms can affect the costs that analysts incur for access to the information of listed firms. Geographically proximate analysts possess an information advantage over others, and thus their earnings forecasts are more accurate (Malloy, 2005; Bae et al., 2008; O'Brien and Tan, 2015). Affiliated analysts whose workplaces are located in the same provinces as share pledge companies have easier access to private information and thus issue more accurate earnings forecasts. The results of columns (3) and (4) in Table 6 show that the coefficients on *Location* are −0.055 and −0.111, with z statistics of −1.71 and −1.86, and are significant at the 10% level. Thus, when analysts' workplaces are located in the same province as the listed firms, they can reduce optimistic bias due to the

Table 6
Effect of information asymmetry on stock recommendations of affiliated analysts.

	(1)	(2) Site Visit	(3)	(4) Location	(5)	(6) Star Analyst	(7)	(8) AQ
	Rec_1	Rec_2	Rec_1	Rec_2	Rec_1	Rec_2	Rec_1	Rec_2
Affiliated_Analyst	0.080***	0.194***	0.092***	0.223***	0.090***	0.213***	0.134***	0.220***
	(2.61)	(3.17)	(3.78)	(4.17)	(3.68)	(3.98)	(4.22)	(3.16)
Affiliated_Analyst*IS	0.081	−0.069	0.099	0.019	0.062*	0.058	−0.050	−0.010
	(1.22)	(−0.46)	(0.90)	(0.16)	(1.75)	(0.52)	(−0.08)	(−0.01)
IS	−0.074	−0.209	−0.055*	−0.111*	−0.021	−0.053	0.013**	0.011
	(−1.30)	(−1.53)	(−1.71)	(−1.86)	(−1.04)	(−1.05)	(2.31)	(0.03)
Size	0.027	−0.065	0.006	−0.078***	0.007	−0.073***	0.007	−0.074***
	(1.02)	(−1.34)	(0.35)	(−2.82)	(0.41)	(−2.67)	(0.45)	(−2.68)
Lev	0.244**	0.437*	0.437***	0.753***	0.435***	0.739***	0.412***	0.741***
	(2.21)	(1.74)	(5.15)	(4.46)	(5.13)	(4.38)	(4.83)	(4.36)
ROA	3.332***	5.987***	4.143***	7.906***	4.128***	7.866***	4.093***	7.874***
	(7.61)	(6.28)	(12.35)	(11.27)	(12.29)	(11.19)	(12.21)	(11.24)
Age	−0.045	−0.013	−0.055**	−0.092**	−0.057**	−0.097**	−0.057**	−0.096**
	(−1.46)	(−0.22)	(−2.44)	(−2.04)	(−2.54)	(−2.15)	(−2.50)	(−2.13)
MB	−0.021	−0.026	−0.034***	−0.051***	−0.034***	−0.050***	−0.036***	−0.050***
	(−1.63)	(−0.85)	(−3.76)	(−2.78)	(−3.70)	(−2.69)	(−3.90)	(−2.67)
Turnover	−0.001	0.007	0.007*	0.018**	0.007*	0.018**	0.006	0.018**
	(−0.16)	(0.60)	(1.73)	(1.99)	(1.76)	(2.04)	(1.57)	(2.05)
Return	0.113***	0.183**	0.185***	0.265***	0.186***	0.268***	0.186***	0.268***
	(4.03)	(2.53)	(9.30)	(5.67)	(9.34)	(5.72)	(9.35)	(5.71)
Brokersize	0.250***	0.237*	0.285***	0.224***	0.284***	0.216**	0.284***	0.222***
	(4.34)	(1.90)	(7.71)	(2.64)	(7.70)	(2.57)	(7.69)	(2.62)
Experience	−0.008	−0.018	−0.008*	−0.005	−0.008*	−0.006	−0.008*	−0.006
	(−1.23)	(−1.28)	(−1.92)	(−0.63)	(−1.88)	(−0.68)	(−1.94)	(−0.67)
Day	−0.220***	−0.186***	−0.225***	−0.230***	−0.226***	−0.230***	−0.226***	−0.231***
	(−9.33)	(−3.49)	(−13.59)	(−6.87)	(−13.60)	(−6.87)	(−13.62)	(−6.90)
Institution	1.132***	2.537***	0.162	0.143	0.172	0.167	0.172	0.168
	(3.59)	(3.64)	(0.97)	(0.47)	(1.04)	(0.55)	(1.04)	(0.55)
Analyst_Num	0.143***	0.265***	0.196***	0.321***	0.194***	0.318***	0.196***	0.318***
	(4.35)	(4.30)	(8.33)	(7.50)	(8.24)	(7.42)	(8.31)	(7.41)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Broker fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	80,699	80,699	122,110	122,110	122,110	122,110	122,110	122,110
Pseudo R^2	0.203	0.342	0.190	0.338	0.190	0.338	0.190	0.338

This table reports the results of information asymmetry on the stock recommendation behavior of affiliated analysts. *IS* represents the variables of *Visiting*, *Location*, *Star*, and *AQ*, respectively. The Z-statistics computed with robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

geographical advantage, which helps them obtain more information about the listed firms. The coefficient on *Affiliated_Analyst*Location* is positive, but it does not pass the significance test, suggesting that affiliated analysts in geographical proximity to the share pledge firms do not issue less optimistic stock recommendations for these firms. They cannot improve the quality of their rating reports even though they have advantage of geographic proximity, and the hypothesis of information asymmetry therefore does not hold.

Third, star analysts are able to better grasp useful information from public or private sources and can thus provide more accurate rating reports. They can also maintain independence under the constraint of the reputation mechanism and thus are not affected by the share pledge firms' pressure to improve the quality of their reports (Stickel, 1992; Jackson, 2005). If an analyst is one of the "top five analysts" in New Fortune's list, the value of *Star* is 1 and 0 otherwise. The result in column (5) of Table 6 shows that the coefficient on *Affiliated_Analyst*Star* is 0.062, with a z statistic of 1.75, and is significant at the 10%. Level. Using Rec_2, the other measurement of stock recommendation, does not produce a significant result. Thus, a star-affiliated analyst cannot issue more circumspect rating reports for a listed firm because of the conflict of interest.

Last, the information environment provided by listed firms determines the difficulty of obtaining information from them by analysts. The higher the information transparency of share pledge firms, the more easily affiliated analysts can acquire information from them, which reduces information asymmetry. The earnings quality, calculated by the DD model, is used as the proxy variable of information transparency (AQ). As shown in column (7) of Table 6, the coefficient on AQ is 0.013, with a z statistic of 2.31, and is significant at the 5% level, suggesting that analysts issue more optimistic rating reports for firms with lower information transparency. However, the coefficient on *Affiliated_Analyst*AQ* is negative but does not pass the significance test, suggesting that affiliated analysts do not issue less optimistic stock recommendations for firms with higher levels of information transparency.

Overall, our findings in this section show that the optimistic stock recommendations issued by affiliated analysts do not decrease, even if they have visited the share pledge firms, work in the same location as the firms, or are star analysts according to New Fortune's "top five analysts" list, or if the information transparency of share pledge firms is higher. These results also support our conflict of interest hypothesis.

4.3.2. Eliminating the influence of the extra connections of affiliated analysts

In addition to the possible interference of information asymmetry, our finding that affiliated analysts issue optimistic stock recommendations when their securities companies engage in share pledging and are pledgees of the share pledge firms may also be due to the connections between securities companies' other businesses and share pledge firms. To eliminate this possibility, we remove from our data the sample consisting of share pledge firms that have relationships with affiliated analysts via investment banking, sub-warehouse commissions, and the proprietary businesses of securities companies.

Investment banking is an important source of income for brokers. The rating reports issued by their affiliated analysts have become an important strategic resource for brokers. They strive to maintain relationships with their customers in a competitive environment with limited securities resources. The relationship between the investment banking business of securities companies and listed firms has been found to affect the conflicts of interest between their affiliated analysts and the listed firms. Their analysts issue more optimistic rating reports than other analysts to help their securities companies obtain the investment banking business (Lin and McNichols, 1998). Thus, we delete the sample in which the securities companies of affiliated analysts are underwriters of the IPO and SEO of listed firms. The results in columns (1) and (2) of Table 7 show that our conclusions remain valid after excluding this sample.

Second, institutional investors are the main customers of analysts' rating reports, and their commission fees are the most important source of income for securities companies. Analysts have been found to be more likely to track listed firms whose shares are held by institutional investors, and they issue more optimistic rating reports on stocks held by these investors because they obtain more commission fees from them (Firth et al., 2013; Gu et al., 2013). According to New Fortune, commission fees from public funds are the main source of income for securities companies, and the voting rights in firms with shares held by public funds that select star analysts remain at around 60%. Thus, we exclude listed firms in which the shares are mostly held by public funds to reduce the influence of sub-warehouse commission fees from public funds, which represent the main customers of brokers, on analysts' behavior. The results in columns (3) and (4) of Table 7 show that our conclusions are still valid after excluding these firms.

Last, Cao and Zhu (2011) found that analysts are more optimistic about the stocks held by their proprietary businesses, and thus they issue more optimistic stock recommendations for these listed firms. We further exclude the sample of firms in which the shares are mostly held by the proprietary businesses of securities companies. We derive the same finding in columns (5) and (6) of Table 7 after excluding the sample in which stocks are held by the affiliated analysts' brokers.

Our conclusions hold when we also remove the sample in which conflicts of interest are caused by the relationships between investment banking, sub-warehouse commissions, and proprietary business. Our tests shows that the connections between other businesses of securities companies and share pledge firms does not influence our findings, and illustrates that the conflict of interest caused by share pledge financing affects the independence of affiliated analysts and leads to optimistic stock recommendations for share pledge firms.

Table 7
Eliminating the influence of extra connections of affiliated analysts.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Excluding the sample of investment banking		Excluding the sample of sub-warehouse commission		Excluding the sample of proprietary business		Excluding the sample of three connections	
	Rec_1	Rec_2	Rec_1	Rec_2	Rec_1	Rec_2	Rec_1	Rec_2
Affiliated_Analyst	0.100***	0.222***	0.110***	0.236***	0.103***	0.220***	0.110***	0.239***
	(4.18)	(4.18)	(4.34)	(4.22)	(4.45)	(4.29)	(4.25)	(4.12)
Size	0.009	−0.080***	0.024	−0.045	0.007	−0.073***	0.027	−0.052*
	(0.55)	(−2.75)	(1.43)	(−1.61)	(0.46)	(−2.66)	(1.56)	(−1.74)
Lev	0.421***	0.694***	0.428***	0.702***	0.435***	0.744***	0.412***	0.646***
	(4.87)	(4.00)	(4.67)	(3.83)	(5.14)	(4.41)	(4.40)	(3.41)
ROA	4.124***	7.639***	4.004***	7.527***	4.132***	7.849***	3.998***	7.222***
	(12.17)	(10.76)	(11.20)	(10.04)	(12.31)	(11.17)	(11.08)	(9.61)
Age	−0.053**	−0.082*	−0.047*	−0.080	−0.058**	−0.096**	−0.043*	−0.066
	(−2.31)	(−1.76)	(−1.93)	(−1.63)	(−2.56)	(−2.12)	(−1.73)	(−1.29)
MB	−0.036***	−0.054***	−0.024**	−0.041*	−0.033***	−0.049***	−0.026**	−0.045**
	(−3.92)	(−2.85)	(−2.26)	(−1.92)	(−3.64)	(−2.66)	(−2.41)	(−2.08)
Turnover	0.008*	0.016*	0.009**	0.024**	0.007*	0.018**	0.010**	0.023**
	(1.88)	(1.80)	(2.13)	(2.55)	(1.73)	(2.03)	(2.23)	(2.39)
Return	0.188***	0.267***	0.167***	0.269***	0.184***	0.266***	0.165***	0.261***
	(9.25)	(5.42)	(7.08)	(4.97)	(9.26)	(5.67)	(6.84)	(4.58)
Brokersize	0.299***	0.211**	0.242***	0.184**	0.289***	0.221***	0.263***	0.173*
	(7.97)	(2.43)	(5.79)	(2.03)	(7.78)	(2.62)	(6.16)	(1.85)
Experience	−0.007*	−0.005	−0.007	−0.006	−0.008*	−0.006	−0.006	−0.007
	(−1.67)	(−0.57)	(−1.54)	(−0.67)	(−1.86)	(−0.65)	(−1.28)	(−0.69)
Day	−0.224***	−0.238***	−0.199***	−0.201***	−0.225***	−0.230***	−0.196***	−0.206***
	(−13.16)	(−6.85)	(−10.64)	(−5.70)	(−13.57)	(−6.87)	(−10.19)	(−5.63)
Institution	0.192	0.232	0.021	−0.066	0.173	0.165	0.029	−0.032
	(1.11)	(0.67)	(0.12)	(−0.23)	(1.04)	(0.54)	(0.16)	(−0.10)
Analyst_Num	0.185***	0.315***	0.203***	0.326***	0.193***	0.319***	0.193***	0.324***
	(7.70)	(7.04)	(7.97)	(7.19)	(8.22)	(7.41)	(7.44)	(6.86)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Broker fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	115,548	115,548	99,195	99,195	121,542	121,542	93,255	93,255
Pseudo R^2	0.187	0.336	0.191	0.341	0.190	0.338	0.188	0.338

This table reports the results of eliminating the influence of extra connections of affiliated analysts on their stock recommendations. The Z-statistics computed with robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

4.4. Supplementary analysis

The above findings show that affiliated analysts issue optimistic rating reports due to conflicts of interest rather than due to information superiority or other business relationships. In this section, we further examine whether the stock recommendation behavior of affiliated analysts differs in different situations.

4.4.1. The effect of the share pledge ratio on the stock recommendations of affiliated analysts

We divide our sample into high ratio vs. low ratio pledged shares groups and expect the influence of affiliated analysts' stock recommendation behavior to vary. Controlling shareholders who pledge most of their shares to securities companies are typically subject to more pressure from margin calls, as the stock prices may fall below the desired level, and the shares that they hold are not sufficient to make up the drop in stock price (Chan et al., 2015). We expect the stock recommendation behavior of affiliated analysts to be more optimistic and radical in the high share pledge ratio sample than in the low ratio sample.

We use the number of shares pledged by controlling shareholders to securities companies over the total number of shares held by these shareholders to measure an alternative variable of the share pledge ratio (*Ratio*). Table 8 presents the effect of affiliated analysts' stock recommendations in different scenarios. Columns (1) and (2) show that the coefficient on *Affiliated_Analyst*Ratio* is significantly positively associated with stock recommendation at the 5% level. Our empirical results show that a higher share pledge ratio increases the conflict of interest between affiliated analysts and share pledge firms, and the likelihood that stock recommendations are issued by affiliated analysts for high share pledge ratio firms is significantly higher than that for low ratio firms.

4.4.2. Effect of the downward pressure of stock price on the stock recommendations of affiliated analysts

Share pledge firms are faced with the challenge of maintaining stock prices under the downward pressure of China's capital market, which can prompt affiliated analysts to issue optimistic rating reports and help the share pledge firms effectively manage the market value. Thus, we further test the effect of the downward pressure of stock prices on affiliated analysts' stock recommendation behavior.

Following the stock market cycle measurement method of Kao et al. (1998), we define the upward and downward trend of stock prices as follows. If the monthly average stock return in the past 12 months is greater than 0, the stock price is rising in that year, which is defined as an upward trend. If the monthly average is less than 0, it is defined as a downward trend. We expect the stock recommendation behavior of affiliated analysts is more optimistic when the stock price is defined as having a downward trend. Columns (3) and (4) show that the coefficient on *Affiliated_Analyst*Pressure* is significantly positively associated with stock recommendation at 5% or 10% levels. Our empirical results show that the association between affiliated analysts and the likelihood of stock recommendation is stronger when the stock price is following a downward rather than an upward trend, which shows that the downward pressure of stock price increases conflicts of interest for affiliated analysts.

4.5. Robustness tests

4.5.1. Difference-in-differences model

The *Guidelines on Share Pledge Repo Transaction, Registration and Settlement* came into effect in May 2013 and allows securities companies to engage in share pledging in China's capital market. The share pledge business was mainly conducted by banks, trusts, or other financial institutions before this year. Thus, the implementation of the *Share Pledge Repo Transaction* policy in 2013 can be viewed as an exogenous shock, which provides us with an opportunity to test our problem using the difference-in-differences model.

In our sample, the securities companies accept the pledged shares of shareholders at different times, and many of the pledged shares are released after the expiration or just before the expiration, and then the pledge procedures are recompleted, so the share pledge repo transaction business of securities companies is a multiple exogenous shock. We thus use Eq. (1) as the difference-in-differences model, and the sample is from 2008 to 2017, which includes securities companies that accept the pledged shares of listed firms, and analysts also issue rating reports for these firms. The value of *Affiliated_Analyst* is thus 1, and 0 otherwise.

Table 8
Effect of affiliated analysts on stock recommendations in different scenarios.

	(1)	(2)	(3)	(4)
	Share Pledge Ratio		Downward Pressure of Stock Price	
	Rec_1	Rec_2	Rec_1	Rec_2
Affiliated_Analyst	0.122***	0.261***	0.091***	0.191***
	(3.35)	(2.89)	(3.48)	(3.15)
Affiliated_Analyst*Ratio/Pressure	0.271**	0.501**	0.038*	0.104**
	(2.28)	(2.14)	(1.95)	(2.09)
Ratio/Pressure	0.206	0.380	−0.037	−0.048
	(1.31)	(1.42)	(−1.28)	(−0.85)
Size	0.009	−0.068**	0.007	−0.072***
	(0.56)	(−2.47)	(0.44)	(−2.60)
Lev	0.424***	0.711***	0.437***	0.746***
	(4.88)	(4.12)	(5.15)	(4.42)
ROA	4.135***	7.881***	4.090***	7.836***
	(12.34)	(11.23)	(12.11)	(11.04)
Age	−0.057**	−0.095**	−0.057**	−0.096**
	(−2.55)	(−2.11)	(−2.53)	(−2.12)
MB	−0.034***	−0.049***	−0.033***	−0.048**
	(−3.70)	(−2.69)	(−3.56)	(−2.55)
Turnover	0.007*	0.018**	0.007*	0.018**
	(1.77)	(2.04)	(1.68)	(1.98)
Return	0.185***	0.267***	0.175***	0.251***
	(9.30)	(5.72)	(7.89)	(4.64)
Brokersize	0.284***	0.220***	0.284***	0.222***
	(7.68)	(2.60)	(7.68)	(2.63)
Experience	−0.008*	−0.006	−0.008*	−0.006
	(−1.91)	(−0.68)	(−1.93)	(−0.68)
Day	−0.226***	−0.232***	−0.225***	−0.231***
	(−13.63)	(−6.94)	(−13.55)	(−6.92)
Institution	0.185	0.189	0.164	0.157
	(1.11)	(0.62)	(0.99)	(0.51)
Analyst_Num	0.194***	0.317***	0.194***	0.318***
	(8.17)	(7.37)	(8.24)	(7.43)
Year fixed effects	Yes	Yes	Yes	Yes
Broker fixed effects	Yes	Yes	Yes	Yes
N	122,110	122,110	122,110	122,110
Pseudo R^2	0.188	0.339	0.190	0.338

This table reports the effects of affiliated analysts on stock recommendations in different scenarios. The Z-statistics computed with robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

The regression results in Table 9 show that there are still optimistic stock recommendations in the rating reports of affiliated analysts for the share pledge firms when using the difference-in-differences model, which is consistent with our conclusion when using the non-difference-in-differences model.

4.5.2. Controlling the fixed effects of analysts and firms

We further control the fixed effects of analysts and firms in our model (1) to alleviate the influence of endogeneity at the individual level. The results shown in columns (1) and (2) of Table 10 suggest that the association between affiliated analysts and the likelihood of stock recommendation is also stronger when we control for the fixed effects of analysts. Columns (3) and (4) of Table 10 show that the coefficient on *Affiliated_Analyst* is significantly positively associated with stock recommendation at the 1% or 5% level after controlling for the fixed effects of firms. Our conclusion is thus robust when we control for the fixed effects of both firms and analysts.

Table 9
Effect of affiliated analysts on stock recommendations using the difference-in-differences model.

	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample		Sub-sample 1		Sub-sample 2	
	Rec_1	Rec_2	Rec_1	Rec_2	Rec_1	Rec_2
Affiliated_Analyst	0.135***	0.301***	0.097***	0.223***	0.165***	0.345***
	(6.30)	(6.49)	(3.57)	(3.99)	(6.76)	(6.81)
Size	−0.039***	−0.081***	−0.009	−0.121***	−0.036***	−0.070***
	(−3.11)	(−4.94)	(−0.42)	(−3.70)	(−2.71)	(−3.99)
Lev	0.396***	0.568***	0.233**	0.474**	0.362***	0.507***
	(5.72)	(4.89)	(2.48)	(2.36)	(4.66)	(3.97)
ROA	4.131***	6.617***	3.422***	6.107***	4.253***	6.789***
	(15.85)	(15.51)	(9.37)	(8.37)	(14.33)	(13.83)
Age	0.012	0.001	0.009	0.045	0.009	−0.005
	(0.67)	(0.04)	(0.35)	(1.09)	(0.47)	(−0.15)
MB	−0.047***	−0.059***	−0.033***	−0.049**	−0.054***	−0.070***
	(−6.40)	(−4.90)	(−3.02)	(−2.41)	(−6.86)	(−5.34)
Turnover	−0.001	−0.007	−0.006	−0.016	0.001	−0.003
	(−0.19)	(−1.20)	(−1.20)	(−1.53)	(0.20)	(−0.45)
Return	0.157***	0.175***	0.136***	0.200***	0.154***	0.168***
	(10.67)	(6.65)	(5.30)	(3.81)	(9.59)	(5.89)
Brokersize	0.051***	0.116***	0.099***	0.129**	0.043**	0.127***
	(2.67)	(3.45)	(2.81)	(2.03)	(2.03)	(3.33)
Experience	−0.006*	−0.004	−0.008	−0.009	−0.004	−0.004
	(−1.91)	(−0.86)	(−1.63)	(−0.93)	(−1.33)	(−0.66)
Day	−0.217***	−0.249***	−0.210***	−0.232***	−0.218***	−0.257***
	(−18.56)	(−12.67)	(−10.62)	(−5.90)	(−16.28)	(−11.58)
Institution	1.146***	1.677***	0.807**	0.659	1.284***	2.042***
	(4.92)	(3.90)	(2.06)	(0.70)	(5.07)	(4.69)
Analyst_Num	0.192***	0.326***	0.143***	0.282***	0.209***	0.352***
	(9.71)	(11.47)	(5.25)	(6.42)	(9.47)	(10.95)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Broker fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	211,761	211,761	80,848	80,848	165,624	165,624
Pseudo R^2	0.162	0.262	0.178	0.300	0.165	0.268

This table reports the effects of affiliated analysts on stock recommendations using the difference-in-differences model. The Z-statistics computed with robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

4.5.3. The method of propensity score matching

We also examine our problem using the Propensity Score Matching method. The affiliated and non-affiliated analysts are matched 1:1 by firm size, financial leverage, the nature of the ultimate ownership, and other criteria, and we obtain a sample of 88,869 after matching. The regression using the matched sample shows that the stock recommendations issued in the rating reports of affiliated analysts are more optimistic than those of non-affiliated analysts, and our conclusion remains robust (see Table 11).

4.5.4. The instrumental variable method

To alleviate any problems of endogeneity in our results, we further use the instrumental variable method to examine our problem. We use the mean value of industry pledged shares and the mean value of province pledged shares as two instrumental variables of share pledge and use the two estimated values of share pledge as proxy variables. We find that the stock recommendations issued in the rating reports of affiliated analysts are more optimistic than those of non-affiliated analysts. Thus, our conclusion is also robust when we consider the endogeneity problem (see Table 11).

Table 10
Controlling the fixed effects of analysts and firms.

	(1) Rec_1	(2) Rec_2	(3) Rec_1	(4) Rec_2	(5) Rec_1	(6) Rec_2
Affiliated_Analyst	0.076***	0.145***	0.069***	0.136**	0.060***	0.125**
	(3.25)	(3.08)	(2.96)	(2.87)	(2.81)	(2.52)
Size	0.012	0.017	0.009	0.011	0.007	0.009
	(0.83)	(0.56)	(0.78)	(0.48)	(0.69)	(0.42)
Lev	0.264***	0.365***	0.232***	0.312**	0.218***	0.286**
	(3.24)	(2.96)	(2.85)	(2.29)	(2.74)	(2.10)
ROA	4.424***	5.276***	4.022***	4.957***	3.968***	4.415***
	(14.30)	(9.45)	(11.62)	(8.16)	(10.65)	(7.78)
Age	−0.004	−0.018	−0.004	−0.013	−0.003	−0.011
	(−0.18)	(−0.45)	(−0.14)	(−0.38)	(−0.12)	(−0.30)
MB	−0.053***	−0.036***	−0.048***	−0.028***	−0.040***	−0.024***
	(−6.04)	(−5.28)	(−4.89)	(−4.75)	(−4.20)	(−4.56)
Turnover	−0.002	−0.008	−0.001	−0.006	−0.001	−0.005
	(−0.64)	(−0.93)	(−0.55)	(−0.86)	(−0.50)	(−0.82)
Return	0.168***	0.153***	0.156***	0.129***	0.139***	0.117***
	(8.84)	(4.54)	(6.58)	(3.99)	(6.02)	(3.75)
Brokersize	−0.089***	−0.056*	−0.075**	−0.047*	−0.068**	−0.042
	(−2.80)	(−1.84)	(−2.43)	(−1.67)	(−2.30)	(−1.55)
Experience	0.013**	0.002*	0.009**	0.001	0.007*	0.001
	(2.30)	(1.87)	(2.01)	(1.58)	(1.92)	(1.21)
Day	−0.294***	−0.163***	−0.248***	−0.135***	−0.197***	−0.107***
	(−16.35)	(−5.67)	(−14.46)	(−5.10)	(−12.85)	(−4.87)
Institution	0.027	0.033	0.025	0.030	0.022	0.028
	(0.18)	(0.27)	(0.13)	(0.19)	(0.11)	(0.18)
Analyst_Num	0.270***	0.305***	0.233***	0.275***	0.219***	0.254***
	(12.39)	(6.70)	(9.86)	(5.89)	(7.91)	(5.43)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Broker fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Analyst fixed effects	Yes	Yes	No	No	Yes	Yes
Firm fixed effects	No	No	Yes	Yes	Yes	Yes
N	122,110	122,110	122,110	122,110	122,110	122,110
Pseudo R^2	0.289	0.413	0.315	0.448	0.485	0.506

This table reports the effects of affiliated analysts on stock recommendations using the difference-in-differences model. The Z-statistics computed with robust standard errors clustered at firm level are reported in parentheses. ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels, respectively.

4.5.5. Deleting firms with exclusively affiliated or non-affiliated analysts

Some affiliated analysts may only work with specific listed firms, which could also affect our results. To avoid uncertainty and to obtain a corresponding sample between affiliated and non-affiliated analysts in a listed firm, we ensure at least one affiliated and one non-affiliated analyst issue rating reports on a listed firm, and then we examine the difference in the stock recommendations of the two types of analysts. Our results remain robust when we delete the sample in which all the analysts in a listed firm are either affiliated or non-affiliated.

5. Further analysis

5.1. Effect of affiliated analysts on earnings forecasts

The stock recommendations in our above analysis only have the five categories of Sell, Reduce, Neutral, Add, and Buy, and are thus too subjective to quantitatively explain the behavior of affiliated analysts. Thus, we further examine the stock recommendation behavior of affiliated analysts from a quantitative perspective.

Table 11
Robustness tests.

	(1)	(2) PSM	(3)	(4) IV1	(5)	(6) IV2	(7)	(8) Special Sample
	Rec_1	Rec_2	Rec_1	Rec_2	Rec_1	Rec_2	Rec_1	Rec_2
Affiliated_Analyst	0.087***	0.194***	0.027***	0.022**	0.025**	0.017**	0.086*	0.139
	(3.60)	(3.70)	(2.61)	(2.36)	(2.46)	(2.01)	(1.92)	(1.36)
Size	0.018	−0.073**	0.012	−0.002	0.008	−0.001	0.011	−0.087
	(0.97)	(−2.08)	(0.71)	(−0.98)	(0.65)	(−0.73)	(0.29)	(−1.21)
Lev	0.327***	0.489***	0.284**	0.425**	0.236**	0.382**	0.336*	0.216
	(3.64)	(2.59)	(2.48)	(2.01)	(2.08)	(2.32)	(1.88)	(0.59)
ROA	3.856***	7.097***	3.358***	6.842***	3.02***	5.202***	4.191***	7.322***
	(10.78)	(9.26)	(8.64)	(8.02)	(7.63)	(7.02)	(5.63)	(4.94)
Age	−0.052**	−0.074	−0.046	−0.065	−0.038**	−0.053	−0.102**	−0.089
	(−2.15)	(−1.62)	(−1.31)	(−1.42)	(−1.07)	(−1.22)	(−2.05)	(−0.92)
MB	−0.030***	−0.051**	−0.016**	−0.032*	−0.010**	−0.024	−0.025	−0.071*
	(−2.98)	(−2.40)	(−2.13)	(−1.84)	(−2.06)	(−1.56)	(−1.24)	(−1.82)
Turnover	0.000	0.006	0.000	0.002	0.000	0.001	0.011*	0.021
	(0.02)	(0.65)	(0.65)	(0.37)	(0.45)	(0.32)	(1.72)	(1.35)
Return	0.158***	0.207***	0.123***	0.156***	0.100***	0.109***	0.192***	0.239**
	(7.10)	(3.80)	(6.06)	(3.32)	(5.24)	(3.21)	(3.94)	(2.25)
Brokersize	0.263***	0.223**	0.230***	0.198**	0.164**	0.091*	0.200**	−0.177
	(5.78)	(2.22)	(4.25)	(2.05)	(2.30)	(1.91)	(2.22)	(−0.85)
Experience	−0.006	−0.009	−0.002	−0.005	−0.000	−0.001	−0.025***	−0.048**
	(−1.27)	(−0.85)	(−1.01)	(−0.77)	(−1.16)	(−0.52)	(−2.68)	(−2.26)
Day	−0.206***	−0.221***	−0.192***	−0.132***	−0.105***	0.092***	−0.219***	−0.222***
	(−10.86)	(−5.12)	(−8.84)	(−6.07)	(−2.97)	(−2.68)	(−6.17)	(−2.88)
Institution	0.961***	2.363***	0.632**	1.246**	0.458**	1.024**	1.500***	3.445***
	(4.65)	(4.71)	(2.21)	(2.42)	(2.01)	(2.18)	(3.22)	(3.11)
Analyst_Num	−0.001	−0.002**	−0.061	−0.052	−0.032	−0.029	0.125***	0.329***
	(−0.85)	(−2.40)	(−0.64)	(−0.76)	(−0.32)	(−0.55)	(2.78)	(3.58)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Broker fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	88,869	88,869	122,110	122,110	122,110	122,110	21,214	21,214
Pseudo R^2	0.203	0.352	0.223	0.323	0.252	0.364	0.195	0.306

This table reports the results of the robustness tests. The Z-statistics computed with robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 12
Effects of affiliated analysts on earnings forecasts.

	(1)	(2)	(3)	(4)	(5)	(6)
		Full sample		Sub-sample 1		Sub-sample 2
	Bias	Error	Bias	Error	Bias	Error
Affiliated_Analyst	0.002***	0.002***	0.001**	0.001***	0.002***	0.003***
	(2.69)	(3.07)	(2.38)	(2.58)	(3.46)	(3.92)
Size	0.001	0.001***	0.001	0.002***	0.000	0.001**
	(1.47)	(3.21)	(1.64)	(3.21)	(0.92)	(2.48)
Lev	0.010***	0.011***	0.014***	0.014***	0.009***	0.010***
	(4.31)	(5.10)	(4.20)	(4.57)	(3.34)	(4.14)
ROA	−0.134***	−0.102***	−0.148***	−0.125***	−0.131***	−0.095***
	(−10.86)	(−8.53)	(−8.10)	(−7.15)	(−9.78)	(−7.25)
Age	−0.002***	−0.001**	−0.002***	−0.001**	−0.002***	−0.001**
	(−3.46)	(−2.33)	(−2.86)	(−2.12)	(−3.15)	(−2.06)
MB	0.001***	0.001**	0.001***	0.001***	0.001***	0.000*
	(4.58)	(2.56)	(4.17)	(3.07)	(3.52)	(1.72)
Turnover	−0.001***	−0.000***	−0.001***	−0.001***	−0.001***	−0.000***
	(−4.91)	(−4.01)	(−5.01)	(−4.26)	(−4.68)	(−3.89)
Return	−0.010***	−0.009***	−0.010***	−0.009***	−0.009***	−0.009***
	(−17.22)	(−16.53)	(−11.83)	(−10.86)	(−15.08)	(−14.61)
Brokersize	0.000	0.000	−0.000	−0.000	0.000	0.000
	(0.31)	(0.26)	(−0.16)	(−0.26)	(0.06)	(0.11)
Experience	−0.000	−0.000	−0.000	−0.000	−0.000	−0.000
	(−1.23)	(−0.94)	(−0.85)	(−0.75)	(−1.56)	(−1.42)
Day	0.010***	0.011***	0.010***	0.011***	0.009***	0.010***
	(22.33)	(25.91)	(18.02)	(20.57)	(18.73)	(21.98)
Institution	−0.012***	−0.012***	−0.032***	−0.032***	−0.009***	−0.010***
	(−3.57)	(−3.78)	(−4.09)	(−4.37)	(−2.70)	(−2.87)
Analyst_Num	0.001	−0.001	0.001	−0.000	0.000	−0.001*
	(1.32)	(−1.18)	(0.68)	(−0.65)	(0.66)	(−1.86)
_cons	−0.038***	−0.055***	−0.056***	−0.078***	−0.029***	−0.047***
	(−4.19)	(−6.62)	(−3.49)	(−5.59)	(−3.09)	(−5.30)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Broker fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	122,110	122,110	59,675	59,675	95,236	95,236
Adj.R^2	0.157	0.168	0.180	0.192	0.149	0.160

This table reports the effects of affiliated analysts on earnings forecasts. The T-statistics computed with robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

We use the following model in Eq. (2) to examine the effect of affiliated analysts on earnings forecast quality.

$$\begin{aligned} Forecast = {} & \alpha + \beta_1 Affiliated\_Analyst + \beta_2 Analyst\_Num + \beta_3 Institution + \beta_4 Age \\ & + \beta_5 Size + \beta_6 Lev + \beta_7 ROA + \beta_8 MB + \beta_9 Turnover + \beta_{10} Experience \\ & + \beta_{11} Brokersize + \beta_{12} Day + Brokerfixedeffect + Yearfixedeffect + \varepsilon \end{aligned} \tag{2}$$

Forecast is the placeholder for the explanatory variables of analyst earnings forecast quality. We use bias and accuracy to measure the earnings forecast quality. The EPS forecast by analysts minus the value issued by listed firms in annual reports divided by stock price at the beginning year is defined as the variable *Bias*, and the absolute value of the EPS forecast by analysts minus the value issued by listed firms in annual reports divided by stock price at the beginning year is the variable *Error*. Larger values of *Bias* and *Error* mean a larger bias and a lower accuracy, which suggests that the quality of analysts' earnings forecasts are lower. All other variables are defined in Table 2.

Our further analyses in Table 12 show that the coefficients on *Affiliated_Analyst* are significantly positively associated with *Bias* and *Error* at a 1% level, suggesting that the quality of earnings forecasts issued by affil-

Table 13
Effects of affiliated analysts on stock recommendation revisions.

	(1) Full sample Revision	(2) Sub-sample 1 Revision	(3) Sub-sample 2 Revision
Affiliated_Analyst	0.080*	0.041*	0.109**
	(1.87)	(1.73)	(2.35)
Size	−0.004	0.014	0.008
	(−0.20)	(0.27)	(0.34)
Lev	0.422***	0.332	0.337**
	(3.24)	(1.62)	(2.23)
ROA	2.707***	2.118**	3.003***
	(4.70)	(2.50)	(4.76)
Age	−0.074**	−0.078	−0.078**
	(−2.28)	(−1.42)	(−2.11)
MB	−0.021	−0.017	−0.029*
	(−1.39)	(−0.71)	(−1.77)
Turnover	−0.007	−0.001	−0.006
	(−1.04)	(−0.07)	(−0.77)
Return	0.269***	0.241***	0.256***
	(5.77)	(3.51)	(4.92)
Brokersize	−0.056	−0.112	−0.050
	(−0.66)	(−0.89)	(−0.51)
Experience	−0.005	0.001	−0.003
	(−0.55)	(0.11)	(−0.34)
Day	−0.202***	−0.194***	−0.203***
	(−5.45)	(−3.61)	(−4.73)
Institution	0.440*	2.105**	0.277
	(1.80)	(2.31)	(1.23)
Analyst_Num	0.067*	0.039	0.087**
	(1.83)	(0.67)	(2.11)
_cons	3.505***	6.656***	3.108***
	(5.40)	(5.78)	(4.36)
Year fixed effects	Yes	Yes	Yes
Broker fixed effects	Yes	Yes	Yes
N	99,430	47,615	77,426
Pseudo R^2	0.079	0.091	0.083

This table reports the results of the effects of affiliated analysts on stock recommendation revisions. The Z-statistics computed with robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

iated analysts is lower, the bias of earnings forecasts is higher, and the accurate is lower. From a quantitative perspective, our results show that affiliated analysts' optimistic behaviors are due to conflicts of interest and that they issue optimistic rating reports for share pledge firms.

5.2. The effect of affiliated analysts on stock recommendation revisions

In this section, we further examine the influence of affiliated analysts on stock recommendation revisions to provide more evidence for our conflict of interest hypothesis.

Stock recommendation revision occurs when analysts use new information to judge and upgrade, downgrade, or maintain the original stock recommendations for listed firms. The literature suggests that analysts are unlikely to downgrade stock recommendations due to the negation of pre-rating reports and are more likely to upgrade or maintain their recommendations (Barber et al., 2006). We expect that affiliated analysts are more likely to upgrade or maintain stock recommendations for share pledge firms and less likely to downgrade their recommendations in rating reports. We use the Probit model to examine this, and if analysts

upgrade or maintain the stock recommendations in their rating reports, the value of *Revision* equals 1, and if they downgrade their recommendations, the value equals 0. The results shown in Table 13 show that the optimistic behavior of affiliated analysts makes them more likely to upgrade or maintain rather than downgrade their stock recommendations for share pledge firms.

5.3. Market reaction to the stock recommendations of affiliated analysts

In this section, we examine whether investors can identify the optimistic stock recommendations of affiliated analysts. We apply the model used by Lin and McNichols (1998) and Gu et al. (2013) in Eq. (3) and examine the effect of affiliated analysts' optimistic stock recommendations on market reaction.

$$\begin{aligned} CAR = {} & \alpha + \beta_1 Rec(5) + \beta_2 Rec(4) + \beta_3 Rec(3) + \beta_4 Rec(2,1) + \beta_5 Rec(5) * Affiliated\_Analyst \\ & + \beta_6 Rec(4) * Affiliated\_Analyst + \beta_7 Rec(3) * Affiliated\_Analyst + \beta_8 Rec(2,1) \\ & * Affiliated\_Analyst + Brokerfixedeffect + Yearfixedeffect + \varepsilon \end{aligned} \tag{3}$$

We select a short-term window [−2, +2] and a long-term window [+3, +60] as the event windows and compute the cumulative excess returns in the short-term [−2, +2] and long-term windows [−2, +2]. The coefficients of β_1, β_2, β_3, and β_4 represent market reaction to Buy, Add, Neutral, Reduce, and Sell stock recommendations issued by non-affiliated analysts, and the coefficients of β_5, β_6, β_7, and β_8 represent market reaction on Buy, Add, Neutral, Reduce, and Sell stock recommendations issued by affiliated analysts, respectively.

The results in Table 14 show that the Buy stock recommendations issued by non-affiliated and affiliated analysts can bring cumulative excess returns in the short event window. However, the cumulative excess returns of Buy stock recommendations issued by affiliated analysts are significantly negative in the long-

Table 14
Market reaction to the stock recommendations of affiliated analysts.

	(1)	(2)	(3)	(4)	(5)	(6)
		Event window[−2,+2]			Event window[+3,+60]	
	Full sample CAR(−2,+2)	Sub-sample1 CAR(−2,+2)	Sub-sample 2 CAR(−2,+2)	Full sample CAR(+3,+60)	Sub-sample 1 CAR(+3,+60)	Sub-sample 2 CAR(+3,+60)
Rec(5)	0.018**	0.030**	0.020**	0.068**	0.112**	0.083**
	(2.47)	(2.57)	(2.51)	(2.31)	(2.35)	(2.54)
Rec(4)	0.007	0.019*	0.009	0.072**	0.111**	0.089***
	(0.99)	(1.65)	(1.14)	(2.46)	(2.34)	(2.75)
Rec(3)	−0.002	0.009	−0.000	0.094***	0.118**	0.113***
	(−0.30)	(0.73)	(−0.05)	(3.17)	(2.37)	(3.45)
Rec(≤2)	−0.001	−0.017	0.008	0.111**	0.045	0.155***
	(−0.10)	(−0.65)	(0.66)	(2.00)	(0.30)	(2.79)
Rec(5)*Affiliated_Analyst	0.003	0.005*	0.002*	−0.022***	−0.022**	−0.022***
	(1.35)	(1.84)	(1.79)	(−2.73)	(−2.09)	(−2.58)
Rec(4)*Affiliated _Analyst	0.003**	0.003	0.004**	−0.011	−0.005	−0.014*
	(1.97)	(1.23)	(2.16)	(−1.41)	(−0.51)	(−1.71)
Rec(3)*Affiliated_Analyst	−0.007	−0.005	−0.008	−0.058*	−0.040	−0.063**
	(−1.09)	(−0.60)	(−1.18)	(−1.89)	(−1.19)	(−2.02)
Rec(≤2)*Affiliated_Analyst	−0.003	0.025	−0.010	−0.010	0.088	−0.037
	(−0.10)	(0.69)	(−0.33)	(−0.08)	(0.52)	(−0.33)
_cons	−0.005	−0.036*	−0.006	−0.153**	−0.257**	−0.170**
	(−0.35)	(−1.67)	(−0.40)	(−2.53)	(−2.57)	(−2.53)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Broker fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	108,549	52,475	84,564	108,520	52,446	84,564
Adj.R^2	0.015	0.019	0.014	0.012	0.014	0.011

This table reports the results of the market reaction to the stock recommendations of affiliated analysts. The T-statistics computed with robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

term event window and significantly lower than the cumulative excess returns brought by Buy stock recommendations issued by non-affiliated analysts, which are also positive in the long-term window. These findings show that investors cannot recognize the optimistic stock recommendation behavior of affiliated analysts in a short event window, and the independence of affiliated analysts can only be identified after long-term market correction.

5.4. The effect of affiliated analysts' stock recommendations on the stock price crash risk

Our hypothesis is based on the assumption that affiliated analysts issue optimistic stock recommendations to help the share pledge firms avoid a stock price crash risk. Therefore, we use the model in Eq. (4) and further examine whether their optimistic stock recommendations can decrease the stock price crash risk of share pledge firms.

$$\begin{aligned} Crash = {} & \alpha + \beta_1 Affiliated\_Analyst + \beta_2 Size + \beta_3 Lev + \beta_4 ROA + \beta_5 MB + \beta_6 Volatility \\ & + \beta_7 Turnover + \beta_8 Ret + \beta_9 Analyst\_Num + \beta_{10} Institution + \beta_{11} Big4 + \beta_{12} DA \\ & + Yearfixedeffect + Brokerfixedeffect + \varepsilon \end{aligned} \tag{4}$$

Table 15
Effects of affiliated analysts' stock recommendations on stock price crash risk.

	(1) Ncskew	(2) Duvol	(3) Ncskew	(4) Duvol
Affiliated_Analyst	−0.001**	−0.036**	−0.060	−0.064*
	(−2.04)	(−2.21)	(−1.30)	(−1.93)
Affiliated_Analyst*Rec			−0.013**	−0.229*
			(−2.31)	(−1.87)
Rec			−0.007*	−0.017
			(−1.71)	(−0.29)
Size	0.015***	0.039	0.015***	0.038
	(2.87)	(0.45)	(2.86)	(0.44)
Lev	−0.024	0.351	−0.025	0.354
	(−0.65)	(0.82)	(−0.67)	(0.83)
ROA	0.352**	−3.376**	0.334**	−3.421**
	(2.48)	(−2.21)	(2.34)	(−2.20)
MB	−0.002	0.178***	−0.001	0.179***
	(−0.38)	(3.58)	(−0.32)	(3.59)
Turnover	0.007***	0.294***	0.007***	0.294***
	(3.81)	(9.11)	(3.82)	(9.11)
Ret	−0.030**	1.424***	−0.030**	1.424***
	(−2.44)	(10.09)	(−2.48)	(10.11)
Volatility	19.171	−5.203***	17.858	−5.132***
	(0.96)	(−12.04)	(0.89)	(−11.99)
Analyst_Num	0.009	0.311**	0.008	0.309**
	(0.91)	(2.44)	(0.83)	(2.42)
Institution	0.010	0.842*	0.009	0.840*
	(0.17)	(1.88)	(0.15)	(1.87)
Big4	−0.025**	−0.034	−0.017***	−0.026
	(−2.23)	(−1.07)	(−1.91)	(−0.65)
DA	−0.011	0.233	−0.011	0.227
	(−0.13)	(0.22)	(−0.14)	(0.21)
_cons	−0.247**	2.060	−0.266**	2.185
	(−2.05)	(1.06)	(−2.19)	(1.15)
Year fixed effects	Yes	Yes	Yes	Yes
Broker fixed effects	Yes	Yes	Yes	Yes
N	122,110	122,110	122,110	122,110
Adj.R^2	0.914	0.814	0.914	0.814

This table reports the effects of stock recommendations issued by affiliated analysts on stock price crash risk. *Rec* is measured with Rec_1. The T-statistics computed with robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Crash is the placeholder for the two explanatory variables capturing the stock price crash risk. We use the negative coefficient of skewness (*Ncskew*) and the down-to-up volatility (*Duvol*) to measure the stock price crash risk (Chen et al., 2001, Kim et al., 2011).

Table 15 reports the effects of stock recommendations issued by affiliated analysts on the stock price crash risk. In columns (1) and (2), the coefficients on *Affiliated_Analyst* are both significantly negative at the 5% level, suggesting that affiliated analysts can reduce the stock price crash risk of share pledge firms. In columns (3) and (4), the coefficients on *Affiliated_Analyst*Rec* are both significantly negative at the 10% level. Thus, the optimistic stock recommendations issued by affiliated analysts can decrease the stock price crash risk for share pledge firms. This finding corroborates to an extent the suggestion that the optimistic stock recommendations issued by affiliated analysts are aimed at avoiding any stock price crash risk for share pledge firms and at ensuring the security of the pledged shares and the interests of both parties.

6. Conclusion

In our study, we examine the association between affiliated analysts whose securities companies engage in share pledge business and their stock recommendation behavior for share pledge firms in the context of the Share Pledge Repo Transaction. Using a sample of Chinese A-share listed companies from 2013 to 2017, we find that the stock recommendations of affiliated analysts are more optimistic than those of non-affiliated analysts, and the affiliated analysts are more likely to issue Buy and Add recommendations. We also find a dynamic adjustment in the stock recommendation behavior of these analysts. The probability of affiliated analysts issuing optimistic stock recommendations is significantly reduced before and after the years in which the affiliated relationship between securities companies and share pledge firms begins and ends. If the affiliated analysts have visited the share pledge firms, work in the same location as these firms, are star analysts in New Fortune's "top five analysts" list, or if the information transparency is higher, the stock recommendations they issue are also more optimistic. Our findings support the conflict of interest hypothesis. Further analysis shows that the stock recommendation behavior of affiliated analysts is more optimistic and radical in our high share pledge ratio sample than in the low ratio sample. The association between affiliated analysts and the likelihood of stock recommendation is also stronger when the stock price follows a downward rather than an upward trend. We further examine the stock recommendation behavior of affiliated analysts from a quantitative perspective and find that the earnings forecast quality is lower, the bias of earnings forecasts is higher, and the accuracy is lower. In addition, the optimistic behavior of affiliated analysts makes them more likely to upgrade or maintain the stock recommendations of share pledge firms than downgrade their recommendations. The Buy recommendations issued by non-affiliated and affiliated analysts can bring cumulative excess returns in the short-term event window. However, the cumulative excess returns of Buy recommendations issued by affiliated analysts are significantly negative in the long-term event window and significantly lower than those issued by non-affiliated analysts. The optimistic stock recommendations of affiliated analysts can also significantly decrease the stock price crash risk of share pledge firms.

Our findings suggest that affiliated analysts issue optimistic rating reports because of their conflicts of interest with share pledge firms. This conclusion reveals the economic consequences of share pledging and improves our understanding of the behavior of affiliated analysts in a conflict of interest situation from the perspective of share pledges. Our findings have policy implications, as regulators should establish a dynamic regulatory mechanism for share pledging, issue specific guidance, and set a silence period to regulate the behavior of affiliated analysts. In addition, a comprehensive quality evaluation system should be established for rating reports issued by affiliated analysts to prevent them from exploiting the superiority of an information intermediary to collude with listed firms and mislead investors. Regulators should also increase the supervision of the information barrier systems of securities companies, which can avoid them becoming formalistic wall systems. Our study contributes to the accounting literature concerning share pledges and the behavior of analysts.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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How audit effort affects audit quality: An audit process and audit output perspective

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ABSTRACT

Using a unique dataset of audit days in China from 2006 to 2011, this paper examines the relationship between audit effort and audit quality from the perspective of audit process and audit output. The results show that audit effort significantly increases the probability of audit adjustments, which inhibits positive earnings management and improves the quality of audited financial statements. We also find that audit effort does not have a significant effect on the issuance of modified audit opinions overall, but that a modified audit opinion is more likely to be issued in the absence of an audit adjustment. Furthermore, we find that the impact of audit effort on audit quality is attenuated when clients are more complex and when audit firms are larger. Collectively, our evidence suggests that audit effort plays an important role in improving audit quality by influencing audit process and audit output. Our study extends the literature on the impact of audit effort on audit quality in emerging markets, and the conclusions have important implications for the improvement of China's audit market efficiency.

1. Introduction

Audit plays an important role as an external corporate governance mechanism, and the governance effect of audit is directly reflected in audit quality. The overall objectives of audit are to obtain reasonable assurance that there is no material misstatement caused by fraud or error in financial statements, and to issue audit reports in accordance with auditing standards and communicate with client management (MOF, 2019).[1]

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[1] For details, please refer to the standard on auditing revised and implemented by the Ministry of Finance (MOF) in 2019: *China Certified Public Accountants Standard on Auditing No.1101: Overall Objectives of the Certified Public Accountants and the Basic Requirements for the Conduct of an Audit* (MOF [2019] No. 5).

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To realize these objectives, in the modern risk-oriented audit model, the main line of audit work requires auditors to identify, evaluate and respond to the risk of material misstatement. Consistent with the audit objective, audit quality is defined as the joint probability that an existing material misstatement is detected and reported by an auditor (DeAngelo, 1981). The realization process of audit quality can be summarized as detecting, adjusting, and reporting material misstatements, and achieving audit quality. How to realize audit objectives and improve audit quality has always been the focus of audit research.

Prior studies primarily investigate factors influencing audit quality from the perspective of auditor independence, including client importance, audit firm tenure, auditor mandatory rotation, and fees from audit and non-audit services (Reynolds and Francis, 2000; Frankel et al., 2002; Kinney et al., 2004; Carey and Simnett, 2006; Chen and Xia, 2006; Lennox et al., 2014; Zhang et al., 2017). Another stream of literature studies other characteristics of auditors and audit firms, such as auditor demographic characteristics and audit firm size and reputation (Qi et al., 2004; Liu and Zhou, 2007; Zhang and Fu, 2008; Cheng et al., 2009; Fang, 2011; Gul et al., 2013; Wang et al., 2015; Gong et al., 2016; He et al., 2018). Audit is regarded as a process of information searching, processing, judging, and adjusting (Gibbins, 1984). Audit effort is also a vital factor impacting audit quality, as hard work is necessary in carrying out a successful audit. However, due to the unavailability of large datasets on audit effort, evidence of the relationship between audit effort and audit quality is scarce. Many prior studies are based on experimental methods or use indirect indicators (e.g. audit fees) to measure audit effort (Bonner and Sprinkle, 2002; Gul, 2006; Knechel et al., 2009; Yang and Zhang, 2010). Different from such studies, this paper uses a unique dataset of audit days as a direct proxy of audit effort to extend the audit literature.

Using a unique database of audit days in China from 2006 to 2011, this paper investigates the impact of audit effort on audit quality from the perspective of audit process and audit output. We find that audit effort significantly increases the probability of audit adjustments (especially downward audit adjustments), which inhibits earnings management by clients (mainly the inhibition of positive earnings management) and improves the quality of audited financial statements. Consistent with the findings of a higher probability of audit adjustments and higher-quality audited financial statements, we also find that audit effort does not significantly affect the issuance of modified audit opinions overall, but a modified audit opinion is more likely to be issued in the absence of an audit adjustment. Furthermore, we find that the impact of audit effort on audit quality is attenuated when clients are more complex and when audit firms are larger. Collectively, our evidence suggests that audit effort has a significant role in improving audit quality. Our conclusions hold when we control for endogeneity problems.

Our study makes two main contributions. First, we extend the audit literature that examines the economic consequences of audit effort in emerging markets. Prior studies generally use experimental methods or indirect indicators (e.g. audit fees) to measure audit effort (Bonner and Sprinkle, 2002; Gul, 2006; Knechel et al., 2009; Yang and Zhang, 2010). However, audit fees are influenced not only by audit costs, but also by audit risk.[2] To the best of our knowledge, only Caramanis and Lennox (2008) examine the relationship between audit effort and earnings management by clients; they use data for Greece, a developed market. Different from prior studies, this paper comprehensively examines the impact of audit effort on audit quality from the perspective of audit process and audit output based on a unique database on audit days in China, a typical and important emerging market.

Second, our study contributes to the literature on the realization mechanism of audit quality. This paper describes unobservable auditor behavior throughout the audit process and the realization of audit objectives with observable measures, including audit adjustments, audit opinions, and the quality of audited financial statements. We find that audit effort promotes auditors' detection and adjustment of misstatements, as well as reporting material misstatements, which improves the quality of audited financial statements and thus provides evidence on the realization mechanism of audit quality. Our findings have some implications for the improvement of audit market efficiency in China and suggest that auditors should invest sufficient audit

[2] The literature using audit fees as proxy for audit effort has not reached a consistent conclusion. For example, Lobo and Zhao (2013) found a significant positive correlation between audit effort and audit quality, while Hribar et al. (2014) found a significant negative correlation. These contrary conclusions may be the result of ineffective measures of audit effort.

resources to improve audit quality, so as to promote the development of the economy through high-quality audits.

2. Literature review and hypothesis development

2.1. Literature review

Audit quality is defined as the joint probability that an existing material misstatement is detected and reported by an auditor (DeAngelo, 1981), and is generally considered to be determined by the auditor's independence and competency (DeFond and Zhang, 2014). One line of the literature studies the factors affecting auditor independence, such as client importance, audit firm tenure, auditor mandatory rotation, and fees from audit and non-audit services (Reynolds and Francis, 2000; Frankel et al., 2002; Kinney et al.,2004; Carey and Simnett, 2006; Chen and Xia, 2006; Lennox et al., 2014; Zhang et al., 2017). Another line of research studies the characteristics of auditors and audit firms, such as auditor demographic characteristics (Cheng et al., 2009; Gul et al., 2013; He et al., 2018), characteristics of auditor experience (Zhang and Fu, 2008; Fang, 2011; Wang et al., 2015), audit firm size and reputation (Qi et al., 2004; Liu and Zhou, 2007), and the efficiency improvement associated with audit firm mergers (Gong et al., 2016). Prior studies on audit quality mainly focus on audit output measured by audit opinions or accounting quality. However, we still know little about the audit process, especially how it affects the realization of audit quality. This paper investigates the realization mechanism of audit quality from the perspective of audit process and audit output, and thus contributes to the growing literature on the determinants of audit quality.

Audit effort not only affects the probability that auditors will detect an existing material misstatement but also plays an important role in the communication between the auditor and client management. However, there is little academic evidence regarding the impact of audit effort on audit quality; this is attributed to a lack of datasets on audit effort. Dye (1993, 1995) and Hillegeist (1999) suggest that theoretically, hard-working auditors are more likely to detect overstated earnings. The experimental work of Bonner and Sprinkle (2002) indicates that monetary incentives for audit effort have a positive effect on audit performance. Lobo and Zhao (2013) and Hribar et al. (2014) use audit fees as a proxy for audit effort to study the impact on audit quality, but they come to contrary conclusions. Caramanis and Lennox (2008) use a unique database of audit hours in Greece between 1994 and 2002 and find that abnormal accruals are positive more often than negative when audit hours are lower. Gong et al. (2016) utilize audit firm mergers in China and find a significant reduction of audit effort arising from audit market consolidation, but they focus on the factors impacting audit effort rather than the effect of audit effort on audit quality. To summarize, evidence on the economic consequences of audit effort is generally based on mature audit markets in developed markets; China, a typical and important emerging market, has received relatively little attention, which provides a good opportunity for our study.

2.2. Hypothesis development

In practice, audit is regarded as a process of information searching, processing, judging and adjusting (Gibbins, 1984). A complete audit process generally includes accepting business entrustment, planning audit work, identifying, evaluating and responding to material misstatement risk, and preparing audit reports. The overall audit objectives are to obtain reasonable assurance that there is no material misstatement caused by fraud or error in financial statements, and to issue audit reports in accordance with auditing standards and communicate with client management (MOF, 2019). To realize these objectives, in the modern risk-oriented audit model, the main line of audit work requires auditors to identify, evaluate and respond to the risk of material misstatement. In audit practice, auditors collect audit evidence through the implementation of audit procedures to detect material misstatements in financial statements. When auditors detect material misstatements, they either communicate with the management of the client to adjust the detected misstatements (i.e. audit adjustment), or they reflect the unadjusted material misstatements in the form of modified audit opinion. Thus, the process of realizing audit quality can be summarized as detecting, adjusting, and reporting material misstatements and achieving audit quality. If we convert the

above conceptual-level audit stages into specific audit variables, they can be made to correspond to the audit adjustment, the audit opinion, and the quality of audited financial statements. In the realization process of audit quality, hard work is necessary for auditors to carry out a successful audit. Dye (1993, 1995) and Hillegeist (1999) also suggest that hard-working auditors are theoretically more likely to detect overstated earnings. Therefore, audit effort is a vital factor that affects audit quality. Accordingly, the impact of audit effort on audit quality can be divided into three aspects: audit adjustment, audit opinion, and the quality of audited financial statements.

First is the impact of audit effort on the occurrence of audit adjustments. An adjustment occurs when two conditions are met: (1) there is a misstatement in the pre-audit financial statements and (2) the auditor detects the misstatement and requires client management to correct it through an adjustment to the financial statements (Lennox et al., 2014). If management approves the identification, judgment, and adjusting requirements, the detected misstatement will be corrected through an audit adjustment. However, if management does not approve and refuses to correct the detected problems, two outcomes may result: (1) the auditor may agree with management's justification of the detected misstatement and waive the proposed audit adjustment, or (2) management and the auditor may be unable to reach an agreement. If the auditor does not accept management's justification of the misstatement and management refuses to accept a proposed audit adjustment, the auditor may respond by issuing a modified audit opinion.

Accordingly, the impact of audit effort on audit adjustments may be reflected in two ways. Audit adjustments may occur more frequently when audit effort is greater, for three reasons. First, with an increase in audit effort, auditors can implement more comprehensive audit procedures and obtain more appropriate and sufficient audit evidence, thus improving the probability that they will detect misstatements. Second, with more appropriate and sufficient audit evidence, the detected misstatements are more likely to have a significant impact on the reasonableness and fairness of the financial statements, so auditors will be less likely to waive proposed audit adjustments. Third, the increase in audit effort may mean that auditors can communicate more effectively with client management and persuade them to correct the detected misstatements through adjustments. However, audit effort may have no effect on audit adjustments, for two reasons. First, although audit effort may increase the probability of auditors detecting existing misstatements, if management does not approve of auditors' judgments and refuses to accept the proposed adjustments, auditors may respond by issuing a modified audit opinion. Second, given the marginal diminishing of audit returns (Caramanis and Lennox, 2008), if the material misstatement risk of pre-audit financial statements is already low or if audit effort for a client is already high, the marginal impact of additional audit effort on adjustments may be not significant. Therefore, we propose the following null hypothesis:

H1. Audit effort has no effect on the occurrence of audit adjustments.

Second is the impact of audit effort on audit opinions. The audit opinion reflects prudence of auditors regarding audit risk. Theoretically, when auditors find no noteworthy violations or misstatement in a company's financial information, they issue an unqualified audit opinion; otherwise, they issue a modified audit opinion. However, because of the inherent limitation of the audit, it is impossible to eliminate audit risk. For example, the auditor may not fully understand the operation and management of the client given limited costs and time, leading to an inaccurate evaluation of material misstatement risk or a failure to identify material misstatements. The auditor may then improperly issue an unqualified audit opinion. Accordingly, the impact of audit effort on audit opinions may result in two outcomes. On the one hand, when audit effort is greater, the auditor could understand the client more deeply, make more accurate assessments of the material misstatement risk, and detect material misstatements. Thus, the auditor will be more likely to issue a modified audit opinion with increased audit effort. On the other hand, greater audit effort may mean deeper communication between the auditor and client management and more detected misstatements, which may lead to a modified audit opinion that could have been corrected through audit adjustments. The auditor would then no longer need to issue a modified audit opinion. To summarize, higher audit effort does not necessarily lead to more frequent issuance of modified audit opinions and could even lead to less frequent issuance, which is related to whether client management accepts the proposed audit adjustments. Therefore, we form the following null hypothesis:

H2. Audit effort has no effect on the issuance of modified audit opinions.

Third is the impact of audit effort on the quality of audited financial statements. In audit practice, auditors obtain reasonable assurance that financial statements are free from material misstatements by implementing a series of audit procedures, which requires a certain amount of audit resources. Therefore, the impact of audit effort on the quality of audited financial statements may be reflected in two outcomes. First, audit effort improves the quality of audited financial statements by increasing the likelihood that auditors will detect, adjust, and report material misstatements. Second, given the marginal diminishing of audit returns (Caramanis and Lennox, 2008), if the quality of pre-audit financial statements or audit effort for a client is already high, the marginal effect of additional audit effort may be not significant. Thus, we propose the following null hypothesis:

H3. Audit effort has no effect on the quality of audited financial statements.

3. Data and methodology

3.1. Sample selection

We obtain proprietary datasets on audit effort and audit adjustments from China's Ministry of Finance (MOF),[3] and we obtain other company-level data from the China Stock Market and Accounting Research (CSMAR) database. We use the following process to refine our sample: (1) we exclude companies in the financial industry; (2) we exclude company-year observations with negative equity; (3) we exclude company-year observations with more than 365 audit days; and (4) we eliminate company-year observations with incomplete financial data. Finally, we obtain 7833 company-year observations over the 6-year period of 2006–2011.

Table 1 presents the sample breakdown by year (Panel A) and industry (Panel B). As Panel A shows, the sample shows an increasing trend and basically keeps pace with the total number of listed companies in China. As Panel B shows, the industry distribution is similar to the overall distribution of listed companies, indicating that our sample has good representativeness.

3.2. Definitions of main variables

It has always been difficult to measure audit effort because of a lack of data. Studies generally use experimental methods or indirect indicators (e.g. audit fees) to measure audit effort (Bonner and Sprinkle, 2002; Gul, 2006; Knechel et al., 2009; Yang and Zhang, 2010). In contrast, we use the aggregate days worked on an audit project by all audit team members obtained from the MOF as the proxy for audit effort. Specifically, we measure audit effort (*EFFORT*) as the natural logarithm of aggregate audit days (=audit days × number of audit team members), which directly reflects the total working time of an audit team on an audit project (Caramanis and Lennox, 2008; Gong et al., 2016).[4]

Following Lennox et al. (2014) and He et al. (2018), we construct the dummy variable *ADJUST* to capture the occurrence of audit adjustments. Specifically, *ADJUST* equals 1 if there is an audit adjustment to company *i* profits in year *t*, and 0 otherwise. We construct the dummy variable *MAO* to capture the issuance of modified audit opinions. Specifically, *MAO* equals 1 if company *i* receives a modified audit opinion in year *t*, and 0 otherwise. Finally, we measure the quality of audited financial statements with the absolute value of discretionary accruals (*DA_ABS*), which are the residuals from the modified Jones model of performance adjustment (Kothari et al., 2005):

[3] From 2006 to 2011, audit firms in China were required to report their clients' pre-audit earnings privately to the MOF (Lennox et al., 2014; He et al., 2018). Therefore, our final sample period is from 2006 to 2011.

[4] On an audit project, the signing CPA is mainly responsible for the audit report. He et al. (2019) suggest that the audit days mainly reflect the audit effort of the signing CPA. Therefore, we also use the natural logarithm of audit days to measure the signing CPAs' effort, and our results are robust.

Table 1
Sample distribution.

Panel A: By year

Year	2006	2007	2008	2009	2010	2011	Total
N	953	1178	1325	1378	1444	1555	7833
%	12.17%	15.04%	16.92%	17.59%	18.43%	19.85%	100.0%

Panel B: By industry

Industry	n	%	Industry	n	%
Agriculture	88	1.12%	Energy and Water	385	4.92%
Mining	208	2.66%	Construction	171	2.18%
Food and Beverage	357	4.56%	Transportation	307	3.92%
Textile, Apparel, Fur, and Leather	263	3.36%	IT and Computing	455	5.81%
Paper and Printing	124	1.58%	Wholesale and Retail Trade	567	7.24%
Petroleum, Chemical, Plastics, and Rubber	823	10.51%	Real Estate	600	7.66%
Electronics	383	4.89%	Public Utilities	167	2.13%
Metal and Non-metal	706	9.01%	Entertainment	55	0.70%
Machinery, Equipment, and Instruments	1318	16.83%	Conglomerates	242	3.09%
Medicine and Biological Products	568	7.25%			
Other Manufacturing	46	0.59%	Total	7833	100.0%

$$\frac{TA_{i,t}}{A_{i,t-1}} = \alpha_1 \frac{1}{A_{i,t-1}} + \alpha_2 \frac{\Delta REV_{i,t} - \Delta REC_{i,t}}{A_{i,t-1}} + \alpha_3 \frac{PPE_{i,t}}{A_{i,t-1}} + \alpha_4 ROA_{i,t-1} + \varepsilon_{i,t} \quad (1)$$

where TA is the total accruals, which is equal to the net profits minus the net cash flows from operating activities, A is the lagged total assets, ΔREV and ΔREC are the changes in sales and accounts receivable, respectively, PPE is the original value of property, plant and equipment, and ROA is the return on total assets. We estimate Eq. (1) for each industry-year that has at least 10 observations, and the residual of Eq. (1) is the discretionary accrual. We then use the absolute value of discretionary accruals (DA_ABS) to measure the quality of audited financial statements. A smaller DA_ABS means higher audited financial quality.

3.3. Model specification

Following He et al. (2018) and Lennox et al. (2018), we test H1-H3 by estimating the following models:

$$ADJUST = \alpha_0 + \alpha_1 EFFORT + \gamma \sum CONTROLS + \varepsilon \quad (2)$$

$$MAO = \beta_0 + \beta_1 EFFORT + \lambda \sum CONTROLS + \varepsilon \quad (3)$$

$$DA\_ABS = \theta_0 + \theta_1 EFFORT + \kappa \sum CONTROLS + \varepsilon \quad (4)$$

where Eqs. (2) and (3) are estimated using a logit model and Eq. (4) is estimated using a tobit model. The dependent variables $ADJUST$, MAO, and DA_ABS are proxies for the auditors' detecting and adjusting misstatements, reporting material misstatements, and achieving audit quality, respectively. The variable of interest, $EFFORT$, measures audit effort. Following the literature, we include two sets of control variables. The first set captures client characteristics: we control for $SIZE$, equal to the natural logarithm of total assets; LEV, equal to the total liabilities divided by the total assets; BM, equal to the book-to-market ratio; AGE, equal to the natural logarithm of the company's age; SOE, equal to 1 for stated-owned enterprises, and 0 otherwise; ROA, equal to audited profits divided by total assets; $BOARD$, equal to the natural logarithm of the number of directors on the board; $INDDIR$, equal to the percentage of independent directors on the board; $CASH$, equal to cash and cash equivalents divided by total assets; REC, equal to accounts receivable divided by total assets; INV, equal to inventory divided by total assets; RPT, equal to related-party transactions divided by sales; and $SUBS$, equal to the natural logarithm of the number of consolidated subsidiaries. The second set of control variables captures audit firm characteristics, including $SWITCH$, equal to 1 if company i hires a new audit firm in year t, and 0 otherwise; $TENURE$, equal to the consecutive years the incumbent audit firm has audited the company; BIG_AUDIT, equal to 1 for international Big 4 or Chinese domestic Big 10 audit

firms, and 0 otherwise; *MA_AUDIT*, equal to 1 if the incumbent audit firm merges with another audit firm in year *t*; *MROT_FINAL*, equal to 1 if the engagement partner is in the final year of tenure in year *t* because the partner is scheduled for mandatory rotation at the end of the audit, and 0 otherwise; and *MROT_FIRST*, equal to 1 if the engagement partner is in the first year of tenure in year *t* due to mandatory rotation of the former partner at the end of year $t-1$, and 0 otherwise. We also include industry and year fixed effects in all the regressions. We cluster standard errors by client given multiple yearly observations for each client (Petersen, 2009).

4. Main results

4.1. Summary statistics

Table 2 presents the summary statistics for the main variables. All of the continuous variables are winsorized at the top and bottom 1 percent to mitigate the influence of extreme values. The mean of *ADJUST* is 0.663, indicating that 66.3% of the observations in our sample had audit adjustments, which is similar to the findings of Lennox et al. (2014) and He et al. (2018). The mean of *MAO* is 0.055, indicating that 5.5% of the observations received a modified audit opinion. The mean (median) of *DA_ABS* is 0.075 (0.049). The mean (median) of *EFFORT* is 5.571 (5.541), which is similar to the findings of Gong et al. (2016).[5] The distribution of the other variables is similar to those in prior Chinese studies.

4.2. Regression results

Table 3 reports the regression results of estimating Eq. (2). The coefficient on *EFFORT* in column (1) is positive and significant at the 1% level (0.1596 with *z*-stat. = 5.03), indicating that audit adjustments occur more frequently with increased audit effort. That may be because an increase in audit effort results in auditors detecting more material misstatements and communicating more effectively with client management. Given the mean value of the control variables, when *EFFORT* rises from the first quantile to the third quantile, the predicted audit adjustment probability increases by 5.19%, which is similar to the result in He et al. (2018). Thus, the impact of audit effort on audit adjustments is both economically and statistically significant. In addition, the behavior of the control variables is consistent with that in prior studies. For example, audit adjustments occur less often for larger companies, older companies, companies audited by Big 10 audit firms, and state-owned-enterprises. Audit adjustments occur more often when the incumbent audit firm has a longer tenure or engages in an M&A transaction, or during the departing partner's final year of tenure prior to mandatory rotation.

Considering the different impacts of audit adjustments on profits in different directions, we further investigate the different effects of audit effort on upward and downward adjustments. Auditors' reputations are damaged if their clients are found to have overstated earnings, but there is generally no penalty when clients understate earnings (St. Pierre and Anderson, 1984; Kellogg, 1984; Caramanis and Lennox, 2008). Consistent with the asymmetric loss functions faced by auditors, they tend to disagree with client management on accounting choices that increase earnings rather than those that decrease earnings, and they require management to adjust earnings downward (DeFond and Jiambalvo, 1993; Kinney and Marti, 1994; Nelson et al., 2002). Therefore, we predict that the effect of audit effort on downward audit adjustments will be more significant than that on upward adjustments. Following Lennox et al. (2014), we construct a trichotomous variable (*ADJ_SGN*) that equals 2 when there is a net downward adjustment, 1 when there is a net upward adjustment, and 0 when there is no adjustment. Columns (2) and (3) of Table 3 present the results for a multinomial logit model with the no-adjustment observations as the benchmark. Consistent with the prediction, we find a more significant coefficient on *EFFORT* in column (2) than in column (3) (*z*-stat. = 5.32, 1.94), which indicates that auditors require more downward adjustments than upward adjustments as audit effort increases.

[5] We note that the mean (median) of *EFFORT* is 7.017 (7.155) in Gong et al. (2016), who use audit hours instead of audit days to measure audit effort. Assuming that auditors work 8 h a day, our measure of audit effort should differ from theirs by Ln (8) or 2.08.

Table 2
Summary statistics.

Variables	Mean	Std.	25%	Median	75%
ADJUST	0.663	0.473	0.000	1.000	1.000
MAO	0.055	0.227	0.000	0.000	0.000
DA_ABS	0.075	0.086	0.022	0.049	0.094
EFFORT	5.571	1.141	4.787	5.541	6.269
SIZE	21.70	1.231	20.86	21.59	22.41
LEV	0.519	0.233	0.364	0.518	0.654
BM	0.937	0.823	0.397	0.683	1.193
AGE	1.989	0.778	1.609	2.303	2.565
SOE	0.612	0.487	0.000	1.000	1.000
ROA	0.052	0.066	0.028	0.050	0.080
BOARD	2.201	0.200	2.197	2.197	2.303
INDDIR	0.363	0.050	0.333	0.333	0.375
CASH	0.155	0.120	0.070	0.124	0.206
REC	0.091	0.089	0.021	0.0660	0.137
INV	0.181	0.159	0.072	0.143	0.232
RPT	0.867	2.493	0.090	0.329	0.774
SUBS	2.088	0.930	1.386	2.079	2.708
SWITCH	0.092	0.289	0.000	0.000	0.000
TENURE	5.793	3.271	3.000	6.000	8.000
BIG_AUDIT	0.463	0.499	0.000	0.000	1.000
MA_AUDIT	0.152	0.359	0.000	0.000	0.000
MROT_FINAL	0.061	0.240	0.000	0.000	0.000
MROT_FIRST	0.055	0.228	0.000	0.000	0.000

This result also suggests that audit effort may restrain overly optimistic earnings or upward earnings management behavior by management.

Table 4 reports the regression results of the estimation of Eq. (3).[6] The coefficient on *EFFORT* in column (1) is positive but not significant for the full sample, indicating that audit effort does not have a significant effect on the issuance of a modified audit opinion overall. This result also coincides with the finding in Table 3. With increased audit effort, client management accepts adequate adjustments to correct detected misstatements and thus avoids a modified audit opinion. It is noteworthy that companies in China may prefer receiving a modified audit opinion to accepting audit adjustments under certain circumstances because of explicit requirements by the China Securities Regulatory Commission (CSRC) regarding target profitability levels (Chen et al., 2001; He et al., 2012). For example, since 2000, companies are given "special treatment" (ST) status if they report two consecutive years of losses, and ST companies are delisted if they report a loss in a third consecutive year. In addition, companies seeking to raise equity must maintain a certain minimum return on equity for three consecutive years. Because of these institutional features in China, the expected cost of receiving a modified audit opinion may be lower than that of accepting audit adjustments that hurt profits (Chen et al., 2001). We conjecture that audit effort may promote the issuance of modified audit opinions in the absence of audit adjustment.

To test this conjecture, we divide the full sample into two subsamples according to whether there is an audit adjustment, and we test the effect of audit effort on modified audit opinions using two subsamples. Columns (2) and (3) of Table 4 present the results. We find an insignificant coefficient on *EFFORT* for the subsample with audit adjustments in column (2) and a significant positive coefficient on *EFFORT* for the subsample with no audit adjustment in column (3),[7] indicating that when material misstatements have been corrected through audit adjustment, audit effort does not have a significant effect on the issuance of an modified audit opinion. However, if client management rejects the proposed adjustments, auditors will respond by issuing a modified

[6] The number of observations is slightly reduced in this analysis compared with Table 3 because the value of *MAO* is all zero for some industries.

[7] This subsample consists of two cases: (1) when there is no material misstatement in pre-audit financial statements and no adjustment is needed, and (2) when a proposed adjustment is declined by management. Our prediction holds for the second case. However, we cannot empirically separate these two cases.

Table 3
Audit effort and audit adjustment.

Dependent variable: *ADJUST*/*ADJ_SGN*	(1) *ADJUST*	(2) *ADJ_SGN* = 1	(3) *ADJ_SGN* = 2
EFFORT	**0.1596*****	**0.1802*****	**0.0723***
	(5.03)	**(5.32)**	**(1.94)**
SIZE	−0.2648***	−0.3083***	−0.1312**
	(−5.49)	(−6.04)	(−2.47)
LEV	−0.2655	−0.0234	−0.0594*
	(−1.26)	(−1.17)	(−1.68)
BM	−0.0147	0.0105	−0.1428**
	(−0.27)	(0.20)	(−2.16)
AGE	−0.1007*	−0.1703***	0.0166
	(−1.65)	(−2.70)	(0.24)
SOE	−0.3356***	−0.3835***	−0.2524**
	(−3.70)	(−4.08)	(−2.41)
ROA	0.4664	−0.2996	1.0187**
	(0.83)	(−0.83)	(1.98)
BOARD	−0.1450	−0.0826	−0.3204
	(−0.68)	(−0.38)	(−1.33)
INDDIR	0.0431	−0.1695	0.0107
	(0.06)	(−0.24)	(0.01)
CASH	−0.3349	−0.4026	0.2993
	(−0.97)	(−1.38)	(1.53)
REC	0.3501	0.3292	0.3418
	(0.68)	(0.61)	(0.56)
INV	−0.5011	−0.5395	−0.5515
	(−1.52)	(−1.63)	(−1.44)
RPT	−0.0006	−0.0316	−0.1302**
	(−0.05)	(−0.63)	(−2.16)
SUBS	−0.0134	0.0114	−0.0487
	(−0.27)	(0.20)	(−0.77)
SWITCH	0.0066	0.0796	−0.1278
	(0.07)	(0.77)	(−1.02)
TENURE	0.0897***	0.1026***	0.0684***
	(6.03)	(6.57)	(4.02)
BIG_AUDIT	−0.3694***	−0.3700***	−0.3599***
	(−4.61)	(−4.44)	(−3.89)
MA_AUDIT	0.4240***	0.3996***	0.4742***
	(4.67)	(4.23)	(4.44)
MROT_FINAL	0.1816*	0.2203*	0.0904
	(1.70)	(1.91)	(0.66)
MROT_FIRST	0.1036	0.0548	0.1956
	(0.92)	(0.46)	(1.40)
Constant	6.5202***	7.0185***	2.8243**
	(6.02)	(6.13)	(2.18)
Industry fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
N	7833		7833
Pseudo-R^2	0.0711		0.0551
Wald Chi^2	415.92		7935.64
Prob. > Chi^2	0.0000		0.0000

Notes: Column (1) presents the result of a logit model, and columns (2) and (3) present the results of a multinomial logit model. The *z*-statistics shown in parentheses are adjusted for clustering by client. ***, **, and * denote significance at the 1%, 5%, and 10% levels (two-tailed), respectively.

Table 4
Audit Effort and Audit Opinion.

Dependent variable: *MAO*	(1) Full sample	(2) *ADJUST* = 1	(3) *ADJUST* = 0
EFFORT	**0.0142**	**−0.0633**	**0.2285***
	(0.16)	**(−0.69)**	**(1.75)**
SIZE	−0.8758***	−0.9058***	−1.3902***
	(−5.62)	(−7.23)	(−7.50)
LEV	4.1611***	5.5509***	5.6941***
	(8.81)	(8.69)	(5.92)
BM	0.2356	0.0796	0.5320***
	(1.54)	(0.51)	(2.97)
AGE	0.6715***	0.4950***	1.0556***
	(3.19)	(2.86)	(3.71)
SOE	−0.1124	−0.1150	−0.7671***
	(−0.51)	(−0.63)	(−2.61)
ROA	−7.6927***	−8.0118***	−8.0704***
	(−8.67)	(−8.55)	(−5.49)
BOARD	0.6147	0.7708	1.0060
	(0.95)	(1.20)	(1.12)
INDDIR	3.5559*	3.9946*	0.0341
	(1.86)	(1.76)	(0.01)
CASH	−1.5731	−4.0246***	−1.3405
	(−1.36)	(−3.98)	(−0.98)
REC	0.2171	−0.5425	0.2675
	(0.20)	(−0.58)	(0.17)
INV	−3.3477***	−2.5412***	−2.8060**
	(−3.67)	(−3.86)	(−2.49)
RPT	0.0431**	−0.0132	−0.0010
	(2.26)	(−0.27)	(−0.01)
SUBS	−0.0472	0.0481	−0.0206
	(−0.34)	(0.38)	(−0.10)
SWITCH	0.0274	0.1495	−0.0774
	(0.12)	(0.50)	(−0.21)
TENURE	−0.0647*	−0.0115	−0.1551***
	(−1.92)	(−0.38)	(−3.09)
BIG_AUDIT	0.1187	0.0040	−0.2855
	(0.66)	(0.02)	(−0.65)
MA_AUDIT	0.3257*	0.3466*	−0.3188
	(1.86)	(1.94)	(−1.19)
MROT_FINAL	−0.2018	−0.4500	0.3037
	(−0.60)	(−1.00)	(0.43)
MROT_FIRST	−0.2644	−0.5660	−0.2561
	(−0.75)	(−1.31)	(−0.30)
Constant	11.4577***	10.3938***	22.2490***
	(3.47)	(3.53)	(5.25)
Industry fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
N	7550	4655	2088
Pseudo-R^2	0.4282	0.3847	0.4438
Wald Chi^2	556.03	460.70	210.73
Prob. > Chi^2	0.0000	0.0000	0.0000

Notes: The *z*-statistics shown in parentheses are adjusted for clustering by client. ***, **, and * denote significance at the 1%, 5%, and 10% levels (two-tailed), respectively.

audit opinion. Given the mean value of the control variables, when *EFFORT* increases from the first quantile to the third quantile, the predicted modified audit opinion probability increases by 0.62%, which is economically significant.

Table 5 reports the regression results of the estimation of Eq. (4).[8] The coefficient on *EFFORT* in column (1) is negative and significant at the 1% level (−0.0034 with *t*-stat. = −3.16), indicating that the absolute value of discretionary accruals decreases significantly as audit effort increases. Given the mean value of the control variables, when *EFFORT* increases from the first quantile to the third quantile, the predicted absolute value of discretionary accruals decreases by 6.72%.

Considering the different impacts of discretionary accruals on profits in different directions, we further investigate the different effects of audit effort on positive and negative discretionary accruals. Auditors' reputations are damaged if their clients are found to have overstated earnings, but there is generally no penalty when clients understate earnings (St. Pierre and Anderson, 1984; Kellogg, 1984). The results in Table 3 also show that the effect of audit effort on downward audit adjustments is more significant than that on upward adjustments. Therefore, we predict that the effect of audit effort on positive discretionary accruals will be more significant than that on negative discretionary accruals. To test this prediction, we divide the full sample into two subsamples according to the sign of the discretionary accruals, *DA_POS* and *DA_NEG*. We then test the effects of audit effort on *DA_POS* and *DA_NEG*. Columns (2) and (3) of Table 5 present the results. Consistent with our prediction, we find a significant and negative coefficient on *EFFORT* when the dependent variable is *DA_POS*, as shown in column (2), and an insignificant coefficient on *EFFORT* when the dependent variable is *DA_NEG*, as shown in column (3), indicating that the positive discretionary accruals are significantly inhibited as audit effort increases but that the negative discretionary accruals are not sensitive to audit effort. In other words, auditors pay more attention to positive discretionary accruals than to negative discretionary accruals. It is worth noting that these results are consistent with the findings in Table 3. From the perspective of audit process, an increase in audit effort mainly promotes downward audit adjustments. Correspondingly, from the perspective of audit output, increased audit effort mainly restrains positive discretionary accruals.

To strengthen the logic of this paper, we divide the full sample into two subsamples according to whether there is an audit adjustment, and we test the effect of audit effort on the absolute value of discretionary accruals using two subsamples. Columns (4) and (5) of Table 5 present the results. We find a significantly negative coefficient on *EFFORT* for the subsample with audit adjustments in column (4) and an insignificant coefficient on *EFFORT* for the subsample with no audit adjustment in column (5), which indicates that the inhibitory effect of audit effort on discretionary accruals only exists when there is an audit adjustment. These results further support that audit effort improves the quality of audited financial statements and that this effect is mainly achieved through audit adjustments.

4.3. Endogeneity issue

Audit effort is endogenous. It may be determined by clients' characteristics, including client size, business complexity, and operation risk. However, it may be also determined by auditors' characteristics, such as audit firm size, audit firm tenure, and mandatory rotation of audit partners. In addition, audit effort may be persistent over time, making the previous year's audit effort closely associated with the current year's audit effort (Caramanis and Lennox, 2008). To address the endogeneity issue, we estimate the abnormal audit effort according to the ideas of abnormal accruals and abnormal audit fees. We estimate a model of audit effort as follows:

$$EFFORT = \varphi_0 + \varphi_1 LagEFFORT + \phi \sum CONTROLS + \varepsilon \quad (5)$$

[8] To understand the economic implications more intuitively, we also use an ordinary least squares (OLS) model, and all our results are robust.

Table 5
Audit Effort and the Quality of Audited Financial Statements.

Dependent variable: *DA_ABS*	(1) *DA_ABS*	(2) *DA_POS*	(3) *DA_NEG*	(4) *ADJUST* = 1	(5) *ADJUST* = 0
EFFORT	**−0.0034*** **	**−0.0032*** **	**0.0011**	**−0.0040*** **	**0.0002**
	(−3.16)	**(−3.03)**	**(1.10)**	**(−3.06)**	**(0.12)**
SIZE	0.0018	0.0026	0.0012	0.0025	0.0002
	(1.12)	(1.59)	(0.92)	(1.29)	(0.08)
LEV	0.1079***	0.0275***	−0.0742***	0.1139***	0.1022***
	(10.14)	(3.61)	(−12.96)	(7.67)	(7.00)
BM	−0.0216***	−0.0059**	0.0093***	−0.0198***	−0.0130***
	(−8.38)	(−2.50)	(5.60)	(−6.93)	(−4.82)
AGE	−0.0004	−0.0032*	−0.0074***	0.0008	0.0012
	(−0.19)	(−1.65)	(−4.42)	(0.32)	(0.39)
SOE	−0.0120***	−0.0078***	0.0075***	−0.0132***	−0.0142***
	(−4.74)	(−3.13)	(3.21)	(−4.58)	(−2.92)
ROA	0.1507***	0.3565***	0.1518***	0.0091	0.0666
	(4.74)	(13.02)	(7.40)	(0.26)	(1.31)
BOARD	−0.0272***	−0.0090	0.0186***	−0.0245***	−0.0173*
	(−4.02)	(−1.62)	(3.04)	(−3.58)	(−1.78)
INDDIR	0.0354	0.0223	0.0203	0.0529*	−0.0572
	(1.15)	(1.01)	(1.00)	(1.82)	(−1.47)
CASH	0.0050**	−0.0141	−0.1194***	0.0653***	0.0930***
	(2.28)	(−1.25)	(−11.23)	(4.44)	(4.17)
REC	−0.0318**	0.0380**	0.0475***	−0.0138	−0.0345
	(−1.99)	(2.32)	(3.53)	(−0.67)	(−1.30)
INV	0.0488***	0.0891***	−0.0074	0.0417***	0.0896***
	(3.68)	(8.54)	(−0.69)	(2.77)	(4.61)
RPT	−0.0000	0.0016***	0.0002	0.0010*	0.0013
	(−1.43)	(2.71)	(0.81)	(1.71)	(1.54)
SUBS	−0.0049***	−0.0030**	0.0026**	−0.0048***	−0.0037
	(−3.08)	(−2.14)	(1.99)	(−2.67)	(−1.59)
SWITCH	0.0134***	0.0060	−0.0072*	0.0069	0.0194***
	(3.12)	(1.63)	(−1.91)	(1.27)	(2.82)
TENURE	−0.0008*	−0.0007	0.0003	−0.0011*	−0.0009
	(−1.69)	(−1.49)	(0.79)	(−1.89)	(−1.13)
BIG_AUDIT	−0.0001	0.0010	0.0006	−0.0018	0.0025
	(−0.04)	(0.37)	(0.22)	(−0.59)	(0.46)
MA_AUDIT	−0.0069***	−0.0078***	0.0034*	−0.0033	−0.0121***
	(−3.10)	(−3.59)	(1.66)	(−1.24)	(−3.00)
MROT_FINAL	−0.0067*	−0.0056	0.0034	−0.0050	−0.0124*
	(−1.73)	(−1.41)	(0.93)	(−1.07)	(−1.83)
MROT_FIRST	0.0032	0.0034	0.0008	0.0019	0.0071
	(0.81)	(0.78)	(0.20)	(0.41)	(0.89)
Constant	0.0798**	0.0173	−0.1130***	0.0540	0.0526
	(2.15)	(0.50)	(−3.33)	(1.24)	(1.14)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
N	7833	4122	3711	5197	2636
Pseudo-R^2	−0.0955	−0.0999	−0.1025	−0.0856	−0.1117
F	43.09	18.78	63.25	8.77	234.62
Prob. > F	0.0000	0.0000	0.0000	0.0000	0.0000

Notes: The *t*-statistics shown in parentheses are adjusted for clustering by client. ***, **, and * denote significance at the 1%, 5%, and 10% levels (two-tailed), respectively.

The dependent variable *EFFORT* measures the current year's audit effort. One of the determinants of the current year's audit effort is the previous year's audit effort (*LagEFFORT*). The other determinants are the same as the control variables in Eq. (2). We estimate Eq. (5) for each industry-year, and the residual of

Table 6
Abnormal audit effort as the independent variable.

	(1) *ADJUST*	(2) *MAO*	(3) *DA_ABS*
Ab_EFFORT	**0.1588*****	**−0.0006**	−0.0004**
	(3.19)	**(−0.00)**	(−1.99)
Controls	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
N	6771	6335	6784
Pseudo-R^2	0.0690	0.4232	−0.0434
Wald Chi^2/F	309.85	528.94	30.32
Prob. > Chi^2/F	0.0000	0.0000	0.0000

Notes: Columns (1) and (2) present the results for the logit model, and column (3) presents the results for the tobit model. The *z*-statistics/*t*-statistics shown in parentheses are adjusted for clustering by client. ***, **, and * denote significance at the 1%, 5%, and 10% levels (two-tailed), respectively.

Eq. (5) is the abnormal audit effort (*Ab_EFFORT*).[9] Next, we replace the independent variable *EFFORT* with *Ab_EFFORT* in Eq. (2)–(4). Table 6 reports the regression results. Our inferences are unchanged when we repeat the analysis with abnormal audit effort.

Although we have regarded the company's decision to hire an audit firm as exogenous, in reality, the company could choose an audit firm to serve their own interests (Chen and Zhou, 2006). This raises another possible endogeneity issue, self-selection, because a company may choose a lower-quality audit firm if it intends to manipulate earnings. In this case, lower audit effort is associated with lower probability of audit adjustments and higher discretionary accruals. We argue that endogeneity is more likely to be a problem when audit firm tenure is short, and it is reasonable to regard the audit firm choice as exogenous when audit firm tenure is long.[10] If our findings are mainly driven by endogenous audit firm choice, the results should disappear or be much weaker in a long-tenure subsample.

Based on the above analysis, we estimate Eqs. (2)–(4) after partitioning the sample by the median of audit firm tenure (i.e., 6 years). Table 7 reports the regression results. We find that the coefficients on *EFFORT* are both significant at least at the 5% significance level in the two subsamples when the dependent variable is *ADJUST* or *DA_ABS*. We also find that the coefficients on *EFFORT* are both insignificant when the dependent variable is *MAO*. Overall, these results indicate that our findings do not appear to be driven by the endogeneity of audit firm choice.

4.4. Other robustness tests

We perform a battery of additional tests to ascertain the robustness of our findings. First, we include client fixed effects to alleviate the potential impact of other unobservable factors that do not vary with time at the client level. Panel A of Table 8 presents the regression results, and we find that the results hold when controlling client fixed effects. Second, we use the magnitude of audit adjustments (*ADJ_MAG*) as an alternative measure of audit adjustments. Specifically, we use the absolute value of the difference between pre-audit and audited earnings divided by the absolute value of pre-audit earnings (i.e., $|E_{PRE}\text{-}E_{AUD}|/|E_{PRE}|$) and then take the natural logarithm as the measure of adjustment magnitude. Column (1) in Panel B of Table 8 shows that the coefficient on *EFFORT* is positive and significant at the 1% level, indicating that increased audit effort not only improves the frequency of audit adjustments but also increases the magnitude of audit adjustments.

[9] Untabulated results show that the mean (median) of the adjusted R^2 of the model (5) is 0.4371 (0.4478), the standard deviation is 0.3285, and the first and third quantiles are 0.2733 and 0.6119, respectively. Overall, the estimation model of abnormal audit effort fits well.

[10] For example, suppose that two companies, C1 and C2, were audited by the same low-quality audit firm A in 2005. Company C1 initially hired audit firm A in 2000, while company C2 initially hired the same audit firm A in 2005. We argue that company C2 is more likely to hire audit firm A due to its motivation of earnings manipulation. The audit firm choice of company C1 is less likely to be an endogeneity issue because of the longer lag between the audit firm's hiring choice and the motivation of earnings manipulation.

Table 7
Impact of audit firm tenure.

Panel A: Long-tenure subsample

	(1) *ADJUST*	(2) *MAO*	(3) *DA_ABS*
EFFORT	**0.2234*****	**−0.1726**	**−0.0021****
	(4.74)	**(−1.46)**	**(−2.02)**
Controls	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
N	3604	3439	3636
Pseudo-R^2	0.0683	0.4060	−0.0557
Wald Chi^2/F	189.24	319.89	215.66
Prob. > Chi^2/F	0.0000	0.0000	0.0000

Panel B: Short-tenure subsample

	(1) *ADJUST*	(2) *MAO*	(3) *DA_ABS*
EFFORT	**0.1094*****	**0.1324**	**−0.0031*****
	(2.60)	**(1.07)**	**(−3.22)**
Controls	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
N	4196	4197	4197
Pseudo-R^2	0.0837	0.4692	−0.0777
Wald Chi^2/F	494.60	378.63	29.66
Prob. > Chi^2/F	0.0000	0.0000	0.0000

Notes: Columns (1) and (2) present the results for the logit model, and column (3) presents the results for the tobit model. The *z*-statistics/*t*-statistics shown in parentheses are adjusted for clustering by client. ***, **, and * denote significance at the 1%, 5%, and 10% levels (two-tailed), respectively.

Finally, we examine whether the results are robust to alternative measures of the quality of audited financial statements. Following Gong et al. (2016), we use the probability of a restatement to proxy for the quality of audited financial statements. Specifically, the dummy variable *MISSTATEMENT* equals 1 if the audited financial statements of a firm-year observation are misstated and the earnings are restated downward, and 0 otherwise (Guan et al., 2016). In addition, we use clients' accounting conservatism to proxy for the quality of audited financial statements. Following Khan and Watts (2009), we construct the firm-year level accounting conservatism index *C_SCORE*. A larger *C_SCORE* reflects greater accounting conservatism and higher-quality audited financial statements. Columns (2) and (3) in Panel B of Table 8 report the corresponding regression results. We find that the coefficients on *EFFORT* are significant at the 5% and 1% levels, indicating that increased audit effort reduces the probability of financial statement restatement and improves clients' accounting conservatism. These results provide further evidence that the quality of audited financial statements improves as audit effort increases.

5. Additional analyses

5.1. The impact of client characteristics

The previous section examines the relationship between audit effort and audit adjustment, audit opinion, and the quality of audited financial statements. However, the above relationship may be affected by the complexity and risk of the client. Auditors may have expectations regarding the difficulty and risk of the audit work and may therefore improve their work efficiency during the audit process for complex clients to reduce

Table 8
Other robustness tests.

Panel A: Controlling client fixed effects

	(1) *ADJUST*	(2) *MAO*	(3) *DA_ABS*
EFFORT	**0.2005*****	**0.0441**	**−0.0024****
	(4.84)	**(0.35)**	**(−2.01)**
Controls	Yes	Yes	Yes
Client fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
N	4571	853	7833
Pseudo-R^2	0.0401	0.3469	0.0468
Wald Chi^2/F	129.75	93.13	6.81
Prob. > Chi^2/F	0.0000	0.0000	0.0000

Panel B: Alternative measures of key variables

	(1) *ADJ_MAG*	(2) *MISSTATEMENT*	(3) *C_SCORE*
EFFORT	**0.0058*****	**−0.1336****	**0.0012*****
	(2.65)	**(−2.12)**	**(3.04)**
Controls	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
N	7833	7833	7833
Pseudo-R^2/Adj-R^2	0.1065	0.1163	0.5191
Wald Chi^2/F	18.17	244.55	149.91
Prob. > Chi^2/F	0.0000	0.0000	0.0000

Notes: The *z*-statistics/*t*-statistics shown in parentheses are adjusted for clustering by client. ***, **, and * denote significance at the 1%, 5%, and 10% levels (two-tailed), respectively.

the audit risk to an acceptable level within the limited time. At the same time, because of the complexity of transactions, the quality of the pre-audit financial statements of such clients may be relatively low, which gives the auditors greater ability to promote the quality of financial statements through audit effort. We therefore expect audit effort to play a more significant role in improving audit quality when clients are more complex. However, it could be difficult for auditors to fully understand the operations of complex clients, to accurately assess the risk of material misstatements, and to detect potential misstatements. Therefore, under the same level of audit effort, the improvement in audit quality may be more limited in more complex clients. Moreover, auditors may make greater audit efforts with complex clients, and the diminishing returns could attenuate the effect of audit effort on audit quality. Thus, we would expect audit effort to play a less significant role in improving audit quality when clients are complex.

Following Pittman et al. (2019), we use client size (*SIZE*), the number of consolidated subsidiaries (*SUBS*), and the amounts of related party transactions divided by sales (*RPT*) as proxies for client complexity. Then, we partition the sample by the medians of *SIZE*, *SUBS*, and *RPT* and re-estimate Eqs. (2)–(4). Table 9 presents the regression results. Panel A of Table 9 shows that although the coefficients on *EFFORT* are significant for larger clients when the dependent variable is *ADJUST* or *DA_ABS*, the absolute values and significance of these coefficients are lower than those for smaller clients. Furthermore, we use the seemingly unrelated estimation (SUE) method to test the difference between the coefficients in the two subsamples. We find that the difference is significant at the 5% level, which provides support for the effects of audit effort on audit adjustments and indicates that the quality of audited financial statements is attenuated when clients are larger. Similarly, Panels B and C present the regression results of subsamples based on *SUBS* and *RPT*, respectively. We find that the effects of audit effort on audit adjustments and the quality of audited financial statements are less significant in clients with more subsidiaries and those with more related party transactions. In addition,

Table 9
Impact of client characteristics.

Panel A: By client size

	ADJUST		*MAO*		*DA_ABS*	
	(1) Larger	(2) Smaller	(3) Larger	(4) Smaller	(5) Larger	(6) Smaller
EFFORT	0.1322***	0.2601***	0.1592	−0.0586	−0.0016	−0.0053***
	(3.08)	(5.50)	(0.92)	(−0.51)	(−1.64)	(−3.24)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	3917	3916	3137	3716	3917	3916
Pseudo-R^2	0.0852	0.0567	0.3240	0.4719	−0.0642	−0.0793
Wald Chi^2/F	209.16	188.59	892.68	1052.84	65.83	18.06
Prob. > Chi^2/F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Test the difference in coefficients of EFFORT:						
Chi^2	4.06**		1.08		3.96**	
p-value	[0.0439]		[0.2919]		[0.0465]	

Panel B: By the number of consolidated subsidiaries

	ADJUST		*MAO*		*DA_ABS*	
	(1) More	(2) Fewer	(3) More	(4) Fewer	(5) More	(6) Fewer
EFFORT	0.1259***	0.2597***	0.0199	0.0087	−0.0017*	−0.0051***
	(3.20)	(4.82)	(0.17)	(0.06)	(−1.70)	(−2.84)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	4231	3602	3465	3340	4231	3602
Pseudo-R^2	0.0878	0.0633	0.4384	0.4640	−0.0660	−0.0771
Wald Chi^2/F	240.04	188.83	411.88	622.36	46.30	6.80
Prob. > Chi^2/F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Test the difference in coefficients of EFFORT:						
Chi^2	4.05**		0.00		2.96*	
p-value	[0.0441]		[0.9504]		[0.0851]	

Panel C: By the amounts of related party transactions

	ADJUST		*MAO*		*DA_ABS*	
	(1) More	(2) Fewer	(3) More	(4) Fewer	(5) More	(6) Fewer
EFFORT	0.1082**	0.2207***	0.1253	−0.0062	−0.0016*	−0.0046***
	(2.48)	(4.75)	(0.97)	(−0.05)	(−1.91)	(−3.03)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	3917	3916	3530	3548	3917	3916
Pseudo-R^2	0.0780	0.0470	0.4114	0.4628	−0.0531	−0.0934
Wald Chi^2/F	223.44	157.12	361.91	427.37	126.87	9.09
Prob. > Chi^2/F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Test the difference in coefficients of EFFORT:						
Chi^2	3.94**		0.58		3.07*	
p-value	[0.0473]		[0.4459]		[0.0795]	

Notes: Columns (1) to (4) present the results for the logit model, and columns (5) and (6) present the results for the tobit model. The *z*-statistics/*t*-statistics shown in parentheses are adjusted for clustering by client. ***, **, and * denote significance at the 1%, 5%, and 10% levels (two-tailed), respectively.

the impact of audit effort on audit opinions is not significantly different from the overall client characteristics. In sum, these results indicate that the effect of audit effort on audit quality is attenuated when clients are more complex, which may be due to auditors' difficulty in detecting misstatements or to the more significant marginal diminishing of audit returns in more complex clients.

5.2. The impact of audit firm size

Next, we investigate whether the impact of audit effort on audit quality differs by audit firm size. The extent to which audit adjustments are adopted by management depends on the communication between the auditors and client management. During the communication process, auditors with higher independence are more likely to persuade management to accept the proposed adjustments. Numerous studies suggest that auditors in large audit firms have higher independence (Lennox and Pittman, 2010). In addition, large audit firms usually have more audit experience and more effective quality control systems; hence, the audit efficiency of large audit firms would be higher (Teoh and Wong, 1993). Therefore, we expect audit effort to play a more significant role in improving audit quality when audit firms are larger. However, the audit quality of large audit firms is already high, which gives the auditors less room to improve. Moreover, clients audited by large audit firms are usually more complex than those audited by small audit firms. Auditors in large audit firms may correspondingly increase their audit effort, but the diminishing returns could attenuate the effect of audit effort on audit quality (Caramanis and Lennox, 2008). Thus, we expect to observe that audit effort plays a less significant role in improving audit quality when audit firms are larger.

To test the above conjecture, we divide the sample into two subsamples according to audit firm size (i.e., *BIG_AUDIT*) and re-estimate Eqs. (2)–(4). Table 10 presents the regression results. We find that when the dependent variable is *ADJUST* or *DA_ABS*, the coefficients on *EFFORT* are lower in large audit firms than in small audit firms. The results indicate that the effects of audit effort on audit adjustments and the quality of audited financial statements are attenuated when audit firms are larger. In addition, the impact of audit effort on audit opinions is not significantly different for different audit firm sizes. In sum, the results indicate that the effect of audit effort on audit quality is attenuated when audit firms are larger, which may be due to auditors have less room to improve audit quality or to the more significant marginal diminishing audit returns in complex clients of large audit firms.

Table 10
Impact of audit firm size.

	ADJUST		*MAO*		*DA_ABS*	
	(1) Large	(2) Small	(3) Large	(4) Small	(5) Large	(6) Small
EFFORT	0.1299***	0.2590***	−0.0019	−0.0204	−0.0003	−0.0045***
	(2.78)	(5.79)	(−0.01)	(−0.19)	(−0.28)	(−2.95)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	3626	4207	3114	3981	3626	4207
Pseudo-R^2	0.1269	0.0333	0.4901	0.4213	−0.0607	−0.0835
Wald Chi^2/F	321.42	125.70	333.40	429.36	269.47	7.54
Prob. > Chi^2/F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Test the difference in coefficients of EFFORT:						
Chi^2	3.97**		0.01		5.03**	
p-value	[0.0463]		[0.9210]		[0.0249]	

Notes: Columns (1) to (4) present the result for the logit model, and columns (5) and (6) present the results for the tobit model. The *z*-statistics/*t*-statistics shown in parentheses are adjusted for clustering by client. ***, **, and * denote significance at the 1%, 5%, and 10% levels (two-tailed), respectively.

6. Conclusions

Audit plays an important role as an external corporate governance mechanism, and the governance effect of audit is directly reflected in the quality of the audit. In this paper, we investigate the effect of audit effort on audit quality systematically from the perspective of audit process and audit output using a unique database of audit days in China from 2006 to 2011. We find that audit effort significantly increases the probability of audit adjustments (especially downward audit adjustments), which further inhibits the earnings management of clients (which is also mainly reflected in the inhibition of positive earnings management) and improves the quality of audited financial statements. Consistent with the findings of a higher probability of audit adjustments and higher quality audited financial statements, we also find that audit effort does not have a significant effect on the issuance of modified audit opinions overall, but that a modified audit opinion is more likely to be issued in the absence of an audit adjustment. Furthermore, we find that the effect of audit effort on audit quality is attenuated when clients are more complex and when audit firms are larger. Collectively, our evidence suggests that audit effort plays a significant role in improving audit quality.

Our study extends the literature that examines how audit effort affects audit quality in emerging markets. Our conclusions have some implications for improving audit market efficiency in China and suggest that regulators should pay attention to the audit effort of audit firms and encourage them to invest sufficient audit resources to improve audit quality and ensure the realization of audit objectives in order to promote the development of the economy through high-quality audits.

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