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9 | 1 China Journal of Accounting Research Vol. 9/1 (2016) 1–82

ELSEVIER

Volume 9 • Issue 1 • March 2016

China Journal *of* Accounting Research

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Available online at www.sciencedirect.com
ScienceDirect

ISSN 1755-3091

Production and hosting by Elsevier
Radarweg 29, 1043 NX Amsterdam, The Netherlands

ISSN 1755-3091

Founded by Sun Yat-sen University and City University of Hong Kong

Sponsored by: CPA Hong Kong Institute of Certified Public Accountants 香港會計師公會

Published quarterly in March, June, September, and December

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CHINA JOURNAL OF ACCOUNTING RESEARCH

Volume 9/1 (2016)

China Journal of Accounting Research 9 (2016) 1–24

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Contents lists available at ScienceDirect

China Journal of Accounting Research

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

Do business groups affect corporate cash holdings? Evidence from a transition economy☆

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ARTICLE INFO

Article history:
Received 14 May 2015
Accepted 28 October 2015
Available online 19 January 2016

JEL classification:
G32
G34
G38

Keywords:
Business groups
Cash holdings
China
State ownership
Monetary policy

ABSTRACT

We examine whether business groups' influence on cash holdings depends on ownership. Group affiliation can increase firms' agency costs or benefit firms by providing an internal capital market, especially in transition economies characterized by weak investor protection and difficult external capital acquisition. A hand-collected dataset of Chinese firms reveals that group affiliation decreases cash holdings, alleviating the free-cash-flow problem of agency costs. State ownership and control of listed firms moderate this benefit, which is more pronounced when the financial market is less liquid. Group affiliation facilitates related-party transactions, increases debt capacity and decreases investment-cash-flow sensitivity and overinvestment. In transitional economies, privately controlled firms are more likely to benefit from group affiliation than state-controlled firms propped up by the government.

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☆ We are grateful for the helpful comments of Charles J.P. Chen, Feng Liu, Xijia Su, Oliver Rui, Minghai Wei, Liandong Zhang (discussant), an anonymous referee and participants at the CJAR summer research workshop. The first author acknowledges financial support from the National Natural Science Foundation of China (Project No. 71402005) and Social Science Foundation of Beijing (Project No. 15JGC155).

http://dx.doi.org/10.1016/j.cjar.2015.10.002
1755-3091/

1. Introduction

This paper investigates the effect of business groups on firms' cash policies and whether it depends on ownership structure. A business group is a set of legally independent firms bound together by formal and informal ties (for an overview of business groups, see Khanna and Yafeh, 2007). This unique organizational form is internationally widespread, especially in transition economies. For instance, Claessens et al. (2002) find that in eight of the nine Asian countries they study, the top fifteen family groups control more than 20% of the listed corporate assets. In particular, up to the end of 2006, Chinese business groups contributed above 60% of the nation's industrial output (Sutherland, 2009). Despite their significant contribution to national economies, the general understanding of business groups in emerging countries has thus far been inadequate.

The literature suggests two competing explanations of how business groups affect corporate cash holdings. A predominant view in corporate finance is based on the free-cash-flow hypothesis, which posits that in the presence of agency costs of managerial discretion, management has incentives to hold excess cash for its own objectives at shareholders' expense (Jensen, 1986). The complicated ownership and organizational structure of business groups result in a higher level of information asymmetry than seen in standalone firms, which inevitably exacerbates the agency conflicts between managers and shareholders. Alternatively, business group affiliation benefits firms by forming an internal capital market. The precautionary motive hypothesis put forth by Keynes (1936) suggests that in the presence of an internal capital market, business group affiliates tend to hold less cash due to a lower level of financial constraints (Schiantarelli and Sembenelli, 2000). Taken together, the net effect of business groups on cash holdings depends on which role of the business group dominates the other. This study explores business groups in China and aims to contribute to the current debate over their role in emerging economies.

Transition economies like China offer a suitable research setting in which to study the costs and benefits of business groups for two reasons. First, China is characterized by the coexistence of tremendous economic achievements and an underdeveloped institutional environment. As the largest emerging economy, China has experienced unprecedented economic growth during the past three decades. However, the country's investor protection is among the worst worldwide. Allen et al. (2005) suggest that China ranks the lowest in terms of investor protection among the countries included in a study by La Porta et al. (1998). External financing in the country can be very costly or even unavailable (Ayyagari et al., 2010). In such a context, business groups may serve extensive governance functions by creating an internal capital market (He et al., 2013) and enhancing intra-group guarantees and financing flexibility (Chang and Hong, 2000). Second, despite its transition from a centrally planned economy to a market-oriented economy, China has maintained a state-dominated financial system in which the government has substantial influence over the allocation of financial resources (Cai et al., 2014). The state-dominated financial system usually favors state-owned enterprises (SOEs) by providing them financial support in the forms of preferential loans, state subsidies, IPO/SEO opportunities and so forth. As opposed to their SOE counterparts, non-SOEs (NSOEs) face greater difficulties accessing external finance. Thus, a business group is likely to serve as an internal capital market to mitigate the financial constraints facing NSOEs.

Our empirical findings are as follows. Using a panel of 6633 Chinese listed non-financial firms covering 2008–2011, we find that group-affiliated firms hold significantly less cash than their unaffiliated counterparts. This finding is consistent with the view that the precautionary motive of affiliated firms to hold cash is weaker due to the lower level of constraints imposed by the internal capital market. In addition, we examine whether the effects of business groups on cash holdings differ between SOEs and NSOEs. The results show that the role of business groups in decreasing cash reserves is economically and statistically more prominent among NSOEs. In subsequent analysis, we exploit an exogenous shock to the credit supply as a result of tight monetary policy during 2010–2011. As expected, we find strong evidence that the decrease in credit supply due to the monetary policy change strengthens the relationship between business groups and cash holdings and that this relationship is more pronounced among NSOEs.

We perform several additional analyses to shed light on the mechanisms through which business groups can mitigate capital constraints. First, we examine whether group affiliates are involved in more related-party transactions. Consistent with Jia et al. (2013), we find a positive relationship between business groups and the amount of related-party transactions, providing direct evidence of the internal capital market mechanism

through which business groups mitigate the precautionary motive of affiliated firms to hold cash. We also find that group-affiliated firms have a higher debt capacity than their unaffiliated peers, suggesting that business groups help affiliated firms to obtain external financing. Next, we examine whether group affiliates face fewer financial constraints than unaffiliated firms. The results show that the former exhibit a lower level of investment-cash-flow sensitivity than the latter. Finally, further analysis indicates that group affiliation decreases the level of overinvestment. This effect is more pronounced among NSOEs, suggesting that business groups contribute to decreasing the free-cash-flow problem.[1]

Our study contributes to the business group and cash policy literature. We provide evidence based on a transition economy, which offers an interesting institutional setting in which to compare the cost and benefit effects of group affiliation. He et al. (2013) analyze the relationship between business groups and investment-cash-flow sensitivity but do not examine the effect of group affiliation on cash holdings, which is a more direct measure of the agency problem associated with free cash flow. In addition, the sample used by He et al. (2013) only goes up to 2006. Given the significant effect of China's split share structure reform (SSSR) on corporate cash holdings, our study exclusively focuses on the post-reform period (i.e., 2008–2011).[2] Moreover, unlike prior studies of business groups in China (e.g., Keister, 1998; Fan et al., 2008; Carney et al., 2009), which may suffer from the problem of small-sample bias, we consider all of the publicly traded group affiliates in China. The rich data of the listed firms yield relatively unbiased results (He et al., 2013). Our findings suggest that in transition economies like China, firms propped up to a lesser extent by the government are more likely to benefit from business group affiliation. The policy implication stemming from our evidence is that group affiliation for SOEs may be less justified given that the underlying agency cost may not be offset by capital acquisition benefits.

The remainder of this paper is organized as follows. Section 2 briefly introduces China's business groups and institutional factors. Section 3 provides the literature review and hypothesis development. Section 4 discusses the research design and sample. Section 5 presents the empirical results. Section 6 discusses the results of additional analyses. The final section concludes the paper.

2. Institutional background

2.1. Business groups in China

A key aspect of the economic reform generating China's unprecedented growth is the establishment of business groups, known as *qiyejituan* in Chinese. To facilitate China's economic transition from a centrally planned economy to a market-oriented economy without causing the chaos seen in other ex-communist economies such as Russia, business groups have been introduced as intermediary institutions and economic engines for economic development (Keister, 1998; Yiu et al., 2005). In the mid-1980s, business groups increased rapidly with the encouragement and assistance of the state. It is widely believed that such groups can develop new technology, deliver superior financial performance and achieve economies of scale. In one decade, business groups in China went from non-existent to numbering more than 7000 by the early 1990s. As of 1995, the state-owned business groups were valued at 1.12 trillion yuan (USD$135.7 billion), one quarter of the nation's total state-owned assets (Kan, 1996).

Through the establishment of two stock exchanges in the early 1990s, some business groups began to include both publicly traded firms and SOEs in their portfolios of affiliated firms. As the listed group affiliates are independent legal entities that are required to disclose their financial and non-financial information regularly, we can clearly identify affiliated firms by their corporate structures. In addition, the financial information pertaining to these firms yields rich data for our large-sample analysis. Fig. 1 demonstrates the complexity of a business group in China. Founded in 1969, Wanxiang Group includes four listed affiliated firms, including one in Shanghai and three in Shenzhen.[3]

[1] We acknowledge the referee for raising this point.

[2] Chen et al. (2012) investigate the sensitivity of cash holdings to the split share structure reform using a sample covering 2000–2008. They find that by 2008 more than 79% firms had completed the conversion of non-tradable shares to tradable shares.

[3] Consistent with He et al. (2013), we do not include firms with shares traded in non-domestic markets such as Hong Kong and the United States.

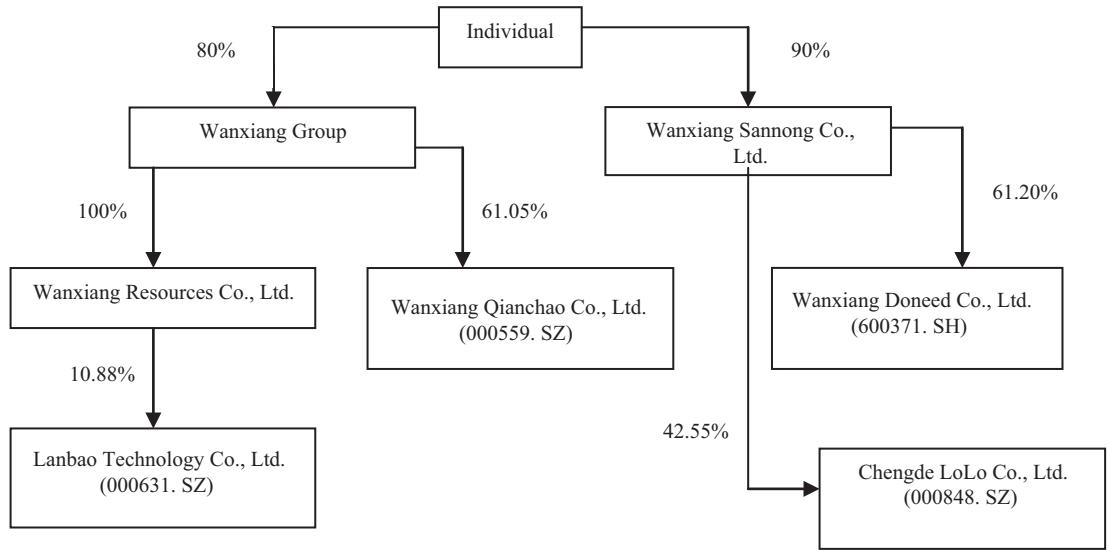

Figure 1. Structure of Wanxiang Group. *Source:* 2008 Annual Report of Relevant Firms.

Consistent with China's transition to a market economy, continued efforts have been made to let the state sector concentrate on strategic and "life-blood" industries in the national economy. As a result, the number of business groups has declined in recent years and their economic significance has improved. For instance, although the number of business groups at various levels fell to 2767 in 1999, their value now accounts for more than 50% of the assets of all SOEs and NSOEs (Ma, 2005).

Many scholars consider business groups an organizational response to the underdeveloped institutions of emerging economies (e.g., Chang and Hong, 2000; Khanna and Palepu, 2000a,b; Jian and Wong, 2010). Thus, firms in emerging countries may be better off as parts of business groups due to higher transaction costs and because such groups can act as intermediaries between economic actors and imperfect markets by filling institutional voids. In contrast, the relatively lower transaction costs in developed economies with more efficient capital markets, stronger legal protection and better financial intermediaries decrease the need for an internal capital market and the broad diversification offered by business groups.

Business group structures vary across countries, exhibiting differences in both formal links (such as ownership structure) and informal ties (such as family, kinship and friendship) (Morck et al., 2005). Chinese business groups are most similar to those in Japan and Korea, partly because Chinese officials have been observing and learning about Japanese *keiretsu* and Korean *chaebol* for years (Ma, 2005). However, Chinese business groups differ from *keiretsu* and *chaebol* in the following two ways. First, Korean *chaebols* are characterized by private ownership with limited bank involvement, and Japanese *keiretsus* have multiple corporate owners, typically centered on a main bank (Gedajlovic and Shapiro, 2002). However, Chinese business groups involve considerable government intervention. Second, Chinese business groups are more focused, although somewhat more diversified, than *keiretsus* and *chaebols*. This is particularly true for state-owned business groups, as the government requires them to act as the leading players or national champions in their sectors. As such, China offers an ideal laboratory in which to analyze the effect of ownership structure on the role of business groups.

2.2. Ownership structure of Chinese listed firms

A distinct feature of China's stock markets is the dominant role of state ownership in Chinese listed firms. For example, nearly two thirds of Chinese listed firms are currently still under state control. Compared with their NSOE counterparts, SOEs usually have multiple objectives, including not only profit maximization but also social aims such as the creation of job opportunities and maintenance of social stability. In return, the

governments at various levels often provide SOEs with perks such as business contracts and financial assistance. For instance, stock market regulators always treat SOEs preferentially by offering them listing privileges (Aharony et al., 2000). In addition, SOEs have greater access to equity offerings for capital needs (Gordon and Li, 2003), debt financing (Sapienza, 2004; Jia, 2009) and state subsidies, particularly when they face financial distress (Chen et al., 2008; Lee et al., 2014). Consequently, SOEs are expected to be associated with less financial constraints and bankruptcy risk than NSOEs.

It was not until 2005, when China underwent the SSSR, that state and legal person shares became freely tradable on the stock exchanges. Before the reform, such shares could be exchanged only under special circumstances at a negotiated price and with government approval. The reform required non-tradable shares to become tradable after the end of a lock-up period. For most firms, the lock-up period ended in 2007/2008, after which the shareholders were able to sell up to 50% of their shares in the following six months (Chen et al., 2009). As a major policy change, the SSSR has had a significant effect on the financing activities of Chinese listed firms in areas such as cash policy (Chen et al., 2012) and leverage decisions (Liu and Tian, 2012). To parse out the potential confounding effect of the SSSR on cash holdings, we focus exclusively on the post-reform period (i.e., 2008–2011) in the present study. We believe that doing so allows us to better answer our research question about the link between business groups and cash holdings.

2.3. China's monetary policy during 2008–2011

Firms' cash-holding incentives are likely to be affected by external factors such as financial market liquidity. The recent financial crisis has had a profound influence around the world. All of the major economies suffered from a sudden contraction of liquidity and China was no exception. The main concern of China's monetary policy before the crisis was controlling inflation, as its consumer price index was far above 3%. However, as the unexpected crisis hit China's economy, the government promptly switched its monetary policy from preventing the economy from overheating to stimulating the economy by expanding domestic demand to offset a slump in exports resulting from the financial crisis. To achieve this, the Chinese government loosened the once-tight monetary policy in 2008, with China's central bank, the People's Bank of China (PBC), slashing benchmark interest rates by a factor of five and the deposit requirement ratio by a factor of four. Moreover, during 2008–2009, the government put a 4-trillion-yuan (USD$586 billion) stimulus package in place to bolster economic expansion and help sustain global growth. The central bank further loosened credit controls in 2009, which spurred a surge in new bank loans of 9.6 trillion yuan, up from 4.9 trillion yuan in 2008.

China's monetary policy entered into a tightening cycle in 2010 for two reasons. First, China's domestic economy experienced a strong recovery as a result of the loose monetary policy and proactive fiscal policy in 2008–2009. Second, China was facing rising inflation and the threat of hot money inflows expected from the quantitative easing policy of the U.S. In an effort to counteract these effects, China's stance gradually swung from "loose" to "appropriately tight." For instance, the PBC had raised interest rates five times and the deposit requirement ratio nine times by August 2011.

Studies have used the broad definition of money to measure China's monetary policy based on the PBC officially defining its intermediate target as M2 in 1996 (Xie, 2000). Fig. 2 presents the targeted and actually realized growth rates of M2 for the period 2005–2011. As expected, the actual growth rate peaked at 28.4 in 2009 and then declined to 17.3 by 2011. Given the preceding discussions, we define the loose (tight) monetary policy period as 2008–2009 (2010–2011) in this study.

3. Literature review and hypothesis development

3.1. Literature related to business groups

The past two decades have witnessed a surge in research related to business groups. Most of this literature focuses on emerging economies (Khanna and Palepu, 2000a,b; Khanna and Rivkin, 2001), based on the argument that business groups are more common in countries with poor legal and regulatory institutions (Granovetter, 2005). Studies have examined the effect of business groups through a wide array of indicators such as market valuation (e.g., Bae and Jeong, 2007; Bae et al., 2008), financial constraints (e.g., Shin and

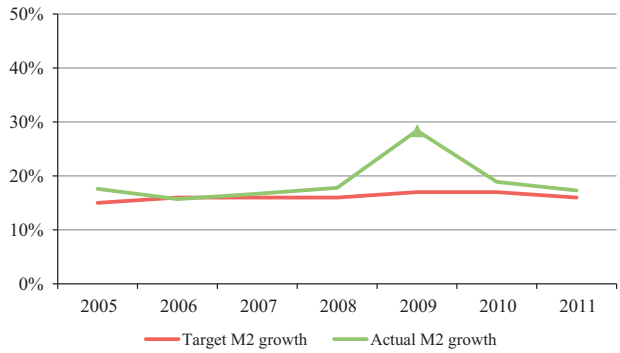

Figure 2. Targeted and actual growth rates of M2 2005–2011.

Park, 1999; Bena and Ortiz-Molina, 2013; He et al., 2013), risk sharing (e.g., Khanna and Yafeh, 2005; He et al., 2013), financial performance (e.g., Khanna and Palepu, 2000b; Khanna and Rivkin, 2001; Carney et al., 2011) and tunneling (e.g., Bae et al., 2002; Baek et al., 2006). In contrast, limited empirical evidence has been produced to show the effect of business groups on cash holdings. Without making a strict distinction between affiliates and non-affiliates, Pinkowitz et al. (2006) examine the effect of bank power on cash holdings and find that Japanese *keiretsu* members hold less cash than other firms. A recent study by Locorotondo et al. (2014) documents a negative relationship between business group affiliation and cash holdings based on a sample of Belgian firms.

3.2. Literature related to corporate cash holdings

Neoclassic economics theory suggests that a firm's optimal cash holdings should be at a level such that the marginal benefit of the cash holdings is equal to their marginal cost. A vast number of studies have correspondingly focused on the determinants and motives of cash holdings in different contexts, such as the U. S. (e.g., Kim et al., 1998; Opler et al., 1999; Bates et al., 2009), the U.K. (e.g., Ozkan and Ozkan, 2004), Italy (e.g., Bigelli and Sánchez-Vidal, 2012) and other countries (e.g., Campello et al., 2012; Dittmar et al., 2003; Pinkowitz et al., 2006). However, studies of cash holdings in China remain scant, with the exceptions of those by Wu et al. (2012) and Chen et al. (2012). Wu et al. (2012) examine the effect of financial deepening on the relationship between trade credit and cash holdings. They find that firms in regions of higher financial development hold less cash for payables and substitute more receivables for cash. Chen et al. (2012) suggest that there is a negative relationship between the SSSR and the cash holdings of Chinese listed firms. Our study extends and complements these papers by focusing on the group-cash relationship, in which business groups appear to capture liquidity demand, beyond the factors examined in previous studies.

3.3. Hypothesis development

The precautionary motive proposes that cash is held as a buffer to guard against unexpected contingencies or cash deficiencies (Keynes, 1936; Hill et al., 2014). Opler et al. (1999) suggest that firms with strong growth opportunities, riskier cash flows and less access to capital markets hold more cash. Extending a study by Opler et al. (1999), Han and Qiu (2007) find a positive relationship between cash holdings and cash flow volatility among financially constrained firms. Acharya et al. (2007) provide theoretical and empirical evidence showing that firms with greater hedging needs hold more cash. In a subsequent study, Bates et al. (2009) also document a positive relationship between cash holdings and cash flow volatility. They indicate that the precautionary motive dominates agency conflicts in explaining the increase in cash holdings. A recent study by Hill et al. (2014) finds that firms with political connections hold less cash due to decreased concerns about liquidity shortages.

As cash is held for precautionary purposes to counteract future cash flow shocks, business groups may alter firms' liquidity strategies by decreasing the uncertainty of future cash flows in several ways. First, business groups allow the formation of internal capital markets, which can partially replace the external markets in meeting the financial needs of affiliated firms. A group pools funds from its affiliated members and reallocates them to the most profitable projects. As such, business groups can be seen as a more efficient channel for allocating capital and managerial resources among affiliated firms. This is especially the case when external markets are underdeveloped. In addition, business groups can benefit affiliated firms by facilitating risk sharing (Khanna and Yafeh, 2005). This is done mainly through the transfer of resources from well-performing affiliates to poorly performing ones, particularly during times of financial difficulty. For instance, Prowse (1992) provides evidence that group affiliates assist member firms that are suffering from financial distress so as to ensure the long-term survival of the group. This is corroborated by Friedman et al. (2003), who find that group controllers tend to prop up affiliated firms during a crisis using their private funds or group-wide savings. Given intra-group coordination and internal transactions, business groups can decrease the bankruptcy probabilities of affiliated firms (Lincoln et al., 1996), which may in turn decrease the precautionary motive for holding cash.

In addition to providing internal capital markets, business groups may help affiliated firms to obtain external financing. Group affiliation can improve the debt-bearing capacity of member firms by linking the member firms to one another. Group reputation enables affiliates to gain access to external credit (Chang and Hong, 2000; Schiantarelli and Sembenelli, 2000). In addition, intra-group guarantees help affiliated firms to gain financing through bank loans and corporate bonds, as the assets of one group firm can serve as collateral for other member firms (Shin and Park, 1999; Verschueren and Deloof, 2006).

Overall, business group affiliations are expected to yield improved access to finance and an ability to generate more stable future cash flows, in turn decreasing the precautionary motives of affiliated firms to hold cash. As long as this effect dominates the potential agency problem often associated with business groups (La Porta et al., 1999; Bae et al., 2002; Morck et al., 2005; Jiang et al., 2010), we expect a negative association between group affiliation and cash holdings. These arguments lead to our first hypothesis.

H1. Business-group-affiliated firms hold less cash than their unaffiliated counterparts.

Studies have suggested that political connections play a dominant role in firms' cash policies. Faccio et al. (2006) document that politically connected firms are more likely to be bailed out by the government in times of distress than non-connected peers. This implicit guarantee in turn disincentivizes firms from retaining excess cash. Political connections appear to be more explicit in China than in Western economies and are reflected in the form of state ownership. As discussed in Section 2.2, China's state-dominated financial system favors SOEs. Compared with their NSOE counterparts, SOEs are more likely to exhibit the soft budget constraint formulated by Kornai (1980). According to soft budget constraint theory, an organization with a budget constraint can always depend on a supporting organization to bail it out when its budget constraint is breached. In China, SOEs have better access to external financing through either the banking sector or the equity markets than NSOEs (e.g., Chen et al., 2012; Megginson and Wei, 2013). Furthermore, SOEs are more likely to receive financial assistance when facing financial distress (Cull and Xu, 2000). Therefore, the marginal effect of business groups in terms of mitigating financial constraints and decreasing cash holdings driven by precautionary motives should be greater among NSOEs than SOEs. Hence, we posit the following hypothesis.

H2. The inverse relationship between business groups and cash holdings is more pronounced among NSOEs than among SOEs.

In addition to micro-level firm characteristics, macroeconomic factors such as monetary policy affect firms' cash-holding decisions (Faulkender and Wang, 2006; Zaman, 2011; Harford et al., 2012). The monetary transmission mechanism is particularly important for firms. Whenever monetary policy changes, market interest rates such as mortgage and bank deposit rates change accordingly. These changes in turn affect the investment and financing behavior of firms in the economy. For example, other things being equal, higher interest rates resulting from tight monetary policy tend to encourage firms to hold more liquidity rather than make investments. In such circumstances, bank borrowing may become very expensive or even unavailable, making financially constrained firms more vulnerable than others and thereby having a significant bearing on their cash or

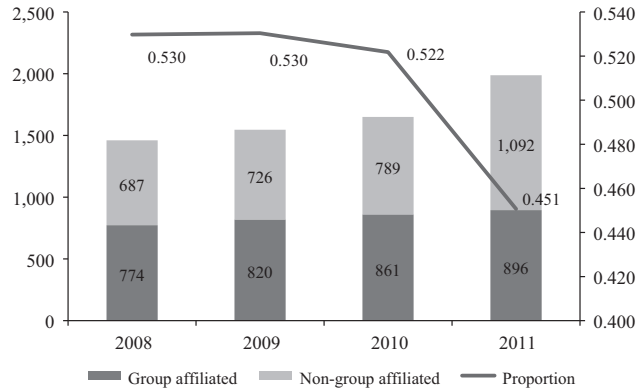

Figure 3. Percentage of group-affiliated firms.

liquidity management decisions. As bank financing is a dominant financing channel for Chinese firms (Allen et al., 2005), the sensitivity of this form of financing to monetary policy changes can be highly significant. As discussed previously, business groups are likely to decrease firms' cash holdings through the channels of both internal and external financing. We expect that the effect of business groups on cash holdings is more prominent in times of tight monetary policy. Furthermore, compared with their SOE counterparts, NSOEs suffer from a higher level of capital constraints, as explained in Section 2.2. Therefore, we expect that the interaction effect of monetary policy and business groups on cash holdings is more pronounced among NSOEs than SOEs. Hence, we put forward the following hypotheses.

H3a. Group-affiliated firms hold even less cash than unaffiliated firms in times of tight monetary policy than they do in times of loose monetary policy.

H3b. The relationship in H3a is more pronounced for NSOEs than for SOEs.

4. Research design

4.1. Sample and data

We base our sample selection on all of the firms listed on the Shanghai and Shenzhen Stock Exchanges during 2008–2011. As explained earlier, we restrict our sample to begin in 2008 to circumvent the influence of the SSSR on cash holdings (Chen et al., 2012). We collect the business affiliation data manually from the annual reports of the listed firms. Following He et al. (2013), we identify a firm's group affiliation in each year based on whether its ultimate controller has more than one listed firm in that year.[4] Fig. 3 demonstrates the proportion of group-affiliated firms over our sample period. On average, group-affiliated firms account for 50% of all of the listed firms. This proportion is higher than that in a study by He et al. (2013), who find it to be slightly above 30% in 2006. The difference arises mainly due to the acceleration of mergers and acquisitions in China in recent years, which has resulted in a growing number of group affiliates. In addition, as shown in Fig. 3, there is a dramatic decrease in the proportion of group-affiliated firms in 2011, although the number of affiliated firms stays almost the same as that in previous years. This drop is driven by a sharp increase in the number of listed firms following the launch of China's Growth Enterprise Board.

[4] We define business groups as having at least two listed firms. Business groups in China were originally encouraged to publically list their strongest son firms. As a result, almost all Chinese listed firms are affiliated with a business group (Jiang et al., 2010; Jia et al., 2013). Our classification is likely to bias the results against finding a negative association between group affiliation and cash holdings because internal capital markets may also exist in our non-group sample. In other words, our results may become stronger if we restrict business groups to have at least one listed company.

Our analyses call for a separation of SOEs and NSOEs. We identify an SOE (NSOE) based on whether its ultimate controller is a state asset management bureau or other government-related unit. We retrieve the information related to ultimate controllers from the CCER Sinofin Database. Finally, we download the financial and accounting data used in our analyses from the China Security Markets and Accounting Research (CSMAR) database.

Table 1 Panel A summarizes the sample selection process. Of the 8629 initial firm-year observations, we remove 651 observations that are listed for less than 1 year. In addition, we eliminate 147 firm-year observa-

Table 1
Sample selection and distribution.

Sample selection process	Firm-year observations
Panel A: Sample selection process	
Initial sample from 2008 to 2011	8629
Less:	
Firms listed for less than one year	651
Financial firm-years	147
Firm-years with insufficient data	1198
Final sample	6633

Year	Total	Stand-alone sample ($GROUP = 0$)	Affiliated sample ($GROUP = 1$)
Panel B: Annual distribution of business groups			
2008	1457	684	773
2009	1544	724	820
2010	1650	789	861
2011	1982	1089	893
Total	6633	3286	3347

Industry	Total	Standalone sample ($GROUP = 0$)	Affiliated sample ($GROUP = 1$)
Panel C: Industry distribution of business groups			
Agriculture, forestry and fishing	105	69	36
Mining	194	57	137
Food	273	159	114
Textile	224	156	68
Wood and furniture	36	28	8
Papermaking and printing	122	90	32
Petroleum, chemical products and rubber	704	321	383
Pharmaceutical	491	271	220
Metal and non-metal	562	255	307
Equipment manufacturing	1121	540	581
Electric machinery	400	232	168
Other manufacturing	34	30	4
Utilities	294	76	218
Construction	156	70	86
Transportation	269	62	207
Information technology	215	159	56
Trade	532	217	315
Real estate	554	290	264
Service	203	118	85
Media	56	37	19
Other	88	49	39
Total	6633	3286	3347

tions from the financial sector and 1198 firm-year observations with insufficient data for our study. The final sample consists of 6633 firm-year observations.

Table 1 Panel B presents the yearly distribution of the sample. The numbers of both group-affiliated and unaffiliated firms increase gradually across the years. In particular, a significant increase is observed in the number of unaffiliated firms, from 789 in 2010 to 1089 in 2011. This further explains why the proportion of affiliated firms decreases significantly in 2011, as demonstrated in Fig. 3.

Table 1 Panel C presents the industry distribution of observations, where the industries are based on the classifications of the China Securities Regulatory Commission (CSRC). Equipment manufacturing constitutes the largest share with 1121 observations, 581 of which are affiliated with business groups. Other manufacturing is the smallest sector with 34 observations, only 4 of which are group affiliated.

4.2. Model specification

We examine the association between cash and business groups based on the framework implemented by Opler et al. (1999), variants of which have been used to test several issues related to cash holdings (e.g., Ozkan and Ozkan, 2004; Fritz Foley et al., 2007; Harford et al., 2008). We estimate the following equation:

$$CASH_{i,t} = \alpha_0 + \alpha_1 GROUP_{i,t} + \alpha_2 LIQ_{i,t} + \alpha_3 SIZE_{i,t} + \alpha_4 Q_{i,t} + \alpha_5 LEV_{i,t} + \alpha_6 CF_{i,t} + \alpha_7 CAPEX_{i,t} + \alpha_8 DIV_{i,t} + \alpha_9 CONCEN_{i,t} + year + Industry + \varepsilon_{i,t} \quad (1)$$

where for firm i in year t *CASH* refers to cash and cash equivalents divided by net assets, i.e., total assets minus cash and cash equivalents; *GROUP* is a dummy variable that equals one if the firm is group affiliated and zero otherwise; *LIQ* refers to working capital minus cash and cash equivalents divided by total assets; *SIZE* is the natural logarithm of total assets; *Q* is the market value of total assets divided by the book value of total assets; *LEV* refers to total liabilities divided by total assets; *CF* refers to operating cash flow scaled by total assets; *CAPEX* refers to capital expenditure divided by total assets; *DIV* is the ratio of cash dividends to earnings; and *CONCEN* is the share proportion of the largest shareholder divided by the share proportion of the second largest shareholder. If H1 is supported and business group affiliates hold less cash than unaffiliated firms, then we should observe that α_1 is significantly negative. Table 2 presents the variable definitions.

To test H2, which states that the effect of business groups on cash holdings is more pronounced for NSOEs than for SOEs, we estimate Eq. (1) for the NSOE and SOE subsamples, respectively. If H2 is true, then we expect that the coefficient of *GROUP* is greater for the NSOE subsample. In addition, we test whether the difference between the *GROUP* coefficients for the two groups is statistically significant.

To test whether the relationship between group affiliation and cash is amplified in times of tight monetary policy as hypothesized in H3a, we adopt a difference-in-difference approach by including a policy dummy (*POLICY*) and an interaction term between *POLICY* and *GROUP* in Eq. (1). The regression model is thus expressed as follows:

$$CASH_{i,t} = \beta_0 + \beta_1 GROUP_{i,t} + \beta_2 POLICY_{i,t} + \beta_3 GROUP * POLICY_{i,t} + \beta_4 LIQ_{i,t} + \beta_5 SIZE_{i,t} + \beta_6 Q_{i,t} + \beta_7 LEV_{i,t} + \beta_8 CF_{i,t} + \beta_9 CAPEX_{i,t} + \beta_{10} DIV_{i,t} + \beta_{11} CONCEN_{i,t} + Industry + \varepsilon_{i,t} \quad (2)$$

where *POLICY* is an indicator variable equal to one if the observation occurs during a period of tight monetary policy (i.e., 2010–2011) and zero otherwise (i.e., 2008–2009). H3a is supported if β_3 is significantly negative. To further test H3b, we estimate Eq. (2) separately for the NSOE and SOE subsamples. We expect that β_3 is significantly more negative for NSOEs.

5. Empirical findings

5.1. Summary statistics

Table 3 reports the descriptive statistics and univariate test results for both the unaffiliated (in Panel A) and affiliated (in Panel B) firms. All of the variables except the dummy variables are winsorized at the 1st and 99th percentiles. The average cash-to-assets ratios of the unaffiliated and affiliated samples are 0.300 and 0.221,

Table 2
Variable definitions.

Variables	Definitions
Cash holding (*CASH*)	Cash and cash equivalents/(total assets-cash and cash equivalents)
Business group (*GROUP*)	A firm is identified as a group-affiliated firm in each year if its ultimate controller had more than one listed firm in that year. *GROUP* equals one for group-affiliated firms and zero otherwise
State ownership (*SOE*)	Dummy variable that equals one if the ultimate controller of the firm is the government and zero otherwise
Tight monetary policy (*POLICY*)	Dummy variable that equals one for tight monetary policy periods (i.e., 2010–2011) and zero otherwise (i.e., 2008–2009)
Liquid substitutes (*LIQ*)	(Working capital − cash and cash equivalents)/total assets
Firm size (*SIZE*)	Natural logarithm of total assets
Tobin *Q* (*Q*)	Market value of total assets/book value of total assets
Leverage (*LEV*)	Total liabilities/total assets
Cash flow (*CASHFLOW*)	Operating cash flow/total assets
Capital expenditure (*CAPEX*)	Capital expenditures/total assets
Dividend (*DIV*)	Cash dividends/earnings
Ownership concentration (*CONCEN*)	The ratio of the percentage of shares held by the largest shareholder to the percentage of shares held by the second largest shareholder
Return on asset (*ROA*)	Net income/total assets
Fix assets ratio (*FIX*)	Fix assets/total assets
Asset growth rate (*GROWTH*)	(Total asset in year t-total assets in year $t-1$)/total assets in year $t-1$
Firm age (*AGE*)	Number of years since the firm's inception
Investment level (*INVEST*)	Investment expenditure/total assets
Accumulative return (*RET*)	Buy-and-hold return calculated based on monthly returns of the year
Free cash flows (*FCF*)	(Operating cash flow − normal investment expenditure)/total assets
Tunneling opportunity (*TUNNEL*)	Other receivables/total assets
Minority equity (*MINO*)	Minority equity/total equity
Executive compensation (*PAY*)	Natural logarithm of the three highest paid executives' compensation
Share concentration (*TOP*)	Percentage of shares held by the largest shareholder
Board size (*BSIZE*)	Number of directors on the board
Independent directors (*INDEP*)	Number of independent directors on the board

respectively, which are higher than the respective values of 0.145 and 0.176 found by He et al. (2013). The difference arises partly due to the different sample periods we examine.[5] Another important observation is that unaffiliated firms hold greater cash reserves on their balance sheets than their affiliated peers at both the mean and median levels, lending initial support to H1. This pattern is more evident during the period of tight monetary policy (i.e., 2010–2011). As seen in Panel C, the difference in *CASH* between the two subsamples is statistically significant at the 1% level over 2010–2011 but insignificant over 2008–2009. This finding is consistent with H3a.

Turning to the statistics for the control variables, on average, group-affiliated firms have higher levels of size, leverage, cash flow, capital expenditure, dividend payments and ownership concentration and lower liquidity and Tobin's *Q* than unaffiliated firms. However, the significance of the differences varies across the years.

5.2. Pearson correlations

Table 4 presents the Pearson correlation matrix. As expected, *GROUP* is significantly negatively correlated with *CASH*, suggesting that group-affiliated firms tend to hold less cash than their unaffiliated counterparts. This is once again consistent with H1. In addition, *CASH* is significantly positively correlated with liquidity,

[5] The sample period in the study by He et al. (2013) is 1998–2006.

Table 3
Descriptive statistics for the main variables. This table presents descriptive statistics for the firm-level characteristics of the unaffiliated and affiliated samples for the period 2008–2011. The variables are defined as follows: *CASH* is calculated as cash and cash equivalents/(total assets − cash and cash equivalents). *LIQ* is calculated as (working capital − cash and cash equivalents)/total assets. *SIZE* is the natural logarithm of total assets. *Q* is defined as the market value of total assets/book value of total assets. *LEV* is total liabilities/total assets. *CASHFLOW* is operating cash flow/total assets. *CAPEX* is capital expenditures/total assets. Dividend (*DIV*) is measured as the ratio of cash dividends to earnings. CONCEN is the share proportion of the largest shareholder/share proportion of the second largest shareholder. Diff shows the difference in means between the two subsamples. *P*-value shows the *p*-values of tests for the equality of means. All of the variables except for the dummy variables are winsorized at the 1% and 99% levels.

Period	Obs.	*CASH*		*LIQ*		*SIZE*		*Q*		*LEV*		*CASHFLOW*		*CAPEX*		*DIV*		*CONCEN*	
		Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Panel A: Unaffiliated sample (GROUP = 0)																			
2008	684	0.193	0.116	−0.086	−0.036	21.068	20.993	1.567	1.244	0.510	0.495	0.048	0.046	0.050	0.036	0.287	0	9.867	3.468
2009	724	0.244	0.146	−0.080	−0.024	21.176	21.095	2.724	2.104	0.505	0.494	0.059	0.056	0.034	0.033	0.232	0	9.345	4.011
2010	789	0.332	0.177	−0.040	0.005	21.286	21.209	2.958	2.298	0.479	0.475	0.039	0.044	0.048	0.038	0.206	0.063	9.346	4.100
2011	1089	0.382	0.197	0.042	0.078	21.374	21.249	1.980	1.476	0.404	0.386	0.019	0.022	0.065	0.054	0.302	0.148	7.925	3.501
Total	3286	0.300	0.161	−0.031	0.014	21.245	21.146	2.293	1.685	0.467	0.464	0.039	0.040	0.051	0.042	0.261	0.059	8.982	3.743
Panel B: Affiliated sample (GROUP = 1)																			
2008	773	0.189	0.131	−0.085	−0.087	21.854	21.693	1.278	1.081	0.528	0.537	0.050	0.048	0.059	0.041	0.390	0.045	15.218	8.244
2009	820	0.232	0.152	−0.079	−0.072	21.985	21.802	2.202	1.827	0.529	0.547	0.063	0.058	0.050	0.034	0.253	0.074	15.971	8.608
2010	861	0.229	0.144	−0.058	−0.050	22.170	22.004	2.305	1.805	0.532	0.549	0.043	0.043	0.051	0.037	0.215	0.086	15.575	8.065
2011	893	0.232	0.140	−0.050	−0.039	22.321	22.182	1.622	1.307	0.534	0.543	0.032	0.033	0.056	0.041	0.271	0.123	15.351	7.659
Total	3347	0.221	0.142	−0.068	−0.061	22.092	21.921	1.861	1.448	0.531	0.544	0.047	0.045	0.054	0.038	0.280	0.094	15.530	8.095

Period	Obs.	Diff	*P*-value	Diff	*P*-value	Diff	*P*-value	Diff	*P*-value	Diff	*P*-value	Diff	*P*-value	Diff	*P*-value	Diff	*P*-value	Diff	*P*-value
Panel C: Comparison of firm characteristics between unaffiliated and affiliated firms																			
2008	1457	0.004	0.3671	−0.001	0.4876	−0.786	0.0000	0.289	0.0000	−0.018	0.0493	−0.002	0.3306	−0.009	0.0068	−0.103	0.0028	−5.351	0.0000
2009	1544	0.012	0.2230	−0.001	0.4714	−0.809	0.0000	0.522	0.0000	−0.023	0.0151	−0.004	0.2019	−0.015	0.0275	−0.021	0.1987	−6.626	0.0000
2010	1650	0.103	0.0000	0.018	0.0924	−0.884	0.0000	0.653	0.0000	−0.052	0.0000	−0.004	0.1532	−0.003	0.2954	−0.009	0.3234	−6.229	0.0000
2011	1982	0.150	0.0000	0.092	0.0000	−0.946	0.0000	0.358	0.0000	−0.130	0.0000	−0.013	0.0003	−0.004	0.2311	0.031	0.0878	−7.426	0.0000
Total	6633	0.079	0.0000	0.037	0.0000	−0.847	0.0000	0.432	0.0000	−0.064	0.0000	−0.008	0.0001	−0.003	0.1617	−0.019	0.0732	−6.548	0.0000

Tobin's *Q*, cash flow and dividends, and negatively correlated with firm size, leverage, capital expenditure and ownership concentration. This indicates that these control variables are important in explaining a firm's cash policy and should therefore be included in multivariate analyses. Finally, the correlation coefficients of the main variables are less than 0.7, suggesting that multicollinearity should not be a concern in this study (Lind et al., 2002).

5.3. Test of H1

Table 5 presents pooled OLS regressions to determine the effect of business groups on cash holdings in the first two columns. As reported in column (1), the coefficient of *GROUP* is significantly negative (−0.0536, *t*-stat = −6.65). In terms of economic interpretation, a one-standard-deviation increase in the likelihood of being group affiliated precedes a roughly 5% decrease in the cash ratio. The result is not sensitive to the inclusion of a variety of control variables (−0.0166, *t*-stat = −2.25) as shown in column (2). This suggests a substantial weakening in the demand for cash from affiliated firms, consistent with H1.

All of the control variables except for Tobin's *Q* significantly explain firms' cash levels. For instance, the non-cash liquidity substitute (*LIQ*) has a negative effect on cash. The results also show that larger firms hold larger amounts of cash, which does not lend support to the view that larger firms hold less cash because such firms are less capital constrained and more diversified. This finding suggests that other factors may explain the effect of size on cash holdings (Ozkan and Ozkan, 2004). In addition, more leveraged (*LEV*) firms hold significantly less cash, a finding in line with the notion that firms with a higher level of leverage incur higher opportunity costs of holding cash (Baskin, 1987) and/or have greater access to external finance (Ferreira and Vilela, 2004). Furthermore, firms with a higher level of cash flow (*CASHFLOW*) tend to hold more cash, as internally generated funds are critical drivers of cash. Consistent with other studies (e.g., Hill et al., 2014; Locorotondo et al., 2014), the coefficient of capital expenditure (*CAPEX*) is negative and that of dividends (*DIV*) is positive. Finally, ownership concentration (*CONCEN*) is negatively associated with cash holdings, a finding consistent with the view that the presence of strong controllers may lead to a reduction in agency costs, which in turn implies that firms with strong controllers have lower cash reserves.

The preceding results estimated from the OLS regressions provide support for H1, which states that group-affiliated firms hold less cash than their unaffiliated peers. However, as suggested by Khanna (2000), OLS regressions may suffer from severe self-selection bias in this case, as group affiliation may be endogenously selected based on unobserved firm characteristics, leading to a bias in the coefficient estimates. In an effort to address the potential selection bias issue, we implement a variant of the Heckman two-stage approach: the treatment effect model.[6] In the first stage, we estimate a logit model for group affiliation on a bunch of variables that are likely to influence a firm's decision to become affiliated with a given group. Apart from the control variables in the preceding OLS regressions, we include some other variables in the first-stage regression: fixed asset ratio (*FIX*), return on assets (*ROA*), asset growth rate (*GROWTH*), lagged affiliation status (*L_GROUP*) and firm age (*AGE*). We then include the hazard ratio (*HAZARD*) based on the logistic regression in the first stage with *CASH* as the dependent variable. Controlling for potential selection bias does not weaken our main results, as shown in column (4). For instance, the coefficient of *GROUP* remains negative and statistically significant (−0.019, *t*-stat = −2.33). Furthermore, the coefficient of the hazard ratio (*HAZARD*) is positive but insignificant (0.006, *t*-stat = 0.82), implying that selection bias may not be a concern in our study.[7]

5.4. Test of H2

Table 6 presents the results of subsample analyses of the group-cash relationship. The results in column (2) pertain to the NSOE subsample, and column (3) reports the results for the SOE subsample. The coefficient of

[6] Although the dependent variable is only observed for a subset of sample participants in the Heckman two-stage model, it is observed for both the treated and untreated subsamples in the treatment effect model (Guo and Fraser, 2010). In our study, both affiliated and unaffiliated samples are observable. In such cases, the treatment effect model is more appropriate than the Heckman two-stage model for capturing potential self-selection bias.

[7] Untabulated results suggest that our main findings also remain unaffected when a propensity score matching approach is adopted.

Table 4
Correlation matrix for the main variables. This table presents the Pearson correlation matrix for the firm-level characteristics for the full sample. The variables are defined as follows: *CASH* is calculated as cash and cash equivalents/(total assets − cash and cash equivalents). *GROUP* is a dummy variable that equals one if the firm is group affiliated and zero otherwise. *LIQ* is calculated as (working capital − cash and cash equivalents)/total assets. *SIZE* is the natural logarithm of total assets. *Q* is defined as the market value of total assets/book value of total assets. *LEV* is total liabilities/total assets. *CASHFLOW* is operating cash flow/total assets. *CAPEX* is capital expenditures/total assets. Dividend (*DIV*) is measured as the ratio of cash dividends to earnings. *CONCEN* is the share proportion of the largest shareholder/share proportion of the second largest shareholder. All of the variables except for the dummy variables are winsorized at the 1% and 99% levels. The numbers reported in parentheses are *p*-values.

	CASH	*GROUP*	*LIQ*	*SIZE*	*Q*	*LEV*	*CASHFLOW*	*CAPEX*	*DIV*	*CONCEN*
CASH	1.0000									
GROUP	−0.1136	1.0000								
	(0.0000)									
LIQ	0.0482	−0.0638	1.0000							
	(0.0001)	(0.0000)								
SIZE	−0.1822	0.3183	0.1028	1.0000						
	(0.0000)	(0.0000)	(0.0000)							
Q	0.1717	−0.1326	−0.2340	−0.4737	1.0000					
	(0.0000)	(0.0000)	(0.0000)	(0.0000)						
LEV	−0.3960	0.1449	−0.5631	0.2189	−0.0669	1.0000				
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)					
CASHFLOW	0.1327	0.0447	−0.1155	0.0553	0.0534	−0.1556	1.0000			
	(0.0000)	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0000)				
CAPEX	−0.1250	0.0121	0.1178	0.1618	−0.1804	−0.1290	0.1807	1.0000		
	(0.0000)	(0.3234)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)			
DIV	0.0374	0.0178	0.0744	0.1136	−0.0975	−0.1136	0.0338	0.0749	1.0000	
	(0.0023)	(0.1463)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0059)	(0.0000)		
CONCEN	−0.0846	0.1557	−0.0038	0.1147	−0.0822	0.0577	0.0023	−0.0267	0.0075	1.0000
	(0.0000)	(0.0000)	(0.7568)	(0.0000)	(0.0000)	(0.0000)	(0.8500)	(0.0299)	(0.5409)	

Table 5
Effect of business groups on cash holdings. This table presents regression results of the effect of business groups on cash holdings for the full sample. The variables are defined as follows: *CASH* is calculated as cash and cash equivalents/(total assets − cash and cash equivalents). *GROUP* is a dummy variable that equals one if the firm is group affiliated and zero otherwise. *LIQ* is calculated as (working capital − cash and cash equivalents)/total assets. *SIZE* is the natural logarithm of total assets. *Q* is defined as the market value of total assets/book value of total assets. *LEV* is total liabilities/total assets. *CASHFLOW* is operating cash flow/total assets. *CAPEX* is capital expenditures/total assets. *DIV* is measured as the ratio of cash dividends to earnings. *CONCEN* is the share proportion of the largest shareholder/share proportion of the second largest shareholder. *FIX* is measured as fixed assets/total assets. *ROA* is measured as net income/total assets. *GROWTH* is measured as the growth rate of total assets. *AGE* is the number of years since the firm's inception. *L_GROUP* is the lagged term of GROUP. *HAZARD* is the hazard ratio calculated from the first stage. All of the variables except for the dummy variables are winsorized at the 1% and 99% levels. The numbers reported in parentheses are heteroskedasticity corrected *t*-statistics.

	OLS		Treatment effect model	
	CASH		First stage *GROUP*	Second stage *CASH*
	(1)	(2)	(3)	(4)
GROUP	−0.0536*** (−6.65)	−0.0166** (−2.25)		−0.0190** (−2.33)
LIQ		−0.3638*** (−13.58)		−0.3640*** (−13.58)
SIZE		0.0062* (1.83)	0.1389*** (5.69)	0.0065* (1.90)
Q		0.0034(0.68)		0.0035(0.69)
LEV		−0.8691*** (−25.09)		−0.8690*** (−25.09)
CASHFLOW		0.3376*** (5.80)		0.3377*** (5.80)
CAPEX		−0.4769*** (−6.39)		−0.4781*** (−6.38)
DIV		0.0143*** (2.66)		0.0143*** (2.66)
CONCEN		−0.0005*** (−5.76)	0.0018** (2.26)	−0.0005*** (−5.70)
FIX			0.1816(0.90)	
ROA			0.0250(0.06)	
GROWTH			−0.0051(−0.11)	
L_GROUP			3.3713*** (57.18)	
AGE			0.0238*** (4.18)	
HAZARD				0.0060(0.82)
Intercept	0.1156*** (8.67)	0.3618*** (2.64)	−5.1091*** (−8.48)	0.3571*** (2.60)
INDUSTRY	Y	Y	Y	Y
YEAR	Y	Y	Y	Y
Obs.	6633	6633	6633	6633
Adj. R^2	0.1051	0.3121		0.3121
Log likelihood			−1084.750	

* Indicate significant difference at the 10% level (two-sided).
** Indicate significant difference at the 5% level (two-sided).
*** Indicate significant difference at the 1% level (two-sided).

GROUP is negative and significant at the 5% level among NSOEs (−0.0326, *t*-stat = –2.19), but significantly positive among SOEs (0.0206, *t*-stat = 1.92). The results provide evidence that the former firms are being propped up to a lesser extent by government support and therefore have a greater precautionary motive than the latter firms. In other words, the benefits of affiliating with a business group appear to be greater for NSOEs. Meanwhile, group affiliation magnifies the free-cash-flow problem for SOEs, in which managers' private interests diverge from the interests of the firms they manage.

Further comparison of the coefficient of *GROUP* suggests a significant difference between the two groups (*p*-value = 0.001). Taken together, these results support H2, suggesting that although group affiliation significantly decreases the cash holdings of firms with greater precautionary motives, the effect is moderated by the state ownership of listed firms.

5.5. Test of H3a and H3b

Table 7 presents the results for the effect of monetary policy on the association between group affiliation and cash balances. To perform a difference-in-difference estimation, we estimate Eq. (2), in which *POLICY*

Table 6
Effect of business groups and state ownership on cash holdings. This table presents regression results of the effect of business groups on cash holdings for the non-state-owned (NSOE) and state-owned (SOE) subsamples, respectively. The variables are defined as follows: *CASH* is calculated as cash and cash equivalents/(total assets − cash and cash equivalents). *GROUP* is a dummy variable that equals one if the firm is group affiliated and zero otherwise. *LIQ* is calculated as (working capital − cash and cash equivalents)/total assets. *SIZE* is the natural logarithm of total assets. *Q* is defined as the market value of total assets/book value of total assets. *LEV* is total liabilities/total assets. *CASHFLOW* is operating cash flow/total assets. *CAPEX* is capital expenditures/total assets. *DIV* is measured as the ratio of cash dividends to earnings. *CONCEN* is the share proportion of the largest shareholder/share proportion of the second largest shareholder. All of the variables except for the dummy variables are winsorized at the 1% and 99% levels. The numbers reported in parentheses are heteroskedasticity corrected *t*-statistics. The numbers reported in brackets are *p*-values comparing the coefficients between the two subsamples.

	CASH		
	(1) Full sample	(2) NSOEs	(3) SOEs
GROUP	−0.0166**(−2.25)	−0.0326**(−2.19)	0.0206*(1.92)
[*P*-value of equality test]			[0.001]**
LIQ	−0.3638***(−13.58)	−0.4542***(−12.51)	−0.3199***(−7.54)
SIZE	0.0062*(1.83)	0.0069(1.11)	0.0123***(3.22)
Q	0.0034(0.68)	−0.0066(−1.02)	0.0230***(2.79)
LEV	−0.8691***(−25.09)	−1.1584***(−22.19)	−0.5766***(−12.19)
CASHFLOW	0.3376***(5.80)	0.2594***(3.16)	0.4404***(5.52)
CAPEX	−0.4769***(−6.39)	−0.4993***(−5.58)	−0.5806***(−5.78)
DIV	0.0143***(2.66)	0.0255**(2.38)	0.0037(0.66)
CONCEN	−0.0005***(−5.76)	−0.0003(−1.49)	−0.0004***(−5.20)
Intercept	0.3618***(2.64)	0.7739***(4.16)	0.0530(0.48)
INDUSTRY	Y	Y	Y
YEAR	Y	Y	Y
Obs.	6633	2901	3732
Adj. R^2	0.3121	0.3872	0.2555

* Indicate significant difference at the 10% level (two-sided).
** Indicate significant difference at the 5% level (two-sided).
*** Indicate significant difference at the 1% level (two-sided).

is a dummy variable equal to one if the observation occurs during a period of tight monetary policy (i.e., 2010–2011) and zero otherwise (i.e., 2008–2009). The coefficient of interest is the interaction between group affiliation and tight monetary policy (*GROUP* * *POLICY*). Supporting H3a, column (1) shows that the group-policy interaction is negative and significant at the 1% level, indicating that the moderating role of the group on cash reserves is more noticeable during a period of tight monetary policy. Columns (2) and (3) report the relationships for NSOEs and SOEs, respectively. In line with our expectation as stated in H3b, we find that the coefficient of *GROUP* * *POLICY* is negative and significant at the 5% level for NSOEs (−0.0716, *t*-stat = –2.50) but insignificant for SOEs (−0.0275, *t*-stat = −1.36). The difference is also statistically significant (*p*-value = 0.008). This indicates that the effect of group affiliation on cash balances during periods of tight monetary policy is confined to firms with an innate disadvantage in acquiring external financing. Another important observation is that during periods of relatively loose monetary policy, group-affiliated SOEs (0.034, *t*-stat = 2.74) tend to hold economically and statistically more cash than affiliated NSOEs (0.0059, *t*-stat = 0.27). The difference in the coefficient of *GROUP* is significant at the 5% level. The results suggest that SOEs suffer from more severe agency problems than NSOEs, which causes the corporate cash holdings of the former firms to deviate from the level needed for operational and investment purposes (Chen et al., 2012).

6. Further analyses

The preceding results show that business group affiliates hold lower cash reserves than their unaffiliated peers. Our interpretation of these results is that group affiliation can improve affiliates' access to both internal and external capital markets, consistent with the precautionary motive explanation for holding cash. To gain further insight into the mechanism by which group affiliations alleviate the capital constraints of affiliates, we

Table 7
Effect of tight monetary policy on the group-cash relation. This table shows how the effect of business groups and state ownership on the cash holdings is influenced by exogenous monetary policy. The variables are defined as follows: *CASH* is calculated as cash and cash equivalents/(total assets − cash and cash equivalents). *GROUP* is a dummy variable that equals one if the firm is group affiliated and zero otherwise. *POLICY* is a dummy variable that equals one if the firm is under a tight monetary policy (i.e., 2010–2011) and zero otherwise. *LIQ* is calculated as (working capital − cash and cash equivalents)/total assets. *SIZE* is the natural logarithm of total assets. *Q* is defined as the market value of total assets/book value of total assets. *LEV* is total liabilities/total assets. *CASHFLOW* is operating cash flow/total assets. *CAPEX* is capital expenditures/total assets. *DIV* is measured as the ratio of cash dividends to earnings. *CONCEN* is the share proportion of the largest shareholder/share proportion of the second largest shareholder. All of the variables except for the dummy variables are winsorized at the 1% and 99% levels. The numbers reported in parentheses are heteroskedasticity corrected *t*-statistics. The numbers reported in brackets are *p*-values comparing the coefficients between SOEs and NSOEs.

	CASH		
	Full sample (1)	NSOEs (2)	SOEs (3)
GROUP	0.0271***(2.89)	0.0059(0.27)	0.0340***(2.74)
[*P*-value of equality test]			[0.026]**
POLICY	0.1196***(10.51)	0.1132***(8.41)	0.0581***(3.05)
GROUP * *POLICY*	−0.0834***(−6.02)	−0.0716**(−2.50)	−0.0275(−1.36)
[*P*-value of equality test]			[0.008]***
LIQ	−0.3613***(−13.55)	−0.4503***(−12.45)	−0.3196***(−7.53)
SIZE	0.0077**(2.34)	0.0092(1.49)	0.0125***(3.47)
Q	0.0044(0.94)	−0.0044(−0.76)	0.0223***(2.99)
LEV	−0.8631***(−25.05)	−1.1559***(−22.28)	−0.5771***(−12.25)
CASHFLOW	0.3445***(5.93)	0.2663***(3.25)	0.4373***(5.48)
CAPEX	−0.4859***(−6.47)	−0.5029***(−5.61)	−0.5851***(−5.83)
DIV	0.0125**(2.33)	0.0254**(2.37)	0.0035(0.63)
CONCEN	−0.0005***(−5.98)	−0.0003(−1.46)	−0.0004***(−5.27)
Intercept	0.3129**(2.52)	0.7390***(4.02)	0.0452(0.44)
INDUSTRY	Y	Y	Y
Obs.	6633	2901	3732
Adj. R^2	0.3139	0.3869	0.2548

* Indicate significant difference at the 10% level (two-sided).
** Indicate significant difference at the 5% level (two-sided).
*** Indicate significant difference at the 1% level (two-sided).

conduct several additional analyses of the role of group affiliations in facilitating internal financing (related-party transactions) and external financing (debt capacity) and lowering financial constraints (investment-cash-flow sensitivity). In addition, we examine whether business groups help to decrease the investment inefficiency induced by the free-cash-flow problem.

6.1. Business group and related-party transactions

Drawing on internal market theory (Leff, 1978), business groups benefit affiliated firms by forming efficient group-wide internal labor and capital markets. To provide direct evidence of the veracity of this argument, we examine the association between group affiliation and internal financing while paying particular attention to related-party transactions (*RPT*), which are prevalent in China (e.g., Keister, 1998). The CSRC mandates that all Chinese listed firms disclose such transactions in their financial reporting, which enables us to investigate the internal resource flows within a business group. These transactions mainly include inter-corporate lending and loan guarantees; internal purchases and sales of goods or assets; and leases. To capture the intra-group related-party transactions, we exclude those not occurring between members of the same business group. We employ a Tobit regression as follows:

$$RPT_{i,t} = \alpha_0 + \alpha_1 GROUP_{i,t} + \alpha_2 SIZE_{i,t} + \alpha_3 LEV_{i,t} + \alpha_4 GROWTH_{i,t} + Year + Industry + \varepsilon_{i,t} \quad (3)$$

where for firm *i* and year *t* *RPT* is the value of intra-group related-party transactions divided by total assets, *GROUP* is a dummy variable that equals one if the firm is affiliated with a group and zero otherwise, *SIZE* is

the natural logarithm of total assets, *LEV* refers to total liabilities divided by total assets and *GROWTH* is the growth rate of total assets. We also control for year and industry fixed effects.

Table 8 presents the results. Consistent with Jia et al. (2013), we document a positive and significant association between *GROUP* and *RPT* (0.043, *t*-stat = 17.32). According to an economic interpretation, a one-standard-deviation increase in group affiliation results in a 4.3% increase in the amount of related-party transactions within a group. Turning to split-sample analysis, as reported in columns (2) and (3), the effect of group affiliation on related-party transactions is more pronounced for NSOEs (0.031, *t*-stat = 6.40) than for SOEs (0.021, *t*-stat = 5.94). The coefficient of *GROUP* differs significantly between the two groups (*p*-value = 0.000). This lends further support to our main finding that business groups play a greater role in decreasing cash balances for NSOEs.

6.2. Business groups and debt capacity

In addition to facilitating the internal capital markets, business groups can improve the debt-bearing capacity of affiliates (e.g., Chang and Hong, 2000; Manos et al., 2007). To confirm our conjecture, we estimate the following pooled OLS regression:

$$LEV_{i,t} = \alpha_0 + \alpha_1 GROUP_{i,t} + \alpha_2 SIZE_{i,t} + \alpha_3 TA_{i,t} + \alpha_4 ROA_{i,t} + \alpha_5 GROWTH_{i,t} + \alpha_6 CONCEN_{i,t} + Year + Industry + \varepsilon_{i,t} \quad (4)$$

where for firm *i* and year *t* *LEV* is a proxy for debt capacity. To enhance the robustness of our analysis, we use two measures for *LEV*: *LEV1*, which is calculated as total liabilities (i.e., short-term loans plus long-term loans) divided by the book value of total assets, and *LEV2*, which is calculated as total liabilities divided by the market value of total assets. All of the other variables are as defined previously expect for *TA*, which refers to tangible assets divided by total assets. Table 9 presents the results.

As shown in column (1), the coefficient of *GROUP* is positive and significant at the 1% level (0.0223, *t*-stat = 4.39). This indicates that a one-standard-deviation increase in group affiliation leads to a 2.23% increase in loans from debt markets. When it comes to split-sample analysis, as shown in columns (2) and (3), the positive effect of group affiliation on debt capacity occurs for NSOEs (0.030, *t*-stat = 2.79) but not

Table 8
Do affiliated firms have more related party transactions within the groups? This table presents Tobit regression results of the effect of business groups on related party transactions within the groups. The dependent variable is related party transactions, measured by the amount of related party transactions within a group divided by total assets. The other variables are defined as follows: *GROUP* is a dummy variable that equals one if the firm is group affiliated and zero otherwise. *SIZE* is the natural logarithm of total assets. *LEV* is total liabilities/total assets. *GROWTH* is the growth rate of total assets. All of the variables except for the dummy variables are winsorized at the 1% and 99% levels. The numbers reported in parentheses are heteroskedasticity corrected *t*-statistics. The numbers reported in brackets are *p*-values comparing the coefficients between SOEs and NSOEs.

	Related party transactions		
	(1) Full sample	(2) NSOEs	(3) SOEs
GROUP	0.0431*** (17.32)	0.0306*** (6.40)	0.0210*** (5.94)
[*P*-value of equality test]			[0.000]***
SIZE	−0.0098*** (−8.18)	−0.0116*** (−5.21)	−0.0115*** (−7.52)
LEV	0.1318*** (14.76)	0.1340*** (8.92)	0.1201*** (10.57)
GROWTH	0.0044** (2.02)	−0.0030 (−1.03)	0.0108*** (3.70)
Intercept	0.1696*** (4.13)	0.172*** (3.62)	0.224*** (5.08)
INDUSTRY	Y	Y	Y
YEAR	Y	Y	Y
Obs.	6542	2835	3707
Pseudo R^2	−0.1891	−0.3466	−0.1099

* Indicate significant difference at the 10% level (two-sided).
** Indicate significant difference at the 5% level (two-sided).
*** Indicate significant difference at the 1% level (two-sided).

Table 9

Do affiliated firms have a higher debt capacity than unaffiliated firms? This table presents OLS regression results of the effect of business groups on debt capacity. The dependent variable in measured as total liabilities divided by total assets, where total assets are calculated in book value in Panel A and market value in Panel B. The other variables are defined as follows: *GROUP* is a dummy variable that equals one if the firm is group affiliated and zero otherwise. *SIZE* is the natural logarithm of total assets. TA is tangible assets/total assets. *ROA* is the return on total assets. *GROWTH* is the growth rate of total assets. *CONCEN* is the share proportion of the largest shareholder/share proportion of the second largest shareholder. All of the variables except for the dummy variables are winsorized at the 1% and 99% levels. The numbers reported in parentheses are heteroskedasticity corrected *t*-statistics. The numbers reported in brackets are *p*-values comparing the coefficients between SOEs and NSOEs.

	Panel A: LEV1			Panel B: LEV2		
	(1) Full sample	(2) NSOEs	(3) SOEs	(4) Full sample	(5) NSOEs	(6) SOEs
GROUP	0.0223***(4.39)	0.0301***(2.79)	−0.0070(−0.91)	0.0230***(5.48)	0.0210**(2.34)	0.0051(0.81)
[*P*-value of equality test]			[0.033]**			[0.076]*
SIZE	0.0283***(9.17)	0.0085(1.39)	0.0391***(13.91)	0.0748***(29.47)	0.0550***(12.09)	0.0859***(32.44)
TA	0.1354***(6.90)	0.1836***(5.49)	0.0772***(3.48)	0.0917***(6.05)	0.1170***(4.85)	0.0488***(2.60)
ROA	−0.8872***(−16.01)	−0.7478***(−9.74)	−1.0077***(−14.14)	−0.5883***(−13.65)	−0.4491***(−7.55)	−0.7241***(−12.88)
GROWTH	0.0074*(1.75)	−0.0004(−0.07)	0.0171***(3.27)	0.0011(0.32)	−0.0046(−0.97)	0.0077(1.46)
CONCEN	−0.0000(−0.45)	0.0004**(2.34)	−0.0002***(−2.67)	0.0001(1.25)	0.0005***(3.27)	−0.0000(−0.72)
Intercept	−0.1922(−1.22)	0.2631*(1.95)	−0.3770**(−2.34)	−1.3821***(−22.85)	−0.9220***(−9.46)	−1.5856***(−25.70)
INDUSTRY	Y	Y	Y	Y	Y	Y
YEAR	Y	Y	Y	Y	Y	Y
Obs.	6633	2901	3732	6633	2901	3732
R^2	0.2407	0.2160	0.2808	0.4739	0.3636	0.5187

* Indicate significant difference at the 10% level (two-sided). All of the results are based on OLS regression.

** Indicate significant difference at the 5% level (two-sided). All of the results are based on OLS regression.

*** Indicate significant difference at the 1% level (two-sided). All of the results are based on OLS regression.

for SOEs (−0.007, *t*-stat = −0.91). As expected, the difference in the *GROUP* coefficient is significant at the 5% level (*p*-value = 0.033). The results are not sensitive to the use of the alternative measure for the dependent variable, as observed in columns (4)–(6). The results offer an extra explanation of the positive association between business groups and corporate cash holdings.

6.3. Business group and investment-cash-flow sensitivity

The previous results consistently suggest that group affiliations decrease a firm's reliance on precautionary cash holdings. The question that naturally arises is whether group-affiliated firms face less financial constraints than their unaffiliated peers. He et al. (2013) find a negative association between group affiliation and financial constraints, proxied by investment-cash-flow sensitivity. However, their study focuses on an earlier period than ours (i.e., 1998–2006). Given the rapid development of China's economy and the structural change in the stock markets following the SSSR, a further investigation of the effect of business groups on financial constraints in recent years is merited. Following Almeida and Campello (2007), we estimate the following equation:

$$CAPEX_{i,t} = \alpha_1 + \alpha_2 CASHFLOW_{i,t} + \alpha_3 GROUP_{i,t} + \alpha_4 GROUP * CASHFLOW_{i,t} + \alpha_5 SIZE_{i,t} + \alpha_6 Q_{i,t} + \alpha_7 LEV_{i,t} + \alpha_8 ROA_{i,t} + Year + Industry + \varepsilon_{i,t} \quad (5)$$

where all of the variables are as defined previously. The main variable of interest is *GROUP * CASHFLOW*. The results for the full sample are shown in columns (1) and (2) of Table 10. Without considering the variation between the group-affiliated and unaffiliated firms, Chinese listed firms exhibit a high level of financial constraints on average, as the coefficient of *CASHFLOW* is positive and significant at the 1% level. When we include the business group variable (*GROUP*) and an interaction term between *GROUP* and *CASHFLOW*, we find that group-affiliated firms have a lower level of capital constraints than the unaffiliated firms. For example, the coefficient of *GROUP * CASHFLOW* is significantly negative (−0.111, *t*-stat = −1.83). This

Table 10
Do affiliated firms suffer less from capital constraints? This table presents OLS regression results of the effect of business groups on investment-cash flow sensitivity. The variables are defined as follows: *CAPEX* is capital expenditures/total assets. *CASHFLOW* is operating cash flow/total assets. *GROUP* is a dummy variable that equals one if the firm is group affiliated and zero otherwise. *SIZE* is the natural logarithm of total assets. *Q* is defined as the market value of total assets/book value of total assets. *LEV* is total liabilities/total assets. *ROA* is measured as net income/total assets. All of the variables except for the dummy variables are winsorized at the 1% and 99% levels. The numbers reported in brackets are *p*-values comparing the coefficients between SOEs and NSOEs. The numbers reported in parentheses are heteroskedasticity corrected *t*-statistics.

	CAPEX			
	Full sample		NSOEs	SOEs
	(1)	(2)	(3)	(4)
CASHFLOW	0.2121***(3.95)	0.2639***(3.33)	0.3200***(3.15)	0.0883***(3.48)
GROUP		−0.0064*(−1.90)	−0.0026(−0.44)	−0.0028(−0.96)
*GROUP * CASHFLOW*		−0.1111*(−1.83)	−0.2282***(−2.78)	0.0333(1.25)
[*P*-value of equality test]				[0.000]***
SIZE	0.0106***(5.65)	0.0119***(6.37)	0.0201***(4.31)	0.0082***(7.38)
Q	−0.0086**(−2.53)	−0.0084**(−2.50)	−0.0078*(−1.65)	−0.0045**(−2.18)
LEV	−0.0825***(−3.91)	−0.0821***(−3.86)	−0.1251***(−3.84)	−0.0119(−1.08)
ROA	−0.1577*(−1.92)	−0.1623**(−2.00)	−0.3150**(−2.30)	0.0277(0.71)
Intercept	−0.1394***(−3.35)	−0.1676***(−3.87)	−0.2800***(−3.22)	−0.1096***(−3.74)
INDUSTRY	Y	Y	Y	Y
YEAR	Y	Y	Y	Y
Obs.	6633	6633	2901	3732
Adj. R^2	0.1283	0.1325	0.1524	0.1816

* Indicate significant difference at the 10% level (two-sided).
** Indicate significant difference at the 5% level (two-sided).
*** Indicate significant difference at the 1% level (two-sided).

corroborates the results of He et al. (2013), who find that the coefficient of *GROUP* * *CASHFLOW* is −0.1313 (column [1] of Table 3 Panel B). Taken together, our findings suggest that, on average, group affiliations help to decrease the financial constraints facing listed firms.

Columns (3) and (4) report the subsample analysis results. The coefficient of *GROUP* * *CASHFLOW* is significantly negative for NSOEs (−0.228, *t*-stat = −2.78) but insignificant for SOEs (0.033, *t*-stat = 1.25). The difference in the coefficient is also significant at the 1% level (*p*-value = 0.000). The results support the view that the marginal effect of group affiliation is greater for firms that have more difficulty acquiring external financing.

6.4. Business groups and overinvestment

Thus far it is apparent that group affiliates hold less cash due to the existence of an internal capital market. A more intriguing question is whether business groups mitigate or exacerbate the free-cash-flow problem. In this section, we examine the effect of group affiliation on overinvestment, which is the most likely consequence of retaining free cash flows (e.g., Lang and Litzenberger, 1989; Richardson, 2006).

We estimate the following equation based on the framework adopted by Richardson (2006):

$$INVEST_{i,t} = \alpha_0 + \alpha_1 SIZE_{i,t-1} + \alpha_2 LEV_{i,t-1} + \alpha_3 GROWTH_{i,t-1} + \alpha_4 RET_{i,t-1} + \alpha_5 AGE_{i,t-1} + \alpha_6 CASH_{i,t-1} + \alpha_7 INVEST_{i,t-1} + \varepsilon_{i,t} \quad (6)$$

where *INVEST* is measured as investment expenditure divided by total assets. *RET* is the accumulative return, calculated based on monthly returns of the year. The fitted value of Eq. (6) is the normal level of investment and the residual is the abnormal investment estimate. Positive residuals correspond with overinvestment (*OVERINVEST*).

Table 11
Do group affiliations decrease overinvestment? This table presents OLS regression results of the effect of business groups on overinvestment. The variables are defined as follows: *OVERINVEST* is the positive residual estimated from Eq. (6). *GROUP* is a dummy variable that equals one if the firm is group affiliated and zero otherwise. *ROA* is measured as net income/total assets. *FCF* refers to free cash flow, calculated as (operating cash flow − normal investment expenditure)/total assets. *TUNNEL* refers to other receivables divided by total assets. *MINO* is minority equity/total equity. *PAY* is the natural log of the sum of the three highest paid executives' compensations. *TOP* is the percentage of shares held by the largest shareholder. *BSIZE* is the number of directors on the board. *INDEP* is the number of independent directors on the board. All of the variables except for the dummy variables are winsorized at the 1% and 99% levels. The numbers reported in parentheses are heteroskedasticity corrected *t*-statistics. The numbers reported in brackets are *p*-values comparing the coefficients between SOEs and NSOEs.

	OVERINVEST		
	(1) Full sample	(2) NSOEs	(3) SOEs
GROUP	−0.004**(−2.555)	−0.008***(−3.384)	−0.000(−0.065)
[*P*-value of equality test]			[0.005]***
ROA	0.039*(1.774)	0.014(0.585)	0.050*(1.775)
FCF	0.007***(3.347)	0.008(1.512)	0.005(1.041)
TUNNEL	−0.051*(−1.675)	−0.021(−0.743)	−0.099*(−1.827)
MINO	−0.012*(−1.732)	−0.027**(−2.527)	−0.002(−0.205)
PAY	−0.001(−0.519)	−0.003*(−1.800)	0.001(0.375)
TOP	−0.001(−0.348)	0.008(1.339)	−0.006*(−1.877)
BSIZE	−0.004(−1.025)	−0.006(−0.716)	−0.002(−0.444)
INDEP	−0.006(−0.630)	−0.021(−1.192)	−0.003(−0.203)
Intercept	0.064***(3.192)	0.113***(3.920)	0.033*(1.946)
INDUSTRY	Y	Y	Y
YEAR	Y	Y	Y
Obs.	2626	1192	1434
Adj. R^2	0.055	0.050	0.074

* Indicate significant difference at the 10% level (two-sided).
** Indicate significant difference at the 5% level (two-sided).
*** Indicate significant difference at the 1% level (two-sided).

In the second stage, we estimate the following equation to test the influence of business groups on overinvestment:

$$OVERINVEST_{i,t} = \beta_0 + \beta_1 GROUP_{i,t} + \beta_2 ROA_{i,t} + \beta_3 FCF_{i,t} + \beta_4 TUNNEL_{i,t} + \beta_5 MINO_{i,t} + \beta_6 PAY_{i,t} + \beta_7 TOP_{i,t} + \beta_8 BSIZE_{i,t} + \beta_9 INDEP_{i,t} + \varepsilon_{i,t} \quad (7)$$

where *FCF* is free cash flow, calculated as operating cash flow minus the normal investment expenditure divided by total assets. *TUNNEL* refers to other receivables divided by total assets. *MINO* is calculated as minority equity divided by total equity. *PAY* is the natural log of executive pay, measured as the sum of the three highest paid executives' compensation. *TOP* is measured as the percentage of shares held by the largest shareholder. *BSIZE* is the number of directors on the board. *INDEP* is the number of independent directors on the board.

As Table 11 shows, group affiliation decreases overinvestment on average. Moreover, this effect is more conspicuous among NSOEs (coefficient = −0.008, *t*-stat = −3.384) than SOEs (coefficient = −0.000, *t*-stat = −0.065). These results suggest that business groups have a positive role in decreasing the free-cash-flow problem, especially for those who experience a greater reduction in cash holdings due to moderated precautionary motives.

7. Conclusion

Although considerable attention has been paid to the question of why business groups exist, focusing solely on either the "tunneling" or "propping up" functions of business groups fails to fully capture the complexity and nuance of the question. This study seeks to achieve a better understanding of the role of business groups by investigating the relationship between group affiliation and cash holdings in a transitional economy characterized by weak investor protection and difficulties in obtaining external financing.

The results show that group affiliation significantly decreases cash holdings. This supports the "propping up" explanation that business groups allow the formation of internal capital markets, which alleviates the free-cash-flow problem associated with the tunneling function. However, this benefit is moderated by state ownership, which is associated with higher agency costs. In addition, the effect is more prominent when the financial market is less liquid as a result of tight monetary policy. Finally, in exploring the manner in which business groups affect firms' decisions to hold cash, we find that group affiliation facilitates related-party transactions, improves debt capacity and decreases investment-cash-flow sensitivity and overinvestment. Furthermore, the effects are more pronounced among NSOEs, which are propped up by the government to a lesser extent.

This study bridges the business group and cash holding literatures. However, additional research is warranted to explore areas such as the dynamic cash holdings of group-affiliated and unaffiliated firms. In particular, studies must determine how SOEs adjust their cash policies when they are privatized. Furthermore, a growing literature shows that the cash holdings of unaffiliated firms serve as a buffer against underinvestment associated with financing frictions. Whether the internal capital market can prevent group affiliates from underinvesting is another topic for future research. Finally, the comparison of the group-cash relationship across countries may also yield new insights.

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China Journal of Accounting Research 9 (2016) 25–39

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Contents lists available at ScienceDirect

China Journal of Accounting Research

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

Executive compensation in business groups: Evidence from China☆

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ARTICLE INFO

Article history:
Received 2 September 2014
Accepted 25 June 2015
Available online 18 August 2015

JEL classification:
G32
G34
J31
L22

Keywords:
Business group
Executive compensation
RPE
China

ABSTRACT

This paper examines executive compensation in the subsidiaries of business groups in China. Analyzing a sample of China business groups (the so-called "*XiZu JiTuan*" in Chinese) from 2003 to 2012, we find convincing evidence of the use of Relative Performance Evaluation (RPE) in the executive compensation of the subsidiaries of business groups. Specifically, when the change in performance of one subsidiary is lower than that of the other subsidiaries, the change in its executive compensation is significantly lower. Further, when the business group is private and the level of marketization is high, the subsidiary's executive compensation is more likely to be influenced by the performance of the other subsidiaries. This research improves our understanding of the decision mechanisms of executive compensation in business groups and enriches the literature on executive compensation and business groups.

1. Introduction

The use of executive compensation as an incentive mechanism to reduce agency problems (Jensen and Meckling, 1976) is a core research area in corporate governance. There is much research about executive compensation in China's listed companies. The literature focuses mostly on pay–performance sensitivity (Fang,

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☆ We are thankful for comments and suggestions from the referee and participants at the 2014 China Journal of Accounting Research Annual Conference in Kunming. Zheng thanks the National Natural Science Foundation of China (Approval Number: 71272199) for financial support.

http://dx.doi.org/10.1016/j.cjar.2015.06.003
1755-3091/

2009, 2011; Xin and Tan, 2009; Li et al., 2013) and the economic consequences of pay dispersion (Lin et al., 2003; Chen and Zhang, 2006; Li and Hu, 2012). However, this empirical literature is generally based on the implicit assumption that the listed companies are all independent, and that executive compensation is determined only by the characteristics of the company itself and the industry. Yet not all listed companies are independent. In Asian countries, independent companies are not even the main form of company. For example, Claessens et al. (2002) find that, in nine Asian countries, about 70% of the listed companies are controlled by business groups. In China, as of 2011 almost 76% of listed companies belonged to different groups (Zheng et al., 2014).

Therefore, it is important to examine executive compensation under the circumstances of business groups. From the perspective of business groups, the relationship between the ultimate controlling shareholder and the executives of the different subsidiaries is just like the situation of one principle and many agents. According to Relative Performance Evaluation (RPE) theory (Holmstrom, 1979, 1982; Murphy, 1999), in a multi-agent setting, although agents are confronted with common risks, valuable information about an agent's action can be conveyed by the outputs of the other agents. Therefore, if we ignore the fact that most listed companies are controlled by business groups, and if we fail to consider the influence of the other subsidiaries in the same group, the results of studies on executive compensation may not be true or reliable and may even mislead policymakers, which in the end will lead to the inefficient allocation of resources.

Exploring executive compensation in business groups is also an important task that can contribute to the literature of business groups. To date, studies about business groups mainly focus on the tunneling behavior of the ultimate shareholder (Bae et al., 2002; Bertrand et al., 2002; Baek et al., 2006; Jiang et al., 2010) and internal capital markets (Shin and Park, 1999; Hoshi et al., 1991; Gopalan et al., 2007; Shao and Liu, 2007, 2009; Yang, 2007; Ma and Chen, 2013; Almeida et al., 2014). These studies generally analyze the economic consequences of the sophisticated ownership structure of business groups, but rarely study the incentive and decision mechanisms in business groups, which can affect the governance of business groups directly. To the best of our knowledge, this paper is the first to empirically examine the incentive mechanism in business groups. Because business groups are prevalent around the world (Almeida et al., 2011; Masulis et al., 2013) and play an important role in some countries, especially in China, learning how to maximize the value of business groups requires us to open the black box of the incentive mechanism. Therefore, our research can shed light on how to improve the governance of business groups and to some degree fill the gap in the literature.

However, to examine subsidiaries' executive compensation decision mechanism, we need to collect data on the corporate governance of subsidiaries in business groups. Because non-public companies are not required to disclose their data, traditional research on business groups generally assumes that one business group has only one listed subsidiary company, and examines the operation or economic consequences based on this assumption,[1] which may not describe the business group comprehensively and objectively. In this study, we use a unique dataset of China business groups to examine executive compensation in business groups. In China, one special kind of business group, the so-called *XiZu JiTuan* in Chinese, has sprung up like bamboo in the past 20 years. *XiZu JiTuan* is defined as more than one listed company under the control of the same ultimate shareholder, which is the output of the development of business groups in the capital markets (Ma and Chen, 2013; Shao and Liu, 2007). These unique data allow us to explore the executive compensation decision mechanisms in the available business groups. The reasons are as follows. First, listed subsidiaries, as the main members of *XiZu JiTuan*, are required to disclose detailed information about their executive compensation and corporate governance, thus solving the problems of data sources and data reliability. Second, the previous literature on corporate governance rarely controls for the influence of the characteristics of the ultimate shareholder (e.g., their preferences) on corporate governance. In *XiZu JiTuan*, we can reduce this problem, because differently listed subsidiaries are ultimately controlled by the same shareholder. Third, by analyzing the ultimate shareholder's treatment of the different listed subsidiaries and the relationship between the ultimate shareholder and listed subsidiaries, such as their position and the ownership structure, we can systematically investigate the motives for and economic consequences of resource allocation inside business groups.

[1] For example, Gopalan et al. (2007) and Shin and Park (1999) investigate the motive and efficiency of the internal capital market of business groups indirectly, solely based on the study of listed companies.

Therefore, we use the sample of *XiZu JiTuan* during 2003–2011 in China, including 271 *XiZu JiTuan* and 4124 firm-year observations, to examine subsidiaries' executive compensation in business groups. Specifically, if there are two listed subsidiaries in the same business group, named firm *A* and firm *B*, then we examine whether the executive compensation of firm *A* is influenced by the performance of firm *B*, in addition to firm *A*'s performance and other characteristics. Our empirical research provides a positive answer. We find that, in the same business group, the executive compensation of one listed subsidiary is not only decided by its own performance but is also based on the performance of other listed subsidiaries or their relative performance ranking. When the change in performance of one listed subsidiary is relatively lower than that of other subsidiaries in the same business group, the change in executive compensation is significantly lower, which means that the relative performance evaluation (RPE) mechanism exists in decisions about executive compensation in business groups. However, our further research shows that the RPE mechanism in business groups exists more obviously only when business groups are private or the level of marketization is high.

This study contributes to the literature in three ways. First, unlike the previous literature on executive compensation that focuses on independent companies, we study executive compensation under the circumstances of business groups, which conforms more with the current situation of the capital markets in Asian countries, especially in China, and avoids the bias in the existing literature while providing a new angle to study executive compensation. Second, the current literature of business groups provides limited insights on the governance inside business groups. To our best knowledge, our paper is the first to study the incentive mechanism in business groups empirically, which also contributes to the literature on business groups. Third, the paucity of RPE in the components of executive compensation remains a puzzle (Murphy, 1999) and is not well understood in the literature. We provide a better research design to test RPE in executive compensation. By examining the RPE mechanism in business groups, we can control for the influence of the characteristics of the ultimate shareholder and obtain more conservative and reliable results, which sheds more light on the puzzle of RPE.

The remainder of this paper is organized as follows. Section 2 provides the theoretical analysis and the corresponding hypotheses. Section 3 describes our sample and research design. Section 4 presents our empirical analysis, and Section 5 concludes.

2. Theoretical analysis and hypothesis development

Executive compensation is a core issue in corporate governance. In a company, top managers are responsible for regular operations and thus have a decisive influence on the company's performance. However, according to agency theory, as a rational agent the top manager has the motivation to maximize his own private interest, which may be detrimental to the benefits of shareholders (Jensen and Meckling, 1976). Therefore, designing an effective incentive mechanism to encourage executives to work hard and maximize the value of shareholders (Jensen & Murphy, 1990) becomes the most important issue in corporate governance.

Since Holmstrom (1979, 1982) came up with RPE theory, many studies have examined the use of RPE in incentive contracts, but they have obtained inconsistent results (Albuquerque, 2009).[2] Murphy (1999) proposes that the paucity of RPE in options and other components of executive compensation remains a puzzle worth understanding. There are several potential explanations. First, the previous literature on executive compensation is based on independent companies and ignores the fact that different companies may belong to different groups. In business groups, the performance of one listed subsidiary and its executive compensation may be influenced by other subsidiaries. If we ignore these factors, our results may be unreliable. Second, the characteristics of the ultimate shareholder can vary greatly, which may also affect the results if we do not control for this factor. Therefore, it is very important to examine executive compensation from the perspective of business groups.

[2] The empirical studies of RPE proposed by Holmstrom (1979) obtain inconsistent results. For example, the results found by Gibbons and Murphy (1990) support the existence of RPE, but many papers could not find any evidence of the use of RPE (Barro and Barro, 1990; Garvey and Milbourn, 2003). Janakiraman et al. (1992) find that RPE exists only when performance is measured by stock returns.

2.1. Decision mechanism of executive compensation in business groups

Theoretically, from the view of business groups, the use of RPE can be an effective way to achieve the goal of maximizing the value of the group. There are two main reasons for this.

First, the use of RPE in business groups provides incremental information for assessing the actions taken by top managers. In business groups, the relationship between the ultimate shareholder and the executives of different subsidiaries is the situation of one principle and many agents. In this multi-agent setting, subsidiaries in the same group may face a common risk, and the output of other agents contains some valuable information about the agents' actions (Holmstrom, 1979, 1982). Therefore, the payment of one agent should not only be based on his own absolute performance, but also on his relative performance among the other agents, while eliminating the effects of common shocks. The tournament theory proposed by Lazear and Rosen (1981) states that because the cost of supervising management is quite high, the agent's compensation should be based on his ranking of the marginal output, rather than his absolute marginal output. Under the circumstances of business groups, the performance of one subsidiary is often affected by other subsidiaries. By building an internal capital market in a business group, internal resources can flow between different subsidiaries, which may reduce transaction costs but result in a high correlation between the subsidiaries' performance. Therefore, to effectively encourage executives, the decisions about subsidiaries' compensation should consider the performance of other subsidiaries. That is, when the performance of firm A is better than that of firm B, the executives of firm A should gain higher compensation.

Second, the use of RPE in business groups can ensure the executives' feeling that pay is equal. How to make executives feel that pay is fair is an important question. Both equity theory (Adams, 1965) and social comparison theory (Festinger, 1954) state that workers will compare their input level and outcome with those of their peers, and feel fairness only when the input level and the outcome match. When determining compensation, it is very important to make employees feel that the results are fair (Greenberg, 1987), otherwise, the perceived unfairness will lead to feelings of disenchantment, the temptation of negative sabotage and a loss of talent (Adams, 1965). Therefore, the procedural justice of the distribution of rewards[3] and perceptions of fairness among executives are crucial to the healthy operation of business groups. When firm A performs better than firm B, to meet the criteria of procedural justice, the executives of firm A should be rewarded with higher compensation.

Hence, we propose our first hypothesis.

H1. In the same business group, if firm A performs worse than firm B, the executive compensation of firm A should be lower. That is, the RPE mechanism exists in business groups.

2.2. Level of marketization

In China, there are various differences in the way executive compensation is designed and evaluated for SOEs and non-SOEs (Chen et al., 2012). However, China's diverse markets and geographic regions provide sufficient variation in the level of marketization to study the effects of the institutional environment on the incentive mechanism in business groups.

2.2.1. Ownership type and executive compensation in business groups

In China, the compensation contracts of state-owned business groups (SOBG) are different from the contracts of non-state-owned business groups (non-SOBG).

First, SOEs are often controlled by the government. The government in China has the power to appoint and dismiss the executives to strengthen their influence in the operation of SOEs and achieve their political objectives. On the one hand, the executive compensation of SOEs is regulated by the government (Chen et al., 2005), and emphasizes egalitarianism. On the other hand, SOEs are required to undertake many policy

[3] The organizational procedures are more frequently cited than outcomes as causes of unfairness in organizations (Greenberg, 1986; Sheppard and Lewicki, 1987), and such procedures contribute more to job satisfaction than do outcomes (Alexander and Ruderman, 1987).

burdens, such as the improving the employment rate and tax income (Lin Justin et al., 1998; Lin Justin and Tan, 1999), so accounting-based performance plays a limited role in evaluating the performance of executives in SOEs. Besides, executives, especially the CEO and the chairman of the board, are often also government officials. The incentive of executives in SOEs may mostly come from the promotion of their administrative position or managerial perks (Chen et al., 2005). The socialist government always has a tendency toward egalitarianism. The government prefers to pay executives average pay rather than performance-based compensation or pay based on tournament ranking (Lin et al., 2003). Therefore, executive compensation in SOBGs depends less on the performance of other subsidiaries.

Second, the executive compensation in non-SOBGs is far more market oriented. Executives in non-SOBGs mainly come from the market of professional managers, and firms must design more effective contracts to attract and retain talent. Moreover, the goal of non-SOBGs is to maximize the value of the company, so it is rational to incentivize executives through performance-based compensation. In non-SOBGs, in evaluating the performance of executives, the relative performance among different subsidiaries contains more information about the efforts of executives.

Therefore, we propose our second hypothesis.

H2. Compared with SOBGs, the executive compensation in non-SOBGs depends more on the performance of other subsidiaries in the same business group.

2.2.2. Marketization and executive compensation in business groups

The last 30 years have seen a great development in the market economy of China (Fan and Wang, 2011). As an important external governance mechanism, China's marketization has improved the efficiency of capital allocation (Fang, 2006), corporate governance (Jiang et al., 2010) and the value of companies (Xia and Fang, 2005).

Theoretically, the development of marketization can impel business groups to design more effective compensation contracts. First, the higher the level of marketization, the stronger the legal protection of property rights, and the tunneling and self-interested behavior of management is then constrained. Second, the degree of regional marketization reflects the quality of the government administration. External corporate governance mechanisms include property rights, the government administration, legal protection, market competition, the credit system and the culture of contracts (Xia and Fang, 2005). In addition to legal protection, government administration is another important characteristic that Chinese companies face that is quite different from that in other countries. When the level of marketization is high, there will be less unreasonable government intervention, and executive compensation will also face less regulation, which can be helpful for business groups in designing effective compensation contracts. Third, the higher the degree of marketization, the more intense the competition in the product market, and the greater the transparency and comparability of a company's performance. A company will be more likely to release information about the efforts and ability of its executives in the form of their accounting performance, because the information will be helpful in creating a more effective compensation policy. We thus propose our third hypothesis.

H3. The higher the degree of marketization under which the group company operates, the more the executive compensation of the subsidiary depends on the performance of other subsidiaries in the business group.

3. Research design

3.1. Data sources

We hand collect the *XiZu JiTuan* data in the following steps. In the first step, we define the criteria for a listed firm belonging to a business group, that is, the ultimate controlling shareholder can exercise "controlling influence" over it (Almeida et al., 2011). In the second step, we analyze the detailed ownership structure data that the Chinese government has required public companies to disclose in their annual financial reports since 2003. Combining these ownership data with the list of Chinese large business groups in the "Annual Report on the Development of China's Large Enterprise Groups" (2004–2008) published by the National Bureau of

Statistics of PRC, we can group the listed companies that are controlled by one ultimate controlling shareholder. Finally, we obtain 271 *XiZu JiTuan* and 4124 firm-year observations from 2004 to 2012, after excluding financial companies and observations lacking complete financial data or data on the main variables. Our financial data are primarily from the China Stock Market and Accounting Research (CSMAR) database.

3.2. Research design

According to previous studies, executive compensation in business groups can have both the RPE mechanism (Aggarwal and Samwick, 1999; Albuquerque, 2009) and compensation peer group effects (Bizjak et al., 2008, 2011). To test the basic hypothesis H1, we use the following change model.

$$\Delta Compensation_{A,t} = \alpha_1 \Delta Performance_{B,t} + \alpha_2 \Delta Performance_{Ind,t} + \alpha_3 \Delta Performance_{A,t} + \alpha_4 \Delta Compensation_{B,t} + \alpha_5 \Delta Compensation_{Ind,t} + \alpha_i Controls_{i,t} + \varepsilon$$

$\Delta Compensation$ is the change in executive compensation, defined as executive compensation in of the current year minus executive compensation in the previous year. In Chinese listed companies, the structure of executive compensation consists of basic salary and performance compensation but relatively little stock-based compensation (Fang, 2009; Li et al., 2013). Therefore, we use the logarithm of the sum of the compensation of the top three managers to measure executive compensation, and we do not include stock-based compensation. $\Delta Performance$ is the change in current performance, which is current return on assets (ROA) minus the ROA of the last year. The subscripts A and B refer to the different subsidiaries in the same business group. If we let firm A be the benchmark subsidiary, then the subscript B denotes another subsidiary, and if there are more than two listed subsidiaries in the same business group, all subsidiaries except for firm A will be set as firm B. $\Delta Performance_{Ind,t}$ and $\Delta Compensation_{Ind,t}$ are the change in the industry's performance and the change in the industry's executive compensation, respectively, to control for industry effects (Albuquerque, 2009; Bizjak et al., 2008, 2011).

We also control for other variables. Following Bizjak et al. (2011), we include $Lagged\ Compensation_A$ and $Lagged\ Performance_A$ to account for any mean reversion in pay and the autocorrelation of performance, respectively. In general, previous research finds a positive correlation between the size of a company and its executive compensation (Core et al., 1999; Firth et al., 2006). When the leverage of a company is high, its executive compensation is constrained by its creditors. So we also include the size of the company (*Size*) and its leverage (*Lev*). Because executives have the motive and the ability to increase their own compensation due to their managerial power (Bebchuk et al., 2002), we also control for variables such as the corporation's block holdings (*Top* 1), independence of the board (*Independence*), dual role of the CEO and chairman of the board (*Dual*) and executives' shareholdings (*MShare*). We also control for fixed year, industry and location effects. All of the continuous variables are winsorized at 1% and 99%.

The definitions for the variables are summarized in Table 1.

4. Empirical results

4.1. Descriptive statistics

Table 2 presents the descriptive statistics of the main variables. As shown in the table, executives hold a very small proportion of the stock (0.2%) in Chinese group companies, so it is reasonable to use only cash-based compensation when measuring Chinese executive compensation. There is little difference in the executive compensation and performance between subsidiaries A and B in the same group, which shows the homogeneity of subsidiaries in the same business group. In addition, the average value of executive compensation is about RMB1.25 million, and the difference between the highest and lowest pay is quite large, at about 100 times.

Table 3 shows the sample distribution by year after dividing the whole sample into state-owned business groups (SOBG) and non-state-owned business groups (NSOBG). We see that the proportion of SOBGs is

Table 1
Variable definitions.

Variable	Definition
$Compensation_A$	Logarithm of sum of compensation of top three managers, the subscript A stands for one subsidiary A in the business group
$Performance_A$	ROA of subsidiary A, defined as net income divided by total assets
$Compensation_B$	Average value of the executive compensation of all of the listed subsidiaries except for firm A in the business group
$Performance_B$	Average value of ROA of all of the listed subsidiaries except for firm A in the business group
$Compensation_{Ind}$	Average value of executive compensation in firm A's industry (excluding firm A)
$Performance_{Ind}$	Average value of ROA in firm A's industry (excluding firm A)
$\Delta Compensation_A$	$Compensation_{A,t} - Compensation_{A,t-1}$
$\Delta Performance_A$	$Performance_{A,t} - Performance_{A,t-1}$
$\Delta Compensation_B$	$Compensation_{B,t} - Compensation_{B,t-1}$
$\Delta Performance_B$	$Performance_{B,t} - Performance_{B,t-1}$
$\Delta Performance_B$ (dummy)	A dummy variable that equals 1 if Change in $Performance_B$ is larger than Change in $Performance_A$, and 0 otherwise
$\Delta Compensation_{Ind}$	$Compensation_{Ind,t} - Compensation_{Ind,t-1}$
$\Delta Performance_{Ind}$	$Performance_{Ind,t} - Performance_{Ind,t-1}$
Lagged $Performance_A$	Subsidiary A's ROA in the previous year, that is, $Performance_{A,t-1}$
Lagged $Compensation_A$	Subsidiary A's executive compensation in the past year, that is, $Compensation_{A,t-1}$
Size	Logarithm of total assets at the end of the year
Lev	Total debt to total assets at the end of the year
Top 1	Percentage of shares held by the largest shareholder
Independent	Percentage of independent directors on the board
Dual	Dummy variable that equals 1 if the chairman and CEO are the same person, and 0 otherwise
MShare	Percentage of shares held by management
Index	The marketization index from Fan and Wang (2011)
Location	Includes two dummy variables, Center and West. If the location of the company belongs to the central area in China, Center equals 1 and 0 otherwise. If the location belongs to the west area, West equals 1 and 0 otherwise
Year	Year dummy variables
Industry	Industry dummy variables based on the CSRC classifications

Table 2
Descriptive statistics.

Variable	*N*	Mean	Std	Min	Median	Max
$Compensation_A$	4124	13.710	0.822	11.450	13.760	16.050
$Performance_A$	4124	0.028	0.066	−0.291	0.030	0.198
$Compensation_B$	4124	13.820	0.744	11.740	13.870	15.740
$Performance_B$	4124	0.028	0.054	−0.243	0.030	0.174
$Compensation_{Ind}$	4124	13.860	0.398	12.750	13.930	14.780
$Performance_{Ind}$	4124	0.142	0.959	−0.383	0.035	7.813
$\Delta Compensation_A$	4124	0.136	0.355	−1.026	0.093	1.405
$\Delta Performance_A$	4124	−0.003	0.067	−0.284	−0.001	0.273
$\Delta Compensation_B$	4124	0.141	0.332	−0.892	0.113	1.386
$\Delta Performance_B$	4124	−0.003	0.065	−0.329	−0.001	0.274
$\Delta Compensation_{Ind}$	4124	0.127	0.106	−0.182	0.124	0.551
$\Delta Performance_{Ind}$	4124	0.122	1.024	−1.223	0.001	7.996
Lagged $Performance_A$	4124	0.031	0.064	−0.272	0.032	0.195
Lagged $Compensation_A$	4124	13.570	0.845	11.230	13.610	15.990
Size	4124	21.930	1.319	19.000	21.780	27.750
Top 1	4124	0.398	0.159	0.092	0.391	0.779
Lev_A	4124	0.534	0.212	0.067	0.542	1.293
Independent	4124	0.357	0.047	0.231	0.333	0.556
MShare	4124	0.002	0.010	0.000	0.000	0.084
Dual	4124	0.095	0.294	0.000	0.000	1.000

Table 3
Distribution of business groups by year.

Year	All firms	SOBGs	Percentage (%)	Non-SOBGs	Percentage (%)	$N = 2$	Percentage (%)
2004	359	302	84.12	57	15.88	131	36.49
2005	392	330	84.18	62	15.82	160	40.82
2006	393	334	84.99	59	15.01	160	40.71
2007	403	336	83.37	67	16.63	146	36.23
2008	441	374	84.81	67	15.19	163	36.96
2009	480	407	84.79	73	15.21	183	38.13
2010	516	432	83.72	84	16.28	201	38.95
2011	566	469	82.86	97	17.14	229	40.46
2012	574	478	83.28	96	16.72	228	39.72
Total	4124	3462	83.95	662	16.05	1601	38.82

Table 4
Correlation matrix of the main variables.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) $\Delta\text{Compensation}_{A}$	1	0.154^{***}	0.055^{***}	0.180^{***}	0.042^{**}	-0.090^{***}	0.102^{***}	0.056^{***}	0.190^{***}
(2) Performance_{A}	0.103^{***}	1	0.178^{***}	0.389^{***}	0.081^{***}	-0.196^{***}	0.049^{**}	0.051^{**}	0.077^{***}
(3) Performance_{B}	0.047^{**}	0.276^{***}	1	0.090^{***}	0.411^{***}	0.215^{***}	0.148^{***}	0.071^{***}	0.107^{***}
(4) $\Delta\text{Performance}_{A}$	0.109^{***}	0.527^{***}	0.127^{***}	1	0.159^{***}	-0.516^{***}	0.050^{**}	0.147^{***}	0.126^{***}
(5) $\Delta\text{Performance}_{B}$	0.014	0.118^{***}	0.517^{***}	0.175^{***}	1	0.497^{***}	0.147^{***}	0.153^{***}	0.144^{***}
(6) $\Delta\text{Performance}_{B}$ (dummy)	-0.083^{***}	-0.214^{***}	0.208^{***}	-0.413^{***}	0.375^{***}	1	0.069^{***}	0.015	0.017
(7) $\Delta\text{Compensation}_{B}$	0.085^{***}	0.045^{**}	0.084^{***}	0.025	0.046^{**}	0.056^{***}	1	0.062^{***}	0.147^{***}
(8) $\Delta\text{Performance}_{\text{Ind}}$	−0.008	−0.030	-0.049^{**}	−0.010	−0.030	−0.021	−0.003	1	0.285^{***}
(9) $\Delta\text{Compensation}_{\text{Ind}}$	0.158^{***}	0.072^{***}	0.098^{***}	0.059^{***}	0.085^{***}	0.019	0.126^{***}	0.074^{***}	1

Note: The lower diagonal presents Pearson coefficients and the higher diagonal shows Spearman coefficients.
* Indicate significance at the 10% level.
*** Indicate significance at the 1% level.
** Indicate significance at the 5% level.

as high as 83% annually, which means that the majority of Chinese business groups are state-owned groups. Notably, about 40% of the business groups have only two listed subsidiaries.

Table 4 shows the correlation analysis of the main variables. $\Delta Compensation_A$ is positively correlated with both $Performance_A$ and $Performance_B$, the performance of all subsidiaries in the same group, which is influenced by internal capital markets. Thus, we generate a dummy variable $\Delta Performance_B$ (*dummy*) that equals one when $\Delta Performance_B$ is larger than $\Delta Performance_A$ in the same business group, and zero otherwise. $\Delta Performance_B$ (*dummy*) is negatively correlated with $\Delta Compensation_A$, suggesting that when firm *A* performs worse than firm *B*, firm *A*'s executive compensation is lower, which supports our hypothesis H1. $\Delta Compensation_B$ and $\Delta Compensation_A$ are positively correlated, which shows that executive compensation amounts among different subsidiaries in the same group change in the same direction, indicating that compensation fairness is taken into consideration when determining executive compensation in Chinese business groups.

4.2. Decision mechanism of executive compensation in business groups

We first investigate whether the executive compensation of one subsidiary is influenced by the performance of other subsidiaries in the same business group.

Table 5 presents the results.[4] In the first step, we run the regression with the subsample that only has two listed subsidiaries in the same business group (columns 1–2), which shows that the coefficient of $\Delta Performance_B$ is negative but insignificant, and the coefficient of $\Delta Performance_B$ (*dummy*) is significantly

[4] We only report the results using the Change Model. In an untabulated test, we run the regression using the Level Model and obtain the same results.

Table 5
Regression of executive compensation on RPE in business groups using ROA.

Variables	$\Delta Compensation_A$ (change model)			
	Subsample with only two subsidiaries ($N = 2$)		All firms	
	(1)	(2)	(3)	(4)
$\Delta Performance_B$	−0.032		−0.125	
	(−0.24)		(−1.41)	
$\Delta Performance_B$ (dummy)		−0.044**		−0.040***
		(−2.39)		(−3.57)
$\Delta Performance_A$	0.617***	0.491***	0.769***	0.621***
	(3.52)	(2.63)	(7.09)	(5.35)
$\Delta Performance_{Ind}$	−0.006	−0.005	−0.0003	−0.0003
	(−0.73)	(−0.68)	(−0.07)	(−0.07)
$\Delta Compensation_B$	0.049**	0.053**	0.044***	0.047***
	(2.07)	(2.23)	(2.72)	(2.89)
$\Delta Compensation_{Ind}$	0.326***	0.324***	0.234***	0.235***
	(3.65)	(3.63)	(3.95)	(3.99)
Lagged $Performance_A$	0.612***	0.618***	0.753***	0.750***
	(2.70)	(2.74)	(5.66)	(5.64)
Lagged $Compensation_A$	−0.197***	−0.197***	−0.197***	−0.197***
	(−10.88)	(−10.94)	(−16.91)	(−16.91)
Size	0.062***	0.062***	0.051***	0.051***
	(6.25)	(6.24)	(9.10)	(9.09)
Top 1	−0.033	−0.031	−0.080**	−0.078**
	(−0.59)	(−0.56)	(−2.33)	(−2.27)
Lev	−0.002	−0.001	0.004	0.005
	(−0.03)	(−0.02)	(0.12)	(0.14)
Independent	−0.174	−0.172	−0.0210	−0.019
	(−1.06)	(−1.04)	(−0.20)	(−0.17)
MShare	1.018	0.983	−0.034	−0.025
	(1.26)	(1.23)	(−0.06)	(−0.05)
Dual	0.026	0.024	0.023	0.022
	(1.01)	(0.93)	(1.27)	(1.20)
Constant	1.461***	1.485***	1.725***	1.738***
	(5.83)	(5.93)	(11.29)	(11.43)
Location	Control	Control	Control	Control
Year	Control	Control	Control	Control
Industry	Control	Control	Control	Control
Observations	1601	1601	4124	4124
Adjusted R-squared	0.160	0.163	0.154	0.156
F	6.454	6.698	14.71	15.28

Notes: The regression results follow the cluster method (by company) and we report robust t values.
Columns 1 and 2 are the results using the subsample of business groups with only two listed subsidiaries, and columns 3 and 4 are the results using the whole sample of business groups. The variables are defined in Table 1.
* Represent significance at the 10% levels (two-tailed).
** Represent significance at the 5% level (two-tailed).
*** Represent significance at the 1% level (two-tailed).

negative at the 5% level. We then run the regression using all of the observations, and the results (columns 3–4) are the same. These results show that when firm *A* performs worse than another firm *B* in the same group, the change in executive compensation of firm *A* is significantly lower. Thus the RPE mechanism exists in the executive compensation of business groups, which supports hypothesis H1.

For the control variables, the coefficient of $\Delta Performance_{Ind}$ is negative but insignificant. This result shows that executive compensation in business groups rarely depends on the performance of the industry. The result is similar to that of Li et al. (2013), who find that very few companies choose industry performance to evaluate the performance of their executives in China. The coefficient of $\Delta Compensation_B$ is significantly positive, which shows that the executive compensation of other subsidiaries in the same group is chosen as the compensation peer group. Similar to Bizjak et al. (2008, 2011), the coefficient of $\Delta Compensation_{Ind}$ is significantly positive. This result shows that, for executive compensation, business groups also use industry compensation peer groups as a benchmark.

4.3. Moderating effect of ownership type

Panel A of Table 6 presents the results when the sample is divided based on the ownership type of the business groups. In columns 1 and 2, the coefficient of $\Delta Performance_B$ is positive in the subsample of SOBGs but significantly negative in the subsample of non-SOBGs. In columns 3 and 4, the coefficient of $\Delta Performance_B$ (*dummy*) is negative in SOBGs and non-SOBGs, but the value of non-SOBGs is significantly larger than that of SOBGs. Therefore, hypothesis H2 is supported. In non-SOBGs, subsidiaries are more likely to adopt the RPE mechanism for executive compensation. Besides, the coefficient of $\Delta Compensation_B$ is significantly positive only in SOBGs, showing that pay fairness is emphasized more in the determination of executive compensation in state-owned firms. That is, SOBGs are more likely to use other subsidiaries' compensation as their benchmark in determining executive compensation.

4.4. Moderating effect of the level of marketization

Next, we test the moderating effect of the level of marketization. Following the literature (Fan et al., 2011), we use the National Economic Research Institute (NERI) Index as a proxy for China's marketization. The Index is comprised of several dimensions, namely the relationship between the government and the market, the development of the non-state sector, the development of factor markets, the development of product markets, and the development of market intermediaries and the legal environment. The NERI Index has been developed by Fan and Wang since 2001 to reflect conditions in the 30 provinces of China (excluding Tibet). The NERI Index captures the process of institutional transition in the provinces. We divide the sample based on the median value of marketization and run the basic regression accordingly. The results are reported in Panel B of Table 6.

We can see that the coefficients of $\Delta Performance_B$ and $\Delta PerformanceB$ (*dummy*) are both significantly negative only with a higher level of marketization, which means that group companies are more likely to use the RPE mechanism only when the market economy is highly developed. Moreover, the coefficient of $\Delta Compensation_B$ is significantly positive only when the degree of marketization is high, meaning that the executive compensation of one subsidiary is more likely to use other subsidiaries' compensation as their benchmark with more developed marketization. When a company is faced with intense market competition, it is very important for the company to retain its talent, which requires the company to ensure that executives feel they have been fairly paid.

4.5. Robustness tests

We perform the following robustness tests to make sure our results are robust and convincing.

4.5.1. Influence of earnings management

According to Schipper (1989), managers have the motivation to pursue their own benefits through earnings management. The problem is more severe in transition economies with insider control problems and in

Table 6
Moderating effects of ownership type and level of marketization.

Variables	$\Delta Compensation_A$ (all firms)							
	Panel A: Ownership type				Panel B: Level of marketization			
	SOBGs	Non-SOBGs	SOBGs	Non-SOBGs	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta Performance_B$	0.026	−0.395**			−0.172*	0.069		
	(0.25)	(−2.39)			(−1.69)	(0.39)		
$\Delta Performance_B$ (dummy)			−0.024**	−0.113***			−0.044***	−0.026
			(−1.99)	(−3.72)			(−3.52)	(−1.04)
$\Delta Performance_A$	0.867***	0.583**	0.785***	0.177	0.738***	0.895***	0.561***	0.815***
	(6.99)	(2.55)	(5.88)	(0.73)	(6.12)	(3.49)	(4.37)	(2.98)
$\Delta Performance_{Ind}$	0.002	−0.012	0.002	−0.014	0.001	0.008	0.001	0.007
	(0.41)	(−0.82)	(0.36)	(−0.99)	(0.09)	(0.29)	(0.11)	(0.25)
$\Delta Compensation_B$	0.039**	0.042	0.042**	0.048	0.062***	−0.005	0.064***	−0.002
	(2.08)	(1.18)	(2.23)	(1.33)	(3.37)	(−0.12)	(3.51)	(−0.05)
$\Delta Compensation_{Ind}$	0.197***	0.370***	0.198***	0.386***	0.252***	0.172	0.252***	0.180
	(2.96)	(2.68)	(2.98)	(2.88)	(3.69)	(1.38)	(3.71)	(1.46)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
P-value for difference on $\Delta Performance_B$	0.028		0.005		0.231		0.504	
Observations	3462	662	3462	662	3162	962	3162	962
Adjusted R-squared	0.157	0.143	0.158	0.155	0.154	0.156	0.156	0.156
F	12.83	3.291	13.06	3.786	11.27	4.59	11.74	4.69

Notes: The regression results follow the cluster method (by company) and we report robust t values.
Panel A presents the results divided into SOBGs and non-SOBGs, and Panel B presents the results based on the level of marketization.
* Represent significance at the 10% level (two-tailed).
** Represent significance at the 5% level (two-tailed).
*** Represent significance at the 1% level (two-tailed).

countries with poor protection of property rights (Leuz et al., 2003). In China, due to poor legal protection (Allena et al., 2005; Jiang et al., 2010), the phenomenon of earnings management is very serious and earnings quality is quite low (Wang and Wu, 2011; Fung et al., 2013). To control for the influence of earnings management, we follow Firth et al. (2006) in using return on sales (ROS) to measure accounting performance. Because operating income and sales are less susceptible to manipulation than net profit and total assets, respectively, ROS is a cleaner measure of accounting performance.

Table 7 presents the results when performance is measured by ROS. In the full sample regression, the coefficient of $\Delta Performance_B$ (*dummy*) is significantly negative, supporting hypothesis H1 that the RPE mechanism exists in business groups. The moderating effects of ownership type and the level of marketization are also the same as before.

4.5.2. Market performance

Generally, the evaluation measures of performance in executive compensation contracts use both accounting performance and market performance. In this section, we use the annual stock return adjusted by the market return (RET) to measure market performance. RET is defined as $(\prod_{t=1}^{12}(1+R_{it}) - \prod_{t=1}^{12}(1+R_{mt}))$, where R_{it} is the monthly stock return after considering cash dividend reinvestments, and R_{mt} is the monthly market stock return. The period runs from January to December every year.

Table 8 presents the results. The coefficient of $\Delta Performance_B$ and $\Delta Performance_B$ (*dummy*) are both negative but insignificant, and the results of the subgroup regressions have no significant differences (unreported). Li et al. (2013) conduct a survey of executive compensation contracts in China's listed companies and find that accounting earnings are typically used in executive compensation contracts, with few firms using stock returns

Table 7
Regression of executive compensation on RPE in business groups using ROS.

Dependent Var.	Independent Vars.					
Change in Compensation$_A$	$\Delta Performance_B$			$\Delta Performance_B$ (*dummy*)		
	Coefficient	*t*-Stat.	R^2 (%)	Coefficient	*t*-Stat.	R^2 (%)
Panel A: All Firms	0.018	0.52	14.9	−0.025**	−2.29	15.0
Panel B: Subsample divided by ownership type						
SOBGs	0.068*	1.74	15.0	−0.012	−1.06	15.0
Non-SOBGs	−0.085	−1.23	14.1	−0.084***	−2.83	15.0
P-value for difference		0.049			0.022	
Panel C: Subsample divided by the level of marketization						
High level	−0.006	−0.16	14.7	−0.032***	−2.67	14.9
Low level	0.139	1.41	15.9	0.001	0.05	15.6
P-value for difference		0.160			0.219	

Notes: The regression results follow the cluster method (by company) and we report robust *t* values.
The results present executive compensation on RPE in business groups using the ROS performance measure, and we only report the coefficients of $\Delta Performance_B$ and $\Delta Performance_B$ (*dummy*) in the table. The variables are defined in Table 1.
* Represent significance at the 10% level (two-tailed).
** Represent significance at the 5% level (two-tailed).
*** Represent significance at the 1% level (two-tailed).

Table 8
Regression of executive compensation on RPE in business groups using RET.

	$\Delta Compensation_A$			
	Subsample with $N = 2$		All firms	
	(1)	(2)	(3)	(4)
$\Delta Performance_B$	0.002		−0.015*	
	(0.18)		(−1.82)	
$\Delta Performance_B$ (dummy)		−0.012		−0.017
		(−0.61)		(−1.36)
$\Delta Performance_A$	0.005	0.002	0.033***	0.024**
	(0.29)	(0.10)	(2.98)	(2.08)
$\Delta Performance_{Ind}$	0.011	0.012	0.009	0.006
	(0.27)	(0.30)	(0.36)	(0.24)
$\Delta Compensation_B$	0.049**	0.048**	0.042**	0.043***
	(2.08)	(2.04)	(2.56)	(2.59)
$\Delta Compensation_{Ind}$	0.316***	0.314***	0.226***	0.225***
	(3.42)	(3.40)	(3.74)	(3.72)
Other variables	Control	Control	Control	Control
Observations	1542	1542	3976	3976
Adjusted R-squared	0.154	0.155	0.147	0.147
F	6.089	6.112	13.65	13.55

Notes: The regression results follow the cluster method (by company), and we report robust *t* values.
The results present the regression of executive compensation on RPE in business groups using market performance RET, and we only report the coefficients of the main independent variables in the table. The variables are defined in Table 1.
* Represent significance at the 10% level (two-tailed).
** Represent significance at the 5% level (two-tailed).
*** Represent significance at the 1% level (two-tailed).

Table 9
Regression of executive compensation on RPE in business groups using an alternative compensation measure.

	$\Delta Compensation_A$ (alternative measure of compensation)			
	Subsample with $N = 2$		All firms	
	(1)	(2)	(3)	(4)
$\Delta Performance_B$	−0.195		−0.197*	
	(−1.20)		(−1.75)	
$\Delta Performance_B$ (dummy)		−0.040		−0.037**
		(−1.57)		(−2.31)
$\Delta Performance_A$	0.366**	0.211	0.521***	0.375***
	(1.99)	(1.08)	(4.16)	(2.74)
$\Delta Performance_{Ind}$	0.001	0.001	0.001	0.001
	(0.07)	(0.08)	(0.13)	(0.14)
$\Delta Compensation_B$	0.065**	0.065**	0.041**	0.041**
	(2.45)	(2.44)	(2.30)	(2.32)
$\Delta Compensation_{Ind}$	0.291**	0.289**	0.340***	0.340***
	(2.10)	(2.08)	(3.81)	(3.82)
Other variables	Control	Control	Control	Control
Observations	1448	1448	3772	3772
Adjusted R-squared	0.154	0.155	0.161	0.161
F	6.403	6.424	16.07	16.17

Notes: The regression results follow the cluster method (by company), and we report robust t values.
The results present executive compensation on RPE in business groups using an alternative measure of executive compensation, and we only report the coefficients of the main independent variables in the table. The variables are defined in Table 1.
* Represent significance at the 10% level (two-tailed).
** Represent significance at the 5% level (two-tailed).
*** Represent significance at the 1% level (two-tailed).

to evaluate their executives. Therefore, our findings are the same as those of Li et al. (2013). The Chinese capital market has not been developing for long, so the efficiency of the market may not be as great as in the markets of developed countries, which may also explain our findings.

4.5.3. Alternative measure of executive compensation

In China, executives include both top managers and directors. We use the logarithm of the sum of the compensation of the top three directors to measure executive compensation, and get the same results as before (see Table 9).

4.5.4. Influence of intra-group transactions

The literature identifies tunneling behavior by controlling shareholders in business groups (Bae et al., 2002; Bertrand et al., 2002). Because of the poor legal system and the existing dominant shareholders in companies, China is an environment that is highly conducive to tunneling behavior (Jiang et al., 2010). Intra-group transactions will affect the performance of subsidiaries and executive compensation, so it is necessary to control for this factor. Following Jiang et al. (2010), we use the other receivables from parent companies or their affiliated companies to measure controlling shareholders' tunneling behavior, and the results (unreported) remain unchanged.

5. Conclusion

It is important to investigate how executive compensation in different subsidiaries is determined in business groups. Using unique data on business groups in China from 2003 to 2012, we shed light on the decision mechanism of executive compensation in business groups. Our results show that the RPE mechanism exists in

executive compensation in business groups. Specifically, when one subsidiary performs worse than other subsidiaries in the same business group, executive compensation is significantly lower in that subsidiary than in others. In addition, we find that the ownership type of business groups and the level of marketization play an important role in determining executive compensation in the groups. When the business groups are non-SOBGs and the level of marketization under which the group operates is high, business groups are more likely to adopt the RPE mechanism in executive compensation. Our research enriches the literature on executive compensation and addresses the gap in the literature on business groups.

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China Journal of Accounting Research 9 (2016) 41–58

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China Journal of Accounting Research

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

Earnings management, corporate governance and expense stickiness

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ARTICLE INFO

Article history:
Received 9 March 2012
Accepted 5 February 2015
Available online 11 March 2015

Keywords:
Earnings management
Corporate governance
Expense stickiness
Interaction effect

ABSTRACT

Cost and expense stickiness is an important issue in accounting and economics research, and the literature has shown that cost stickiness cannot be separated from managers' motivations. In this paper, we examine the effects that earnings management has on expense stickiness. Defining small positive profits or small earnings increases as earnings management, we observe significant expense stickiness in the non-earnings-management sub-sample, compared with the earnings-management sub-sample. When we divide expenses into R&D, advertising and other general expenses, we find that managers control expenses mainly by decreasing general expenses. We further examine corporate governance's effect on expense stickiness. Using factor analysis, we extract eight main factors and find that good corporate governance reduces expense stickiness. Finally, we investigate the interaction effects of earnings management and corporate governance on expense stickiness. The empirical results show that good corporate governance can further reduce cost stickiness, although its effect is not as strong as that of earnings management.

1. Introduction

The term expense "stickiness" captures an asymmetric expense behavior response to the direction of a change in activities; that is, expenses increase more quickly with an increasing activity level than they decease with a declining activity level (e.g., Noreen and Soderstrom, (1997), Cooper and Kaplan (1998), and Anderson et al. (2003)). Because it is an important issue in both accounting and economic researches, expense stickiness, to some degree, reflects the operating efficiency of corporate assets (Gong et al. (2010)).

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http://dx.doi.org/10.1016/j.cjar.2015.02.001
1755-3091/

Compared with the classic linear cost behavior model described by traditional management accounting, expense stickiness fits better with the management decision of resource adjustment in practice. The existence of expense stickiness is strongly connected to management's active behavior (e.g., Anderson et al. (2003) and Banker et al. (2011)). Thus, to truly understand stickiness, it is essential to investigate the reasons why management deliberately adjusts resources.

Most previous studies have investigated expense stickiness based on either adjustment costs or management expectations. Some have suggested that the adjustment cost of reducing input under declining activities is higher than that of raising input under increasing activities (e.g., Jaramillo et al. (1993), Pfann and Palm (1993, 1997), Goux et al. (2001), and Cooper and Haltiwanger (2006)). This, in turn, makes it less likely to reduce the input level (i.e., stickiness) because it is more expensive to do so. Other scholars have suggested that managers tend to be optimistic about future revenue because most firms' future revenues increase, making them reluctant to reduce expenses.

When considering the wide-spread nature of agency problems in modern enterprises (Jensen and Mecking, 1976), it is unlikely that management would behave as expected in an ideal world (i.e., adjustment cost and expectation considerations). There are conflicts between self-interested managers and other stakeholders, of which earnings management behavior under compensation contracts is the most obvious. Healy (1985) found that managers adjust earnings in order to receive higher compensation. While under pressure to avoid breaching debt covenants, managers are also likely to choose between accounting policies (Sweeney (1994)). Moreover, previous studies have indicated an increase in earnings management due to the incentives of meeting or beating last year's earnings, avoiding reporting losses, and meeting or beating consensus analysts' forecasts (e.g., Burgstahler and Dichev (1997) and Degeorge (1999)).

In the earnings management literature, few studies have explored earnings management's effect on expense stickiness. Chen (2008) investigated the relationship between managerial empire building and expense stickiness. Dierynck and Renders (2009) observed the stickiness of labor costs in firms that reported small positive ROAs and slightly increased earnings. Kama and Weiss (2010) provided evidence that firms reduced the stickiness of operating costs to avoid losses or earnings decreases. Compared with the cost of sales, expense is a different type of cost. In this paper, we shed light on the relationship between expense stickiness and earnings management incentives.

We begin by investigating earnings management's effect on expense stickiness. We define the incentive to avoid losses or earnings decreases as upward earnings management, and divide the sample into two parts. Significant expense stickiness is observed in the non-earnings-management sample, compared with the earnings-management sample, indicating that managers, under pressure to report sound earnings, prefer to reduce expenses when sales decline.

Whether expense reduction indicates increased operating efficiency or short-sighted and dysfunctional managerial behavior remains an interesting question. To answer this question, we further divide expenses into R&D, advertising, and other general expenses.[1] The results show that the stickiness reduction difference between the earnings-management and non-earnings-management sub-samples is much more significant in other general expenses than in R&D or advertising expenses. Facing the pressure of upward earnings management makes managers more likely to reduce expenses in a discriminate way for their firms' long-term development.

Next, we analyze what influence corporate governance has over expense stickiness. Taken as an essential part of the management operation environment, corporate governance studies have generated conflicting evidence. Some attribute the chaos to the difficulty of setting up a reliable and effective evaluation system on corporate governance. Drawing from the work of Larcker et al. (2007), we choose the method of factor analysis to produce a comprehensive and objective description of corporate governance. After extracting eight main factors from the summarized corporate governance indices, we find that good corporate governance has a negative effect on expense stickiness.

Then, we check the interaction effect of earnings management and corporate governance. Our results show that the interaction works to further reduce expense stickiness, indicating that self-interest upward earnings

[1] We appreciate the helpful comments of the referee.

management incentives influence the ways in which firms control expenses with the help of good corporate governance. The results imply that compared with corporate governance, earnings management incentives have a more significant effect on reducing stickiness. We attribute this to the fact that earnings management, as taken by managers, has a direct influence on current expenditure decisions, whereas corporate governance works indirectly.

Finally, we subdivide the expenses and find that the above interaction effect is more significant for reducing the stickiness of other general expenses than R&D or advertising expenses. Moreover, the results show that the earnings management mechanism only works in the poor corporate governance sub-sample for R&D expenses, whereas it works in both the good and poor corporate governance sub-samples for other general expenses. This result proves that good corporate governance benefits firms by constructing a disciplined environment and restricting management opportunism.

This paper's contributions are as follows. First, our study is among the first to investigate the relation between earnings management and expense stickiness, and thus it extends the domestic and international literature on those issues. Second, we subdivide the expenses and find that the reductions in other general expense stickiness have efficient characteristics, which provides insights into management behavioral under pressure. Third, compared with previous studies that have used an individual proxy to investigate the effect of corporate governance, we conduct factor analysis and extract the main factors to see the comprehensive influence of corporate governance on expense stickiness. Fourth, instead of using a dichotomy to consider the nature of earnings management, we find that opportunistic earnings management has an active role in controlling costs. Thus, we provide new evidence of the bright side of earnings management from the stickiness aspect to enrich the existing research. Fifth, this paper checks the individual and interaction effects of corporate governance and earnings management on expenses stickiness to provide a true understanding of the stickiness phenomenon. Finally, our evidence helps investors better understand changes in firm expenses, so that they can more accurately forecast firms' future earnings or cash flows.

The remainder of the paper proceeds as follows. We discuss the literature and pose our hypotheses in Section 2 and present our research design in Section 3. We introduce our sample and data in Section 4. We report our empirical findings in Section 5 and additional robustness tests in Section 6. Section 7 concludes the paper.

2. Related literature and hypotheses development

There are two main views about the existence of expense stickiness: rational decision-making and motivational. The rational decision-making view treats expense stickiness as a consequence of management rationally choosing between alternatives after comprehensively weighting costs and benefits. Some studies have been guided by this view in providing detailed explanations of the following specific aspects. It has been suggested that the adjustment cost of reducing input under declining activities is higher than that of raising input under increasing activities (e.g., Jaramillo et al. (1993), Pfann and Palm (1993, 1997), Goux et al. (2001), Cooper and Haltiwanger (2006), Balakrishnan et al. (2004), Banker and Chen (2006), and Balakrishnan and Gruca (2008)). Due to the above consideration, even facing declining demand, managers are less likely to reduce input resources and related expenses, which, in turn, leads to expense stickiness. Banker et al. (2011) analyzed relevant data and concluded that management commonly expect a sales increase in the following year. Thus, even under declining activities, it is rare for management to reduce input.

The second view is motivation-based and relates expense stickiness to managerial incentives, suggesting that managers are not expected to behave as if they were in an ideal world. Among their dysfunctional behavior, perks and earnings management reflecting different contracting stimulations are often observed. Chen et al. (2008) investigated the relationship between empire building and perks, which revealed that higher expense stickiness accompanied stronger managerial incentives for empire building. There is a large body of literature studying different earnings management incentives, such as compensation (Healy, 1985), debt covenants (Sweeney, 1994), meeting or beating last year's earnings, avoiding reporting losses, and meeting or beating consensus analysts' forecasts (e.g., Burgstahler and Dichev (1997) and Degeorge et al. (1999)). However, studies on earnings management's effect on expense stickiness have been rare. Dierynck and Renders (2009) found a small stickiness of labor costs in firms with small positive profit or small earnings

increase, whereas Kama and Weiss (2010) revealed that companies with earnings management exhibited less stickiness of operating costs.

Compared with the studies on cost stickiness, there is no literature investigating whether a similar principle fits the explanation of expense stickiness. Although production costs (both variable and fixed) are unavoidable inputs for production, the occurrence of major parts of expenses, such as those for advertising and R&D, is likely to be decided by managers. Thus, we expect earnings management incentives to affect expense stickiness. When holding the upward earnings management incentive, managers are more likely to reduce expenses in response to a declining demand, which in turn decreases expense stickiness.

Therefore we develop the following hypothesis:

H1. Upward earnings management significantly decreases expense stickiness.

Because managers increase earnings in different ways, it is necessary to investigate whether their methods are efficient. When referring to efficiency, we mean that managers either reduce expenses by flattening the hierarchy and improving administrative efficiency, or by tightly controlling expenses through perk reduction and waste avoidance. However, choosing to cut R&D or advertising expenses for upward earnings management is seen as an inefficient way to pursue short-term goals at the expense of long-term development (Eberhart et al. (2004)).

To further test efficiency, we divide expenses into R&D, advertising, and other general expenses. We define other general expenses as those outside of R&D or advertising. Managers choosing to reduce R&D or advertising expenses to increase earnings is regarded as inefficient because it sacrifices the enterprise's long-term development. Managers choosing to reduce other general expenses is regarded as an efficient way of controlling expenses.

Thus, to further investigate whether managers choose an efficient way to manage earnings, we develop the following competing hypotheses:

H2a. Under the pressure of realizing upward earnings, managers typically reduce R&D or advertising expenses.

H2b. Under the pressure of realizing upward earnings, managers typically reduce other general expenses.

Corporate governance refers to the set of mechanisms that monitor or motivate managers when there is a separation of ownership and control. Some of these mechanisms are the board of directors, institutional shareholders, and market operations for corporate control (Larcker et al., 2007). These mechanisms are designed to solve the widespread agency problem. Based on institutional economics theory, motivating and monitoring are the main ways to solve the agency problem (Yuan, 2005). When motivating, good corporate governance can, to some degree, support goal congruence between managers and enterprises so that the former will try to maximize firm value. Moreover, when managers make decisions that are in the best interests of the business, their goals are achieved more efficiently thanks to good corporate governance. In contrast, the monitoring role is more important because good corporate governance reduces management opportunism while protecting principals' interests.

Sometimes, the self-interested behavior of managers leads to expense stickiness (Chen et al., 2008). In its monitoring role (Wan and Wang, 2011), good corporate governance should, to some degree, reduce expense stickiness. When managers try to improve cost control, good corporate governance is expected to facilitate the process and reduce expense stickiness.

Calleja et al. (2006) showed that costs are stickier for French and German firms than for US and UK firms, and they attributed this to the differences in corporate governance, as French and German firms are subject to code-law governance systems in addition to being historically less subject to the pressure of a market for corporate control. Firms in the US and the UK are arguably subject to more rigorous external scrutiny and their corporate objective of shareholder maximization tends to produce lower levels of cost stickiness. Chen (2008) suggested that firms with larger boards of directors or more independent boards (the separation of Chairman and CEO, more external independent directors), and those with directors who hold larger shareholdings have a lower level of expense stickiness. Furthermore, the above mentioned corporate governance mechanisms work better in reducing expense stickiness when managers hold an empire building incentive. Similar

conclusions, based on the study of China's manufacturing industry, were reached by Wan and Wang (2011). The only difference in result was that the larger board size impeded the control of free cash flow, which increased expense stickiness.

Although Calleja et al. (2006) explained the cross-country differences in costs, they did not provide direct evidence. Although Chen et al. (2008) raised direct evidence of the relationship between corporate governance and expense stickiness, their measures of corporate governance were incomplete. A comprehensive system of corporate governance is expected to comprise both internal (e.g., board independence, board working schedule, structure of shareholding, etc.) and external (e.g., institutional shareholders and creditor monitoring, regulation, auditing, etc.) mechanisms. Given a comprehensive picture of corporate governance, we develop the following hypothesis:

H3. Good corporate governance significantly decreases expense stickiness.

According to the first and third hypotheses, both upward earnings management and good corporate governance may help to reduce expense stickiness. Thus, it seems reasonable to consider their separate and interactive effects. Warfield et al. (1995) and Klein (2002) suggest that good corporate governance can restrict earnings management. The literature usually takes earnings management as evidence of management opportunism. Here, we consider not only the disadvantages of earnings management, but also its benefits. In addition to being evidence of management opportunism, upward earnings management can simultaneously improve firms' cost control. For example, Roychowdhury (2006) and Cohen et al. (2008) found that firms decreased their current year costs for upward earnings management. Thus, from a cost control perspective, upward earnings management is value-adding for the enterprise.

As mentioned, good corporate governance can play both motivating and monitoring roles. On the one hand, good corporate governance can restrict managers' self-interest behavior, which may decrease shareholder wealth. On the other hand, when managers are motivated to maximize firm value, good corporate governance can contribute to the success of management decisions. Here, under upward earnings management, while managers are trying to control costs and expenses, good corporate governance is likely to be beneficial. Thus, expense stickiness is expected to decline. Thus, we develop the following hypothesis:

H4. The interaction effect of good corporate governance and the motivation supplied by upward earnings management can further reduce expense stickiness.

When raising the second hypothesis, we know that managers can reduce expense stickiness either efficiently or at the expense of their firms' long-term benefits. The former (achieved by reducing other general expenses) reflects management's effort to maximize shareholder wealth, whereas the latter (achieved by reducing R&D or advertising expenses) indicates managers' self-interest behavior. If good corporate governance does restrict managers' self-interest behavior, managers are expected to prefer efficient methods to reduce expense stickiness. If corporate governance does not help control expenses, managers are expected to prefer inefficient methods. Based on whether good corporate governance restricts managers' self-interest behavior, we develop the following competing hypotheses:

H5a. The interaction effect between good corporate governance and upward earnings management motivation can significantly reduce the stickiness of other general expenses, relative to R&D or advertising.

H5b. The interaction effect between good corporate governance and upward earnings management motivation can significantly reduce the stickiness of R&D or advertising expenses, relative to other general expenses.

3. Research design

3.1. Measurement of expense stickiness

Consistent with the literature (Anderson et al., 2003; Subramaniam and Weidenmier, 2003), we use the following logarithmic model to measure expense stickiness:

$$\log\left[\frac{SGA_{i,t}}{SGA_{i,t-1}}\right] = \beta_0 + \beta_1 \log\left[\frac{REV_{i,t}}{REV_{i,t-1}}\right] + \left\{\gamma_0 + \sum_{j=1}^{n}\gamma_j CON_{i,t,j}\right\} * DUM * \log\left[\frac{REV_{i,t}}{REV_{i,t-1}}\right] + \varepsilon_{i,t} \quad (1)$$

here

SGA = natural log of total administration and operation expenses;

REV = natural log of revenue;

DUM = a dummy variable with a value of 1 if the current year *REV* decreases ($REV_{i,t}/REV_{i,t-1} < 1$), and 0 otherwise;

CON = control variables. Here, we mainly use *CAPR* and *TOBQ* as control variables because most of the variables used by existing studies have already been considered in relation to corporate governance. The details of *CAPR* and *TOBQ* are as follows:

CAPR = capital intensity, measured as the net value of fixed assets scaled by operating revenue;

TOBQ = growth rate, measured as Tobin's Q (*i* indicates firm and *t* indicates year).

Hence, we restate model (1) as follows:

$$\log\left[\frac{SGA_{i,t}}{SGA_{i,t-1}}\right] = \beta_0 + \beta_1 \log\left[\frac{REV_{i,t}}{REV_{i,t-1}}\right] + \beta_2 DUM * \log\left[\frac{REV_{i,t}}{REV_{i,t-1}}\right] + \beta_3 DUM * CAPR_{i,t} * \log\left[\frac{REV_{i,t}}{REV_{i,t-1}}\right] + \beta_4 DUM * TOBQ_{i,t} * \log\left[\frac{REV_{i,t}}{REV_{i,t-1}}\right] + \varepsilon_{i,t} \quad (2)$$

According to the definition of expense stickiness, a significant negative sign of β_2 in model (2) indicates the existence of expense stickiness.

3.2. Earnings management and expense stickiness

The literature consistently indicates that earnings management allows avoiding reporting losses or earnings decreases, meeting or beating consensus analysts' forecasts, reducing taxation, and decreasing the probability of debt covenant default. Burgstahler and Dichev (1997) and Degeorge et al. (1999) found that earnings management helps in the avoidance of reporting small losses and earnings decreases. Roychowdhury (2006) and Cohen et al. (2008) further suggested that management reduces costs to avoid reporting losses or earnings decreases. Based on the method used by Roychowdhury (2006) and Cohen et al. (2008), we include two categories of data in the upward earnings management subsample. The data in the first category report a small positive profit, which indicates incentives for avoiding reporting losses. The data in the second category report a small increase in ROA, which indicates incentives for avoiding reporting earnings decreases.

In this study, we define those firm-year observations whose ROA is 0–1.5% as the small positive profit sub-sample, and those whose earnings change scaled by total assets is 0–1% as the small earnings increase sub-sample. Together, they make up the sub-sample of upward earnings management. We use *EAMG* as an indicator whose value equals 1 if the observation belongs to the earnings-management sub-sample and 0 otherwise.

To test H1, we regress model (2) with the earnings-management and non-earnings-management sub-samples, separately. As H1 indicates, we expect a lower level of expense stickiness in the earnings-management sub-sample. Thus, we expect β_2 in the earnings-management sub-sample to be significantly higher than in the non-earnings-management sub-sample. The sign of β_2 in the non-earnings-management sub-sample should be significantly negative due to the existence of expense stickiness.

3.3. Efficiency of reducing expense stickiness

To investigate whether the reduction of expense stickiness reflects efficient behavior, we further divide expenses (SGA) into R&D, advertising (ADV), and other general expenses (GSGA). H2a indicates that managers reduce expense stickiness at the expense of firms' long-term benefits, whereas H2b indicates that managers use an efficient way to reduce expenses.

To test H2a and H2b, we replace SGA with either R&D, ADV, or GSGA in model used to test H1. If H2a holds, because managers choose to mainly reduce R&D or advertising expense to increase earnings, β_2 in the earnings-management sub-sample should be significantly higher than in the non-earnings-management sub-sample, and the sign of β_2 in the non-earnings-management sub-sample should be significantly negative when using R&D and ADV instead of SGA. The inter-sample difference of β_2 is not expected to be significant when using GSGA instead of SGA. However, if H2b holds, the above expected results should be opposite.

3.4. Corporate governance and expense stickiness

Most of the previous studies have measured corporate governance with single or aggregative indices, which are obviously arbitrary. Furthermore, the empirical results of those studies are conflicting. Larcker et al. (2007) suspected that part of the explanation for these mixed results is that the measures used in the empirical analyses exhibit a modest level of reliability and construct validity. For example, when using a single indicator (e.g., percentage of independent directors) to represent a complex construct (e.g., board independence), measurement error is likely to result in inconsistent regression coefficients. Similar problems arise if a set of indicators are naively summed to form some type of governance index (e.g., the "G-score" used by Gompers et al. (2003)). The use of multiple indicators can alleviate the measurement error associated with a single indicator. However, unless the individual indicators are measuring the same underlying governance construct, the resulting index is difficult to interpret and likely to contain substantial measurement error. Larcker et al. (2007) suggested that factor analysis be applied to extract main factors from the multiple indicators of corporate governance. The benefits of using factor analysis are worth noting. First, it avoids the measurement error introduced by a single index. Second, it reduces the arbitrary nature of using an aggregative index formed by a set of naive indicators. Third, it eliminates the influence of collinearity and improves the accuracy of parameter estimation and hypothesis testing. Finally, compared with using principal component analysis (PCA), factor analysis can raise a much more clear result thanks to the process of factor rotation, which can effectively identify the interaction effect of the same index on different principal components.

Given the advantages of using factor analysis, we develop our method based on the work of Larcker et al. (2007). We use PCA to identify the main dimensions of corporate governance and the relations between its factors. Eight factors with characteristic values greater than 1 are retained. We run orthogonal and oblique rotation in sequence and get the corresponding factor scores. We use the orthogonal rotation process to get consistent final results and the oblique rotation process to increase the explanation power.

We develop the following model:

$$\begin{aligned}\log\left[\frac{SGA_{i,t}}{SGA_{i,t-1}}\right] &= \beta_0 + \beta_1 \log\left[\frac{REV_{i,t}}{REV_{i,t-1}}\right] + \beta_2 DUM * \log\left[\frac{REV_{i,t}}{REV_{i,t-1}}\right] + \sum_{i=3}^{10}\beta_i DUM * FACT_{i,t} \\ &* \log\left[\frac{REV_{i,t}}{REV_{i,t-1}}\right] + \beta_{11} DUM * CAPR_{it} * \log\left[\frac{REV_{i,t}}{REV_{i,t-1}}\right] + \beta_{12} DUM * TOBQ_{it} \\ &* \log\left[\frac{REV_{i,t}}{REV_{i,t-1}}\right] + \varepsilon_{i,t} \end{aligned} \tag{3}$$

$FACT_i (i = 3, \ldots, 10)$ represents the eight factors of corporate governance and the other variables are defined as in model (2). We first test the individual effect of each factor by sequentially integrating them into model (3). The sign of β_2 is expected to be significantly negative due to expense stickiness. If H3 holds, the sign of β_i $(i = 3, \cdots, 10)$ is expected to be significantly positive because good corporate governance can decrease expense stickiness. Likewise, we expect to find a similar result when integrating all of the factors into model (3).

3.5. Management incentives and corporate governance

To test H4, we run model (2) on four sub-samples. We first raise the following equation to get each firm-year's corporate governance score:

$$CGSC = \sum_{i=1}^{i=8} FACT_i * EIGN_i \quad (4)$$

where

$CGSC$ = the corporate governance score;
$FACT_i$ = the score of each corporate governance factor; and
$EIGN_i$ = each factor's characteristic value produced by conversion with the symbol of economic significance.

A higher amount of *CGSC* indicates better corporate governance of the observation. However, we rank the *CGSC* from lowest to highest. *CGID* equals 1 when *CGSC* is greater than the median (which represents good corporate governance) and 0 otherwise. We further divide the sample into two sub-samples ($CGID = 1$ and 0), giving four sub-samples when using both *EAMG* and *CGID* as classification standards. Represented by the form of (*EAMG*/*CGID*), these four sub-samples are (0/0), (0/1), (1/0), and (1/1).

If H4 holds, because the interaction effect between good corporate governance and upward earnings management motivation can further reduce expense stickiness, we expect β_2 in the (1/1) sub-sample to be significantly higher than in the other three sub-samples.

We replace SGA with R&D, ADV, and GSGA and use the same model (2) to test H5. If H5a holds, when using R&D or ADV instead of GSGA, upward earnings management is expected to significantly reduce expense stickiness only in the $CGID = 0$ subsample. However, if H5b holds, the stickiness of R&D or ADV is expected to decrease with upward earnings management in both the $CGID = 0$ and $CGID = 1$ subsamples.

4. Sample and data

4.1. Data source and sample selection

We begin with all Chinese non-financial firms listed in the A-share market between 2003 and 2010. This period is selected mainly due to the availability of some corporate governance indices. We then remove observations that have M&A or change the main industry, that have missing or negative values of the current or prior year's revenue and expenses, whose current year's expenses are larger than revenue, and those with missing corporate governance indices or control variables. This leaves us with a final sample size of 7702 firm-year observations. Table 1 indicates this sample selection process. The financial data and corporate governance indicators are obtained from the CSMAR and RESSET databases. Data on the ultimate controlling shareholder is collected from the CCER database and we double-check it using the WIND database. We manually collect R&D and ADV from the annual reports of listed firms. These data are usually reported in the note "Other cash paid related to operating activities." R&D includes items such as research, development, and consulting costs. ADV consists of expenses related to advertising and marketing activities.

Panel A of Table 2 lists the distribution of the sample observations by year, which shows no great change in observation numbers in different years. Panel B provides a distribution picture of the different earnings management incentives sub-samples. Specifically, 1462 firm-years, or 18.92% of total observations indicate an incentive to avoid reporting small losses, while a similar amount of 1582 (20.54%) observations indicate an incentive to avoid reporting small earnings decreases. Because there are firm years with both of the above mentioned incentives, the total amount of observations with upward earnings management incentives are 2670—more than a third of the whole sample.

4.2. Descriptive statistics

Table 3 reports the summary statistics of the main variables used in testing the hypotheses. We do not include the description of corporate governance variables in Table 3 because they are shown in the subsequent factor analysis process.

Table 1
Sample selection process.

Sample selection procedure	Number	Remaining observations
Observations of Chinese non-financial firms listed in the A-share market between 2003 and 2010	13,114	13,114
Minus:		
Observations that have M&A or change the main industry	(1378)	11,736
Observations with missing or negative values for the current or last year's revenue and expenses	(96)	11,640
Observations whose current year's expense is larger than revenue	(386)	11,254
Observations with missing corporate governance indices or control variables	(3552)	7702
Final firm-year observations	7702	

Table 2
Sample distribution.

Panel A sample distribution by year

Year	2003	2004	2005	2006	2007	2008	2009	2010	合计
Number	988	1,037	760	768	930	1,140	1,165	914	7,702
Percent	12.83%	13.46%	9.87%	9.97%	12.07%	14.80%	15.13%	11.87%	100%

Sample types	Number	Percent (%)
Panel B sample distribution by earnings management		
Observations with the purpose of avoiding reporting small losses	1462	18.98
Observations with the purpose of avoiding reporting earnings decreases	1582	20.54
Earnings-management observations	2670	34.67
Non-earnings-management observations	5032	65.33
Total observations	7702	100.00

Table 3
Descriptive statistics.

	Mean	Median	Min.	Max.	Std. dev
REV	5735.95	1160.35	7.57	1,913,182.00	46,603.48
SGA	491.59	128.36	2.30	121,072.00	3241.65
SGA/REV (%)	8.57	11.06	6.33	30.31	6.96
$\log[REV_t/REV_{t-1}]$	0.159	0.151	−5.270	3.804	0.375
$\log[SGA_t/SGA_{t-1}]$	0.148	0.138	−2.820	2.682	0.368
DUM^* $\log[REV_t/REV_{t-1}]$	−0.057	0.000	−5.270	0.000	0.192
CAPR	0.694	0.437	0.000	20.342	0.941
TOBQ	1.735	1.324	0.000	23.239	1.257
R&D/REV (%)	0.75	0.02	0.00	6.76	1.39
ADV/REV (%)	0.64	0.02	0.00	5.45	1.47
GSGA/REV (%)	7.17	10.51	5.95	30.27	6.85

Table 3 shows that the mean (median) values of *REV* and *SGA* are 5736 (1160) and 492 (128). Both variables are right-skewed and it is reasonable to take the natural log of the initial amount in the subsequent regression. The standard deviations of *REV* and *SGA* are 46,603 and 3242, respectively, significantly larger than their means, which indicates that there is large variation in these variables. We report a mean (median) *SGA/REV* of 8.57% (11.06%), which is smaller than the value of 26.41% (17.79%) reported in the work of Anderson et al. (2003). Here, we suggest that this may be due to the difference between Chinese Accounting Standards and U.S. GAAP.

On average, firm revenues and expenses increase during the sample period due to the positive values of log $[REV_t/REV_{t-1}]$ and $\log[SGA_t/SGA_{t-1}]$. The mean (median) of $\log[REV_t/REV_{t-1}]$ and $\log[SGA_t/SGA_{t-1}]$ are 0.159 (0.151) and 0.148 (0.138), respectively. However, $\log[REV_t/REV_{t-1}]$ has a minimum of −5.27 (indicating

that some firms have a significant decrease in revenue), a maximum of 3.804 (indicating that some firms have large growth in revenue), and a standard deviation of 0.375 (indicating that the annual changes in firm revenues are quite different). The same characteristics are found in $\log[SGA_t/SGA_{t-1}]$ (with a minimum of −2.82, a maximum of 2.682, and a standard deviation of 0.368). The mean (median) of $DUM^* \log[REV_t/REV_{t-1}]$ is −0.057 (0) and it is therefore left-skewed. It has a minimum of −5.27, a maximum of 0, and a standard deviation of 0.196, indicating that the annual variances in revenues for decreasing firms are also quite large.

The mean (median) values of *CAPR* and *TOBQ* are 0.694 (0.437) and 1.735 (1.324), and their standard deviations are 0.941 and 1.257, respectively, which indicates significant cross-sample variance.

After further dividing *SGA* into R&D, ADV, and GSGA, we find that the mean (median) values of (R&D/REV) and (ADV/REV) are 0.75% (0.02%) and 0.64% (0.02%), respectively. Given that (GSGA/REV) has a mean (median) value of 7.17% (10.51%), on average, other general expenses comprise the majority of total expenses.

5. Main empirical results

5.1. The existence of expense stickiness

The results of the OLS regression based on model (2) are shown in Table 4. Compared with the results in Column (1), Column (2) adds control variables. Based on results in Column (1), β_1 is 0.518 and significantly positive at the 1% level. The value of β_1 is consistent with our expectation that expenses increase with growing revenue but at a lower speed. β_2 is −0.275 and significantly negative at the 1% level, which indicates the existence of expense stickiness, as expected. When putting additional control variables into the estimation, we find similar results. Here, β_2 is −0.363, which is lower than that in Column (1) and suggests a larger level of expense stickiness. β_3 is positive but not statistically significant and β_4 is significantly positive, indicating a lower level of expense stickiness in fast-growing firms. In summary, the results reported in Table 4 indicate expense stickiness in Chinese firms listed in A-share markets, which is consistent with previous research findings (e.g., Kong et al. (2007) and Gong et al. (2010)).

5.2. Earnings management and expense stickiness (H1)

The regression results of upward earnings management on expense stickiness are reported in Table 5. Compared with the results in Columns (1) and (2), Columns (3) and (4) add *CAPR* and *TOBQ*.

Table 4
Regression results based on model (2) for the whole sample.

	Expected sign	Coefficients (*t*-statistics)	
		(1)	(2)
β_0		0.050	0.048
		(9.77)***	(9.48)***
β_1	+	0.518	0.521
		(37.77)***	(37.88)***
β_2	–	**−0.275**	**−0.363**
		(−10.24)***	**(−10.15)*****
β_3	?		0.008
			(1.18)
β_4	?		0.033
			(3.83)***
Adj-*R*2		0.196	0.197
F		853.11	474.29
N		7702	7702

The superscripts ** and * indicate two-tailed statistical significance at the 5%, and 10% levels, respectively.
*** indicates two-tailed statistical significance at the 1% level.
The bold variable(s) is the tested variable(s) we focus on.

As Table 5 shows, β_2 in Column (1) is positive and not statistically significant, indicating that upward earnings management decreases expense stickiness. The value of β_2 is lower in Column (2) than that reported in Table 4 (results of the whole sample), which suggests that expense stickiness is mainly explained by the observations in the non-earnings-management sub-sample. Similar results are found after estimating with additional control variables and the value of β_2 in Column (4), −0.447, is lower than that in Column (2), −0.337, revealing a higher level of expense stickiness after controlling for other variables.

To summarize, the results in Table 5 provide evidence that expense stickiness is mainly found in the non-earnings-management sub-sample. Moreover, the value of β_2 in the earnings-management sub-sample is larger than that in the non-earnings-management sub-sample and the difference (not tabulated) is statistically significant at the 1% level (χ^2 test = 22.37). Thus, consistent with H1, the evidence suggests that upward earnings management significantly decreases expense stickiness.

5.3. Efficiency of expense stickiness reduction (H2)

What expense types do managers tend to reduce under earnings pressure? The results are reported in Table 6. The results of R&D are shown in Columns (1) and (2) of Table 6. The values of β_2 in both columns are negative and statistically significant, indicating the existence of expense stickiness in both samples. In the earnings-management sub-sample, R&D decreases 0.155% (0.330–0.175%) with every 1% of revenue, and 0.078% (0.38–0.302%) in the non-earnings-management sub-sample. The results suggest that R&D in both sub-samples is sticky. Although the amount of R&D reduction is greater in the earnings-management sub-sample than in the non-earnings-management sub-sample, the difference between these two sub-samples is not statistically significant (χ^2 test = 1.57). The results in Columns (3) and (4) provide evidence that there is little stickiness of ADV in either sub-sample. The results of GSGA are represented in Columns (5) and (6). The value of β_2 in Column (6) is −0.505 and statistically significant at the 1% level and that in Column (5) is 0.11 and not statistically significant, indicating that upward earnings management significantly reduces the stickiness of GSGA.

The results in Table 6 imply that when facing the pressure of upward earnings management, managers may reduce R&D (which may be seen as a way to pursue a short-term target at the expense of long-term benefits), but it is more likely that managers choose to decrease other general expenses that lead to a lower level of expense stickiness. Thus, the evidence suggests that the ways in which managers reduce expense stickiness are efficient when they hold an upward earnings management incentive.

Table 5
Regression results of earnings management incentive on expense stickiness.

	Coefficient (*t*-statistics)			
	(1)	(2)	(3)	(4)
	$EAMG = 1$	$EAMG = 0$	$EAMG = 1$	$EAMG = 0$
β_0	0.034	0.068	0.034	0.067
	(4.15)***	(10.35)***	(4.15)***	(10.2)***
β_1	0.431	0.522	0.430	0.523
	(14.97)***	(32.66)***	(14.89)***	(32.75)***
β_2	**0.014**	**−0.337**	**0.080**	**−0.447**
	(0.26)	**(−10.52)*****	**(1.16)**	**(−10.16)*****
β_3			−0.001	−0.009
			(−0.13)	(−0.76)
β_4			−0.038	0.053
			(−1.78)	(5.45)***
Adj-*R*2	0.163	0.205	0.163	0.209
F	260.09	647.79	130.90	333.18
N	2670	5032	2670	5032

The superscripts ** and * indicate two-tailed statistical significance at the 5% and 10% levels, respectively.
*** indicates two-tailed statistical significance at the 1% level.
The bold variable(s) is the tested variable(s) we focus on.

Table 6
Efficiency of reducing expense stickiness.

	Independent variable *R&D*		Independent variable *ADV*		Independent variable *GSGA*	
	(1)	(2)	(3)	(4)	(5)	(6)
	$EAMG=1$	$EAMG=0$	$EAMG=1$	$EAMG=0$	$EAMG=1$	$EAMG=0$
β_0	0.021	0.042	0.041	0.055	0.027	0.071
	(2.05)**	(2.96)***	(3.55)***	(3.17)***	(4.66)***	(12.68)***
β_1	0.330	0.380	0.460	0.575	0.464	0.551
	(9.85)***	(25.33)***	(17.74)***	(39.87)***	(18.21)***	(36.62)***
β_2	**−0.175**	**−0.302**	**0.04**	**−0.07**	**0.11**	**−0.505**
	(−2.27)**	**(−5.79)*****	**(0.65)**	**(−1.18)**	**(1.39)**	**(−12.01)*****
β_3	0.221	0.259	−0.005	−0.024	−0.007	−0.014
	(5.42)***	(5.86)***	(−0.13)	(−0.76)	(−0.13)	(−0.76)
β_4	0.032	0.041	0.004	0.002	−0.050	0.059
	(−1.51)	(4.05)***	(0.02)	(0.01)	(−2.36)**	(6.78)***
Adj-*R*2	0.336	0.361	0.352	0.389	0.150	0.184
F	180.8	496.2	169.4	446.5	118.5	285.4
N	2670	5032	2670	5032	2670	5032
χ^2 test		1.57		1.86		11.82***

The superscript and * indicates two-tailed statistical significance at 10% level.
** indicates two-tailed statistical significance at 5% level.
*** indicates two-tailed statistical significance at 1% level.
The bold variable(s) is the tested variable(s) we focus on.

5.4. Corporate governance and expense stickiness (H3)

The detailed descriptions of the corporate governance variables are listed in the Appendix. Because the results in the literature (e.g., Larcker et al. (2007), Jin and Yuan (2007), Gao et al. (2006), and Bai et al. (2005)) can be conveniently reached and Armstrong et al. (2010) provided a comprehensive overview of the studies on this issue, to be parsimonious we only present the variables without detailing the reasoning behind their selection.

Table 7 reports the results of our corporate governance factor analysis. We extract eight factors with characteristic values greater than one, and which explain about 60% of the raw data variance, similar to the results of Larcker et al. (2007), who obtained 61.7% explanatory power. The first factor (*FACT1*) represents ownership concentration, including "shareholding of largest shareholders," "shareholding of second to tenth shareholders," and "Z index." The score of *FACT1* increases with growing ownership concentration. The "numbers of board meetings, supervisors' meetings and shareholders' meetings" make up the second factor (*FACT2*), which reflects the number of meetings, with a higher score indicating a larger number of meetings. *FACT3*, which reflects external governance, is made up of "listed in B or H-share market," "audited by the Big 4," and "audit fee," which are interrelated because firms listed in markets other than A-share markets have more demand for the assurance service supplied by reputable auditors and correspondingly are charged higher audit fees. *FACT4*, which reflects the nature of firms, includes two indicators—"central" and "local" SOE—with private firms receiving higher scores. *FACT5*, which reflects "shareholding of institutional investors" and "shareholding of funds," represents institutional investors and its score increases with institutional investors' shareholding. *FACT6*, including "percent of independent directors" and "board size," is assigned a higher score with a larger percent of independent directors or a smaller board size. Given a fixed number of independent directors, a smaller board size indicates a larger percent of independent directors. "Separation of chairman and CEO" and "management shareholding" constitute the seventh factor (*FACT7*), with a higher score assigned to firms that separate chairman and CEO, or have more management shareholdings (the higher the level of management's shareholding, the more goal-congruence between management and shareholders). *FACT8* reflects the "same place," with a higher score if independent directors work at the same place where the firm is located.

The regression results of corporate governance on expense stickiness are shown in Table 8. We present the results of integrating each factor into estimating model (3), one at a time, from Columns (1) to (8). The estimation result including all of the factors is shown in Column (9). The value of β_2 in all of the columns is

Table 7
Corporate governance factors.

Factor	Coefficient of load	Factor	Coefficient of load
Ownership concentration (*FACT1*)		Institutional investors (*FACT5*)	
Shareholding of the largest shareholder	0.846	Shareholding of institutional investors	0.825
Shareholding of the second to the tenth largest shareholders	−0.732	Shareholding of funds	0.713
Z index	0.780		
Number of meetings (*FACT2*)		Percent of independent directors and board size (*FACT6*)	0.821
No. of board meetings	0.791	Percent of independent directors	−0.713
No. of supervisors' meetings	0.714	Board size	
No. of shareholders' meetings	0.759		0.702
		Separation of chairman and CEO, management shareholding (*FACT7*)	
External governance (*FACT3*)		Separation of chairman and CEO	−0.705
Listed in B or H-share market	0.797	Management shareholding	
Audited by the Big 4	0.767		
Audit fee	0.680	Same place (*FACT8*)	
		Independent director works in the same place where the firm is located	0.965
Nature of firms (*FACT4*)			
Central SOE	−0.857		
Local SOE	0.835		

significantly negative, with a minimum of −0.37 and a maximum of −0.329, indicating the existence of expense stickiness. In Column (1), β_3 is positive and statistically significant, suggesting that the concentration of shareholding can decrease expense stickiness. A high ownership concentration may represent the concentration of management authority, which in turn promotes the success of managers' cost control processes. From Column (2), we find that more meetings benefit the reduction in expense stickiness, as β_4 is significantly positive. This result may be because a higher number of meetings indicates a more transparent governance environment and convenient communication between different firm levels, prompting the widespread pursuit of cost control targets by firms. β_5 in Column (5) is positive and statistically significant, suggesting that firms that list in B or H-share markets and are audited by reputable auditors have a lower level of expense stickiness, indicating that good external governance can help managers to better control costs. The value of β_6 is significantly positive in Column (4), suggesting that firms other than central SOEs have a lower level of expense stickiness. We provide evidence of the ways in which institutional shareholders benefit from the cost control aspect because β_7 in Column (5) is positive and statistically significant, suggesting that an increase in institutional investors' shareholding can help reduce expense stickiness. β_8 in Column (6) is positive but not statistically significant. Although the effect is not statistically significant, it still indicates that an increase in the percentage of independent directors may, to some degree, reduce expense stickiness. The significantly positive sign of β_9 in Column (7) shows that separating the chairman and CEO or increasing management shareholdings can help reduce expense stickiness. When independent directors work in the same place where a firm is located, it has a limited effect on reducing expense stickiness because β_9 is positive but not statistically significant in Column (8). When all of the factors are considered, we find similar results in Column (9), with a little weaker statistical significance of some coefficients. To summarize, the results reported in Table 8 provide evidence that good corporate governance (especially high ownership concentration, hardworking boards, good external governance, separation of chairman and CEO, and management shareholdings) can significantly decrease expense stickiness, which is consistent with H3.

5.5. Interaction effect between earnings management and corporate governance (H4)

The regression results, based on sub-samples divided by earnings management and corporate governance, are listed in Table 9. As noted, $EAMG = 0$ (1) indicates the sub-sample without (with) earnings management

Table 8
Corporate governance and expense stickiness.

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
β_0		0.049	0.049	0.049	0.049	0.049	0.048	0.051	0.048	0.051
		(9.56)***	(9.57)***	(9.58)***	(9.59)***	(9.55)***	(9.46)***	(9.88)***	(9.44)***	(9.96)***
β_1		0.520	0.520	0.520	0.520	0.520	0.521	0.517	0.521	0.516
		(37.89)***	(37.85)***	(37.82)***	(37.79)***	(37.84)***	(37.89)***	(37.64)***	(37.9)***	(37.61)***
β_2		**−0.368**	**−0.361**	**−0.354**	**−0.348**	**−0.329**	**−0.363**	**−0.355**	**−0.370**	**−0.337**
		(−10.3)***	**(−10.1)*****	**(−9.84)*****	**(−9.56)*****	**(−8.62)*****	**(−10.1)*****	**(−9.94)*****	**(−10.3)*****	**(−8.63)*****
β_3	**Interaction with FACT1**	**0.106**								**0.082**
		(4.81)***								**(3.61)*****
β_4	**Interaction with FACT2**		**0.067**							**0.035**
			(3.48)***							**(1.67)***
β_5	**Interaction with FACT3**			**0.082**						**0.062**
				(2.81)***						**(2.12)****
β_6	**Interaction with FACT4**				**0.050**					0.024
					(2.24)**					(1.06)
β_7	**Interaction with FACT5**					**0.068**				0.031
						(2.53)***				(1.09)
β_8	**Interaction with FACT6**						0.017			0.011
							(0.96)			(0.63)
β_9	**Interaction with FACT7**							**0.121**		**0.084**
								(5.39)***		**(3.47)*****
β_{10}	**Interaction with FACT8**								0.029	0.031
									(1.49)	(1.54)
β_{11}	**Interaction with CAPR**	0.012	0.016	0.011	0.007	0.008	0.007	0.011	0.010	0.021
		(1.83)*	(2.24)**	(1.59)	(1.04)	(2.53)***	(0.98)	(1.64)	(1.52)	(2.78)***
β_{12}	**Interaction with TOBQ**	0.040	0.029	0.034	0.030	0.029	0.031	0.036	0.033	0.035
		(4.58)***	(3.37)***	(3.96)***	(3.46)***	(3.35)***	(3.54)***	(4.25)***	(3.84)***	(3.85)***
F		385.15***	382.41***	381.36***	380.64***	380.98***	379.62***	386.63***	379.94***	164.04***
Adj_R^2		0.1996	0.1985	0.198	0.1977	0.1979	0.1973	0.2002	0.1975	0.2026
N		7702	7702	7702	7702	7702	7702	7702	7702	7702

* indicates two-tailed statistical significance at 10% level.
** indicates two-tailed statistical significance at 5% level.
*** indicates two-tailed statistical significance at 1% level.
The bold variable(s) is the tested variable(s) we focus on.

incentives and $CGID = 0$ (1) indicates the sub-sample with relatively bad (good) corporate governance. The corresponding coefficient differences for each column (row) and their t values (based on the Chow test using dummy variables) are listed in the last row (column). The coefficient differences between groups (1/1) and (0/0) and their t values are listed in the lower-right corner.

As Table 9 shows, the value of β_2 is 0.173 and statistically significant at the 10% level in the (1/1) sub-sample, indicating anti-stickiness (e.g., Balakrishnan et al. (2004) and Weiss (2010)).[2] Therefore, the stickiness of expenses in the (1/1) sub-sample is at a lower level than in the other sub-samples. The difference in β_2

[2] The concept of anti-stickiness was first raised by Balakrishnan et al. (2004). Costs are deemed anti-sticky if they increase less when activity rises than they decrease when activity falls by an equivalent amount. For more information, refer to Section II of Balakrishnan et al. (2004) and the graph description or explanation of Weiss (2010).

Table 9
Interaction effect of EM and CG on expense stickiness.

Value of β_2	CGID = 0	CGID = 1	Dif.
$EAMG = 0$	−0.475	−0.317	0.159
	$(-7.38)^{***}$	$(-4.73)^{***}$	$[1.68]^{*}$
	N = 2476	N = 2556	
$EAMG = 1$	0.019	0.173	0.154
	(0.17)	$(1.88)^{*}$	[1.05]
	N = 1375	N = 1295	
Dif.	0.494	0.490	0.649
	$[3.41]^{***}$	$[4.12]^{***}$	$[5.05]^{***}$

The t value of estimating β_2 is included in (), and that of the Chow test is included in [].
The superscript ** indicates two-tailed statistical significance at 5% level.
* indicates two-tailed statistical significance at 10% level.
*** indicates two-tailed statistical significance 1% level.

between (1/1) and (0/0) is 0.649 and is statistically significant at the 1% level, as is the difference between (1/1) and (0/1), which is 0.49 and also significant at the 1% level. Although the difference between (1/1) and (1/0) is not statistically significant, it is still positive and consistent with our expectations. Thus, the above results support H4, which suggests that the interaction effect of upward earnings management and good corporate governance can further reduce expense stickiness.

From Table 9, we further find that upward earnings management increases the value of β_2 to 0.494 (0.490) in the bad (good) corporate governance sub-sample, which is statistically significant at the 1% level, indicating that upward earnings management has a great effect on reducing expense stickiness. Although the increased difference in β_2 by good corporate governance is 0.159 (0.154) in the non-earnings-management (earnings-management) sub-sample, only the amount in the non-earnings-management sub-sample is statistically significant at the 10% level. Compared with corporate governance, upward earnings management has a greater influence on reducing the level of expense stickiness because the differences due to earnings management are not only larger, but also more significant than those due to corporate governance. Earnings management, as taken by managers, has a direct influence on current expenditure decisions, whereas corporate governance works indirectly.

5.6. Effects of corporate governance and earnings management on different expenses (H5)

Table 10 reports the results of testing H5. We do not list the regression results on ADV in Table 10 as they are not statistically significant. The effect of earnings management on reducing R&D stickiness is only

Table 10
Regression results of different expenses.

Value of β_2	*R&D*			*GSGA*		
	$CGID = 0$	$CGID = 1$	Dif.	$CGID = 0$	$CGID = 1$	Dif.
$EAMG = 0$	−0.353	−0.284	0.069	−0.586	−0.392	0.174
	$(6.84)^{***}$	$(5.01)^{***}$	[0.05]	$(-9.95)^{***}$	$(-5.56)^{***}$	$[1.77]^{*}$
	N = 2476	N = 2556		N = 2476	N = 2556	
$EAMG = 1$	−0.105	−0.224	0.019	0.005	0.175	0.170
	(−1.64)	$(-2.86)^{**}$	[0.01]	(0.04)	$(1.92)^{*}$	[1.28]
	N = 1375	N = 1295		N = 1375	N = 1295	
Dif.	0.248	0.060	0.129	0.591	0.567	0.761
	$[4.04]^{***}$	[0.04]	$[2.35]^{**}$	$[4.35]^{***}$	$[4.66]^{***}$	$[6.01]^{***}$

The t value of estimating β_2 is included in () and that of the Chow test is included in [].
* indicates two-tailed statistical significance at 10% level.
** indicates two-tailed statistical significance at 5% level.
*** indicates two-tailed statistical significance at the 1% level.

significant in the bad corporate governance sub-sample, indicating that good corporate governance can restrict managers' discretional behavior of pursuing short-term targets at the expense of long-term benefits. In both good and bad corporate governance sub-samples, upward earnings management can significantly decrease the stickiness of GSGA. Thus, the results in Table 10 suggest that managers mainly choose to reduce other general expenses to meet earnings targets, which is consistent with H5a.

6. Robustness tests

To examine the consistency of our results, we run the following robustness tests. As Subramaniam and Weidenmier (2003) and Kong et al. (2007) suggest, there are different driving factors on stickiness in different industries. Thus, we add dummy variables to our regressions to control for industry fixed effects. Due to the changing economic environment, the driving factors for expense stickiness may change over time. To control for time effects, we add year dummy variables to our regression. We run the regressions based on different earnings-management definitions, including firm-years whose ROA are 0–1%, 0–1.8%, and 0–2% as the observations with the purpose of avoiding reporting small losses, and firm-years whose changes in earnings scaled by total asset are 0–0.5%, 0–0.8%, 0–1.3%, and 0–1.5% as observations with the purpose of avoiding reporting earnings decreases. In addition to regressing based on the whole earnings-management sub-sample, we regress based on the sub-samples of avoiding reporting small losses and earnings decreases separately. Different methods are used to extract corporate governance factors, including PCA, iterative PCA, and factor analysis based on non-weighted least squares. To summarize, the results are similar to those shown in the main empirical section and thus our conclusions are robust to the above mentioned tests.

7. Conclusion

Cost and expense stickiness is an important issue in accounting and economics research. The literature has shown that cost stickiness cannot be separated from managers' motivations. Based on the literature, we first study the influence of earnings management on expense stickiness. Defining small positive profits or small earnings increases as earnings management, we find that there is significantly more expense stickiness in our non-earnings-management sub-sample than in our earnings-management sub-sample, which indicates that managers prefer to reduce more expenses under the pressure of reporting sound earnings. To check whether the expense reduction indicates better operating efficiency or managers' dysfunctional short-sighted behavior, we further divide expenses into R&D, advertising, and other general expenses. The results show that the difference in the reduction in stickiness between the earnings-management and non-earnings-management sub-samples is much more significant in other general expenses than in R&D or advertising expenses. We also analyze the influence of corporate governance on the stickiness of expenses. Based on Larcker et al. (2007), we extract eight main factors from the summarized corporate governance indices and find that good corporate governance has a negative effect on expense stickiness. We finally check the interaction effect between earnings management and corporate governance and find that the interaction further reduces expense stickiness. Our results imply that earnings management incentives have a more significant effect on reducing the stickiness than corporate governance, and that firms benefit from good corporate governance, as it restricts management opportunism, especially under earnings pressure.

Acknowledgments

This research is funded by a National Natural Science Grant (No. 71172143), a Key Socia1 Science Research Institute Grant of the Ministry of Education (No. 12JJD790037) and the Program for New Century Excellent Talents in University (NCET-13-0893).

Appendix A. Selection of corporate governance variables

Variables	Definitions
Board variables	
Separation of chairman and CEO	1 if the same person is chairman and CEO, 0 for separation, and 0.5 for uncertainty
Board size	The number of directors (including the chairman)
Percent of independent directors	The independent directors' percentage of the whole board
Independent director works in the same place where the firm is located	0 for different, 1 for the same, and 0.5 for uncertainty. When there is more than one independent director, the standard is based on the independent director's financial background. If more than one independent director with a financial background is hired, the variable is 0 as long as one of them works in a different place
No of committees	The number of strategy, nomination, compensation, and audit committees set by the board
No. of board meetings	The number of board meetings in the financial year
No. of supervisors' meetings	The number of supervisors' meetings in the financial year
No. of shareholders' meetings	The number of shareholders' meetings in the financial year
Shareholding structure variables	
Shareholding of largest shareholder	The largest shareholders' shareholding percentage of total shares
Shareholding of second to tenth largest shareholders	The sum of the second to tenth largest shareholders' shareholding percentage of total shares
Z index	The shareholding of largest shareholder scaled by that of the second largest shareholder
Relation between ten largest shareholders	1 for existing relationship, 2 for no existing relationship, and 3 for uncertainty
Institutional investor variables	
Shareholding of institutional investors	The shareholding percentage of institutional investors. Institutional investors include funds, brokers, brokerage financial products, QFII, insurance firms, social security funds, annuity, trusts, and financial firms
Shareholding of funds	The shareholding percentage of funds
External governance variables	
Listed in B or H-share markets	1 for firms listed in the B or H-share markets and 0 otherwise
Audited by the Big 4	1 for firms audited by Big 4 firms and 0 otherwise
Audit fee	
Debt covenant variables	
Leverage	Total debt/total asset
Management shareholding variables	
Management shareholding	The shareholding percentage of management. Management includes the CEO, president, vice president, board secretary, and other managers reported in the annual report
Nature of firm variables	
Central SOE	1 for firms whose ultimate controlling shareholder is the central government or its institutions and 0 otherwise
Local SOE	1 for firms whose ultimate controlling shareholder is the local government or its institutions and 0 otherwise

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China Journal of Accounting Research 9 (2016) 59–81

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China Journal of Accounting Research

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

Government governance, executive networks and enterprise R&D Expenditure

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ARTICLE INFO

Article history:
Received 15 May 2014
Accepted 11 September 2015

JEL classification:
G39
M41

Keywords:
Government governance
Executive networks
R&D investment
State-owned enterprises

ABSTRACT

The increasingly competitive market environment makes independent innovation the core of the enterprise's and evens the country's competitiveness. In order to solve the problem of its own limited R&D resources, firms need to find access to outside resources. Since the government mainly provides policy and financial support, the information diffusion and learning effects of executive networks can effectively compensate for the shortage of formal institutional arrangements. In view of this, we manually collect data on R&D expenditures and executive networks having common management members in China A-share listed companies from 2007 to 2010. Combined with corporate governance and government governance data, this paper empirically tests the influence of government governance and executive networks on enterprise innovation. The empirical results reveal that the governance efficiency of the government where the enterprise is located determines the efficiency of resource allocation firms are faced with, which provides institutional constraints on corporate R&D intensity, and that the establishment and scale of executive networks do contribute to R&D decisions. Further testing shows that compared with non-state-owned enterprises, state-owned enterprises are faced with relatively weaker restraints and pressures in terms of policy, finance, technology and competition. Thus, they show no obvious reliance on government governance quality and the information diffusion of executive networks. The findings of this study help us to understand the role of informal systems in social economics, such as relationship networks and social capital, in the context of China's economic development, and provide relevant

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http://dx.doi.org/10.1016/j.cjar.2015.09.001

evidence and enrich macro and micro studies of "government and market" and "market and enterprise" relationships.

1. Introduction

Enterprise R&D activities enable them to make innovations in products, technologies and procedures, which determine companies' competitive advantages and growth in the future (Scherer, 1984; Ettlie, 1998). The process of innovation not only promotes technological progress, but also becomes the main impetus of endogenous economic growth. In spite of China's economy growing miraculously, the sustainability of economic growth is still worrying; therefore, it is imperative to transfer the mode of economic growth, and encourage independent innovation by enterprises. As a result, the state has put forward the strategic objective of building an innovation-oriented country,[1] and is treating these micro-economic entities as main players so as to highlight their importance in the whole innovation system.

According to the "China Statistical Yearbook on Science and Technology", from 1995 to 2009, the average annual growth rate of national R&D expenditures was up to 20.12%, much higher than GDP growth over the same period and showing an upward trend. The statistical report of the Ministry of Science and Technology in 2011[2] also shows that, 71.7% of R&D funds in 2010 are derived from enterprises, and 73.4% of R&D operating departments are also in enterprises. But the Global Competitiveness Report (2011–2012) reveals that the firm-level technology absorption capacity of Chinese mainland enterprises ranks only 61st[3] in 142 countries and regions, indicating that the technological innovation of Chinese mainland enterprises is still not competitive on a global scale. This mismatch of inputs and outputs is subject to the country's overall level of technology development, government investment intensity and selection of investment objects. It is also influenced by their own resource constraints and strategic decisions.

Meanwhile, enterprises have to confront increasingly intense global competition in the new economic environment characterized by knowledge and information. On the one hand, in order to maintain continual motivation to develop and endure competitive strength in an increasingly keen competitive environment, most enterprises have deeply realized that independent innovation is their impulsion for survival and development. On the other hand, with the current guidance to build an innovation-oriented country, a series of preferential policies and security mechanisms to avoid R&D risk have stimulated enterprises' enthusiasm to innovation. Under both internal and external stimulus, innovation undoubtedly becomes the driving force of firms' development and progress, while investment in R&D is inevitably an important corporate expenditure.

"Fiscal Federalism" in China's transition process and performance-driven "Official Promotion System", strongly stimulate local government to progress economic development. The differences in historical conditions and natural resource endowments result in diverse institutional constraints on economic development and in government efficiency in different areas. Under the pressure of horizontal competition, local government essentially becomes the regulating subject for the regional economy, playing the role of quasi-market subject, and directly or indirectly joining in enterprises' operating activities. Therefore, governance as a formal arrangement can be either the supporter of the sustainable development of enterprises, or the taker of corporate value. That is, efficiency of governance is often an important factor influencing the

[1] July 1, 2008, the new revision of <Law on the Advancement of Science and Technology of PRC> was formally upheld, which was replenished by a new sector "technological progress", clarifying enterprises as the main subjects in technological innovation, meanwhile requiring government to guide and support enterprises' technological innovations by fiscal and tax policy, industrial policy, capital market, and a technology intermediary service system.

[2] http://www.sts.org.cn/sjkl/kjtjdt/data2011/science and technology statistical data 2011.pdf.

[3] World Economic Forum, 2011, The Global Competitiveness Report 2011–2012, pp. 491.

degree of government intervention in enterprises' activities. Insufficient government investment enforces enterprises to actively apply the limited resources supplied by the formal institutional arrangement, while at the same time actively seeking informal institutional arrangements (such as networking) for themselves to obtain actual or potential resources (Nahapiet and Ghoshal, 1998).

Wang (2005) considers that social networks play a prominent role in social operations and resource allocation in China. For enterprises, social networks include not only the financial and family relations among management members and their common social relations (Hwang and Kim, 2009), but also political relations between top management and government officials (Fan et al., 2007). These networks provide more opportunities for enterprises' development and growth, which reduces the transaction costs of enterprises in the development process and information asymmetry, as well as increasing the channels for enterprises to obtain more resources by expanding social networks and avoiding the irregular behavior of industry and local government. To sum up, research and development investment decisions are usually the result of formal institutional arrangements under the background of government intervention and informal institutional arrangements embedded in enterprise social networks.

We manually collect data on R&D expenditure and the size of commercial networks constituted by common members of management in listed companies from 2007 to 2010. Combined with firm financial and governance data and an index of government governance, this paper examines the impact of government governance on R&D expenditure as a formal institutional arrangement and explores the mechanism of executive networks as an informal arrangement.

The contributions of this paper are as follows: first, it enriches the existing literature on the internal motivation of enterprise innovation and tests whether informal institutional arrangements and formal institutional arrangements interact with each other in R&D activities; second, from the micro and macro perspectives, this paper examines whether informal institutional arrangements (social network), an effective complementary mechanism for imperfect market systems, help companies acquire technical resources, promote the upgrade of their core value, and thus encourage macroeconomic growth and improve the competitive strength of national science and technology; third, it emphasizes that in the transitioning Chinese market, the absence of paths and mechanisms to obtain resources with formal institutional arrangements makes firms utilize social capital embedded in business networks as a sub-optimal choice.

The remainders of this paper are organized as following: theory and research questions are outlined in Section 2; research design is in Section 3; data analysis and discussion of the empirical results is in Section 4; conclusions are in Section 5.

2. Theory and research questions

Recent research on R&D investment covers two aspects – influence factors and economic effects. Influencing factors contain market and industry characteristics (Rogers, 2002; An et al., 2006; Zhu, 2006), equity nature and structure (Hill and Snell, 1988; Baysinger et al., 1991; Wahal and McConnell, 2000), and corporate financial variables (Baysinger et al., 1991; Bhagat and Welch, 1995). Economic effects include enterprise growth (Mansfield, 1962; Mowery, 1983), productivity and performance (Griliches, 1986; Wu, 2006). However, these studies pay little attention to enterprise R&D activities and their influencing factors from the perspective of institutional arrangements. This paper covers the perspectives of governance, executive networks, and their interaction with each other and enterprise heterogeneity.

2.1. Policy resources for R&D – government governance

Many studies (La Porta et al., 1999; Easterly, 2001; Acemoglu et al., 2001, 2002; Easterly and Levine, 2003; Rodrik et al., 2004; Rose-Ackerman and Kornai, 2004) indicate that governance and its efficiency have an important influence on economic growth and social development. Easterly (2001) even states that in a variety of institutional factors affecting economic growth, governance plays a vital role. Government incompetence, corruption, inefficiency and lack of reactive capacity are fatal for economic growth.

A major feature of the Chinese transition economy is that large numbers of resources are still controlled by the government. The government can intervene in company activities through policies and administrative

instructions. Sometimes the interventions can be distorted, delayed and even corrupted (Mauro, 1995; Treisman, 2000). In the process of economic transformation, 'federalism with Chinese style' (Qian and Weingast, 1997; Qian and Roland, 1998; Jin et al., 2005) becomes a strong incentive to economic development for local governments. Fierce competition between regions is the new reality faced by local governments. They transform from plan executors under the planning system to political entrepreneurs and do everything possible to integrate the economic and political resources under their control, make appropriate industrial development strategy and rely on product and technological innovation to achieve beyond the average performance of the market. Thus, there is close cooperation between the local government and the entrepreneurs in the area. That is, local officials provide policies and resources, and enterprises provide the required performance, employment and taxes, and even personal benefits.

Local economic development faces different resource constraints due to historical conditions and resource endowment, which causes the heterogeneity in the efficiency of local governments. In order to maintain the sustainability of local economic development, local governments with rich resources will provide the company's technological innovation activities with policy and financial support, and enact and implement relevant policies so as to encourage it to make contributions to local competitive advantages. These efficient interventions, which are viewed as effective governance, help enterprises to improve their core values and create favorable conditions for local competitiveness. On the other hand, local governments with poor resources barely support the innovation activities of companies. But since political achievements are still needed, local officials will make the companies perform some social duties by occupying their resources. Meanwhile, the high risk of innovation activities discourages local governments with low efficiency from supporting the companies. They take resources from the people but do not use them for the people and tend to breed corruption. As the enterprise development process is not only embedded in their own social network, but also deeply rooted in the governance background with regional differences, therefore the efficiency of local governments will undoubtedly have a direct impact on policy formulation, implementation efficiency and resource constraints, which will indirectly affect the R&D decisions of companies.

H1. The higher the efficiency of regional governance, the higher R&D expenditures will be.

2.2. Enterprise R&D investment strategic resources – executive networks

Social capital based on relationship networks and trust affects the economic development of a country or region and plays a decisive role in the enterprises' sustainable development (Guiso et al., 2004). Social relationship networks owned by enterprises, especially by executives, can improve information access and delivery speed significantly, helping executives make effective decisions, conduct valid monitoring and improve the effectiveness of corporate governance in order to enhance company value (Ellison and Fudenberg, 1993; Maman, 1999; Cohen et al., 2010). Executive networks can also improve the speed and efficiency of a company's access to resources, restrain investment behavior and thereby affect business growth (Uzzi, 1996, 1999; Uzzi and Gillespie, 2002; Khwaja and Mian, 2008; Khanna and Thomas, 2009). At the same time, network externality makes the decision behavior of network members show the advantages of convergence. The higher concentration of the company's position in the social network, the lower the level of heterogeneity of its investment strategies, and the value of the network enables companies with larger network scale achieve better operating performance. As an informal institutional arrangement, social relationship networks not only provide a competitive advantage for the company in influencing the decision making progress, but also play a role in limiting existing competitors and the exclusion of other potential competitors (Hochberg et al., 2007), which is undoubtedly an important strategic resource to help the company maintain its core competitiveness.

Although corporate governance in China is in a transition period from relationship governance to rule-based governance, traditional culture leaves relationship governance in a dominant position. Executive social networks can be seen as an effective complement to the internal resources of a company. In particular in the cultural context of Chinese collectivism, company value is not only assessed by its own competitiveness and contribution to society, but also decided by the scale of the social network it links to. Studies based on the Chinese context (Keister, 1998; Ren et al., 2007; Li and Zhang, 2007; Li et al., 2008) found that executive relationship networks have a significant effect on company performance. Peng and Liao (2008) analyzed

the intrinsic mechanism of interlocking directorships' impact on corporate governance by discussing the interlocking directorship network, board of directors and the personal behavior of the interlocking directors, and found that the embedded ability of the interlocking directorships has a significant positive impact on a company's governance performance. Lu et al. (2006) and Lu and Chen (2009) found the company could get vital resources through interlocking director enterprises and the organizational function of interlocking directorships in the listed company is to promote inter-firm coordination and information transmission. Chen and Xie (2011) argued that in the interlocking independent directorship network of Chinese listed companies, independent directors with a higher degree of network-concentration are more motivated and also better able to monitor managers' investment decision behavior and therefore curb the inefficient investment behavior of managers with an opportunistic motivation to gain personal profits. Moreover, they can provide more accurate and timely information and knowledge on investment opportunities for business decisions through recommendation functions in order to reduce over-investment and under-investment and improve investment efficiency. With the increasing complexity and risk of innovation and the dramatic changes of the market environment, companies can hardly complete innovation activities effectively on their own and external resources have therefore become an effective source of technological innovation. As government investment in company innovation is policy selective, companies have to look for other ways to seek the core strategic resources for their technological innovations. Companies are always limited by finance, human resources and risks in innovation. A close network connection will assure the timeliness and accuracy of the companies' information, and by learning or acquiring key resources from network members, companies can shape their own core competitiveness. Rogers (1995) found that new innovations are often spread in the informal interpersonal channels and the structure of the diffusion network will affect the speed of adoption of new innovations. Therefore, constructing the social network can help communication, share resources and decrease information asymmetry, thus facilitating companies' R&D activities.

H2. The bigger the executive network, the higher R&D expenditures will be.

2.3. Government governance and executive networks: intersection or parallel

When executive networks provide valid information to help executives make decisions, the disparity of the external environment (government governance) could have a significant impact on corporate risk dispersion and uncertainties decrease. On the one hand, efficient local governments have advantages in policy-making and system-perfection, so listed companies will get the necessary resources and technologies in R&D activities easily, and do not need to rely so much on executive social networks. For listed companies from regions with less governance efficiency, they may not be able to get effective support for R&D activities from the local government through formal institutional arrangements, forcing them to rely more on executive networks, which compensates for the weakness of regional policy support. However, there might be an alternative relationship between the social network scale and governance efficiency in the promotion of R&D investment. Efficient governments will reduce improper intervention in companies, and provide support for information exchange for network members from different regions, which will further promote R&D activities, while less efficient governments may intervene too much in order to protect their own interests, worrying that companies will reveal a handful of actual or potential competitive advantages through their own social networks, especially through regional networks, and ultimately form institutional barriers for R&D activities. There lies a "Matthew Effect" in the executive network and government governance in the promotion of companies' R&D activities.

However, what companies obtain through executive networks is decision-making information related to R&D, which may cause the companies to imitate the network members in making R&D investment decisions. While local governments tend to provide policy and financial support, and companies restrained by governments will adjust their R&D strategies and become a community of interest with the government. Therefore, executive networks and government governance may have completely different effect mechanisms on the R&D activities of companies and there is no intersection in their pathways.

H3a. There is an interaction effect between the efficiency of governance and the effect of executive network scale on R&D expenditures.

H3b. There is no interaction effect between the efficiency of governance and the effect of executive network scale on R&D expenditures.

2.4. Firm heterogeneity: nature of property rights

Chinese state-owned enterprises take on more social responsibilities and correspondingly get more help regarding budget constraints, financing facilities and government backing (Li and Xia, 2008). Due to long-standing monopolies and scale advantages, state-owned enterprises' technological innovations stem mostly from internal motivation and self-reliance and their emphasis on external environment and network relationships is significantly weaker than private enterprises. Additionally, agency costs between private shareholders and management are relatively smaller in private enterprises. Shareholders show stronger control ability. External dependence and linkages are more close and important, which reflects the correlation effect of government, networks and corporate behavior, while state-owned enterprises show the opposite relationships.

H4. Compared to non-state-controlled enterprises, government governance (executive networks) has a weaker effect on the R&D expenditure of state-owned enterprises.

3. Research design

3.1. Sample and data

The original sample includes all A-share listed companies from 2007 to 2010.[4] We exclude the following: (1) firms in the Finance and Insurance industry. Characteristics of relevant financial data in this industry significantly differ from those of other industries; (2) firms with an unknown ultimate controller, which refers to the ultimate shareholder with the largest equity ratio. This information is needed to determine whether the listed companies are ultimately controlled by the government or not, and therefore we exclude companies with opaque ultimate controller information; (3) firms with missing data; and (4) firms which are ST or PT that year. The final sample includes 5899 firm-year observations from 1701 firms. Among them, there are 3505 firm-year observations of state-owned enterprises and 2394 firm-year observations of non-state-owned enterprises.

We collect data about executive networks and R&D expenditure manually on the basis of relevant information disclosed in annual reports. Particularly, information about R&D expenditures of the main board listed companies is obtained from "development expenditure", "G&A (general & administrative) expense" or "other cash paid relating to operating activities" which are announced in "Notes to Financial Statements". The subject "development expenditure" contains spending on research and development, and the item "G&A expense" only discloses period research spending which is an expense. The subject "other cash paid relating to operating activities" offers information about R&D expenditure paid by cash. Therefore, in order to provide an accurate reflection of real R&D expenditure, we refer to "development expenditure" first, and choose the other two subjects if "development expenditure" is not disclosed. We also get information for firms on the SME (small and medium-sized enterprises) board from "Report of the directorates". Through the above data collection process, we find 1958 companies with specific annual R&D data. In regard to other companies without R&D data, we define its R&D expenditure as zero. Data for the ultimate controller are sourced from the CSMAR database, corporate governance and financial data are from the CSMAR database and data about government governance are from the Report on Market Process (Fan et al., 2011). Main continuous variables are winsorized at the 1% and 99% levels to eliminate the influence of extreme values.

[4] According to the processing of R&D expenditures in the Accounting Standard for Business Enterprises No. 6 – Intangible assets issued in 2006, firms should divide R&D process into research stage and development stage. Expensing the expenditures in research stage and capitalizing the expenditures in development stage if they meet the conditions. Therefore, listed companies adjusted the disclosure of R&D expenditures in their financial statements from 2007, and the sample interval in this paper is 2007–2010.

Table 1
Definitions of variables.

Variables	Name	Sign	Definition
Dependent Variable	R&D Intensity	RD	(R&D expenditures/total assets) * 100%
Independent Variables	Government Governance	GOV	Provincial Market Index of Market Process Report (Fan et al., 2011)
	Executive networks	CS	The number of interlocking executives
		FNET	The number of interlocking companies
Moderating Variable	Nature of property rights	STATE	1 for state-owned enterprises[a], otherwise 0
	Firm Age	AGE	Current Year – Registered Year
	Financial Leverage	LEV	Debt Asset Ratio
	Growth of enterprise	MB	Market Value/Total Assets
	Profitability	ROA	Return on assets last year
	Counterbalance Degree of Shareholders	SHRZ	The proportion of shares held by the second to fifth largest shareholders/the proportion of shares held by the largest shareholder
	Proportion of Institutional Ownership	IIS	The total proportion of shares held by all the institutional investors
	Firm Size	SIZE	The logarithm of the book value of assets
	Governance Structure	DCEO	1 for CEO Duality, otherwise 0
	Year Dummy	YEAR	When observed value belongs to year *k*, it takes a value of 1, otherwise 0
	Industry Dummy	INDUSTRY	When observed value belongs to industry *j*, it takes a value of 1, otherwise 0

[a] The corporate nature classifications in this thesis follow the standard of CSMAR database. The state-owned company includes state-owned enterprises, state-owned holding enterprises, development zone holding enterprises and institutions holding enterprise. Others are defined as non-state owned companies.

3.2. Model and variables

Sample companies whose annual R&D expenditure data are unavailable do not necessarily carry out no R&D activities and investment at all. Therefore, in order to ensure the unbiasedness and consistency of regression results of such censored observations, we employ a Tobit model[5] to test the research questions. Based on the existing literature (Bhagat and Welch, 1995; Huang and Chen, 2011) and our research hypotheses, this paper tests variables such as government governance and executive networks and studies their interaction. Variables and their definitions are shown in Table 1.

3.2.1. Dependent variables

R&D expenditure directly reflects the technological innovation ability of enterprises. Considering the large differences in absolute expenditure among listed companies in different industries, this paper adopts a comparative index – R&D intensity, which is the ratio of R&D expenditure to total assets (Nam et al., 2003; Liu and Liu, 2007; Ren, 2010).

3.2.2. Independent variables

3.2.2.1. Government governance. Government governance is based on Market Process Index (Fan et al., 2011). Since it is only available till 2009, this paper adopts data from 2006 to 2009.

[5] Tobit model, also known as limited dependent variable model, is mainly used to verify dependent variables with the following characteristics: variables whose values can be observed are scored higher than 0, while those cannot be observed in the sample are scored 0. Because data regarding listed company's R&D expenditure can only be obtained through their annual reports, we score R&D expenditure of companies without annual disclosure of it as 0. But that does not mean these companies' actual R&D expenditure is 0, so this paper uses Tobit model to test the hypotheses. In response to the reviewer's request of OLS regression testing, we find that the results remain unchanged.

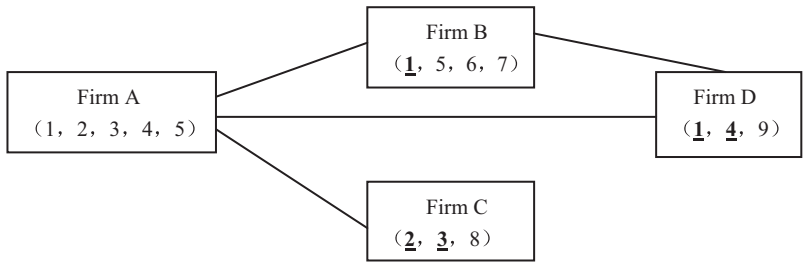

Figure 1. Schematic diagram for executive networks.

3.2.2.2. Executive networks. Size of executive networks evaluates the ability of an enterprise to acquire technological innovation resources from business networks, including the scale of interlocking executives (CS) and the number of interlocking listed companies (FNET). Referring to Mintz and Schwartz (1985) and Stokman et al. (1985), the specific calculation is the number of executives (including directors, senior managers and supervisors) who take executive positions directly in other listed companies (including A-share, B-share and GEM listed companies) and the number of listed companies as a result of management tenure. As illustrated in Fig. 1, Firm A has five interlocking executives and three interlocking listed companies.

3.2.3. Moderating variables

Nature of property rights (STATE). Existing research discovered (Li and Xia, 2008; Feng and Wen, 2008) that the technological innovation ability and R&D intensity of non-state-owned (mainly private-holding) listed companies are considerably higher than those of state-owned enterprises. The government taking both the positions of the judge and the player will often interfere with the decisions of state-owned enterprises because of multiple goals of developing the local economy, employment and social stability. As a result, state-owned enterprises will abandon some of their R&D activities, which need a large amount of money input and help raise enterprise value in the long run in order to undertake these social functions for the government.

3.2.4. Control variables

Referring to the existing literature (Bhagat and Welch, 1995; Helfat, 1997; Bah and Dumontier, 2001; Ahuja and Lampert, 2001; Nam et al., 2003; Feng and Wen, 2008; Ren, 2010; Huang and Chen, 2011), this paper selects the following control variables: (1) Firm age (Age), which refers to the time span from the establishment of the company to the observation year; (2) Financial leverage (LEV), which reflects the company's existing capital structure; (3) The growth of enterprises (MB), which is represented by the market to book value ratio; (4) Profitability (ROA), which reflects the enterprise's resource accumulation ability; (5) Counterbalance Degree of Shareholders (SHRZ), which represents large shareholders' constraint of controlling shareholders; (6) The Proportion of Institutional Ownership (IIS); (7) Firm size (Size); (8) Corporate governance structure (DCEO), which is evaluated by a dummy variable for CEO duality; (9) Year dummies (Year), which are used to control for annual differences in R&D activities; (10) Industry dummies (Industry), which are used to control for the impact of industries on Enterprise R&D investment. According to "Guidelines on the Industry Classification of Listed Companies" enacted by the China Securities Regulatory Commission in 2001, listed companies in China are divided into 13 industries, among which manufacturing has 10 sub-classes. Therefore the Industry variable is set by the 10 sub-classes under manufacturing and the other 11 industries, excluding finance and insurance.

4. Empirical analysis

4.1. Descriptive statistics

4.1.1. Characteristics of executive networks

Table 2 refers to manually collected statistics of executive networks in all the China A-share listed companies. According to Table 2, a high proportion of listed companies are involved in executive networks,

Table 2
Annual statistics of executive networks.

Year	2006	2007	2008	2009	2010
Panel A: Companies involved in executive networks					
Involved network companies	1209	1326	1410	1555	1882
Total listed companies	1456	1572	1626	1774	2129
Proportion (%)	83.04	84.35	86.72	87.66	88.40
Panel B: Number of people involved in executive networks					
Male	1202	1381	1553	1663	1903
Female	138	162	192	223	267
Total	1340	1543	1745	1886	2170
Panel C: Working characteristics of people involved in executive networks					
Hold only one position	1040	1200	1362	1434	1635
Hold two positions	299	340	373	442	529
Hold three positions	1	3	10	10	6
Total	1340	1543	1745	1886	2170
Panel D: Positions of management members holding only one position					
Independent directors	643	734	837	919	1080
Director members (excluding independent directors)	320	369	411	402	437
Managers	6	6	7	11	6
Supervisors	71	91	107	102	112
Total	1040	1200	1362	1434	1635

and it presents an increasing trend. This means that during the transition period, Chinese local governments with low efficiency of resource allocation induce companies, especially listed companies to effectively obtain resources through their own social networks, which has become an effective way of making up for governance deficiencies. In Table 2, management staff involved in executive networks of listed companies also increases year by year, but there is a relatively small proportion of female staff, with an average number around 11% each year. In this paper, positions of management staff involved in executive networks are divided into four categories, i.e. independent directors, board members (except independent directors),[6] members of the Supervisory Board and managers (including president, general manager, department manager and general director who are disclosed in Annual Reports). Panel C in Table 2 shows that most interlocking managers in executive networks hold only one position in the network, while Panel D[7] illustrates most interlocking managers taking only one type of position are independent directors.

4.1.2. Summary statistics

Table 3 shows the descriptive statistics of all the variables except year and industry dummy variables. In the sub-sample (1958 firm-year observations) with R&D data from annual reports, mean (median) R&D intensity is 1.41% (0.77%), which indicates that Chinese listed companies' investment in R&D is generally low. And the gap between its minimum (0.000058%) and maximum (65.35%) value reflects some major differences among the firms. In Table 4, not only the number of companies investing in R&D but also the amounts and intensity of R&D increase year by year, which implies that companies pay more attention to technological innovation and view enhancement of core competitiveness as the key strategy. Table 5 by industry illustrates that companies with higher R&D expenditures are mostly concentrated in the manufacturing and IT industries, which means industrial characteristics is an important determinant of corporate R&D investment. There

[6] If board members serve as managers simultaneously within the same company, they are regarded as board members in statistics.
[7] Part D in Table 2 categorizes all of the positions interlocking managers hold in different listed companies according to four management positions.

Table 3
Descriptive statistics.

Variables	*N*	Mean	Std. dev.	Lower quartile	Median	Upper quartile	Min	Max
RD	5899	0.470	1.290	0	0	0.120	0	10
MKT	5899	8.820	2.010	7.260	8.930	10.550	0.380	11.800
CS	5899	2.500	1.960	1	2	3	0	19
FNET	5899	3.830	3.100	1	3	5	0	22
STATE	5899	0.590	0.490	0	1	1	0	1
AGE	5899	11.87	4.600	9	12	15	0	28
LEV	5899	0.480	0.200	0.340	0.490	0.630	0.0600	0.920
MB	5899	4.880	3.580	2.530	4	5.980	0.620	21.620
ROA	5899	0.050	0.050	0.020	0.040	0.070	−0.150	0.220
SHRZ	5899	0.560	0.540	0.140	0.380	0.830	0.020	2.470
IIS	5899	0.240	0.220	0.040	0.170	0.400	0	0.800
SIZE	5899	21.70	1.21	20.84	21.55	22.39	19.25	25.43
DCEO	5899	0.160	0.370	0	0	0	0	1

Table 4
R&D investment: annual statistics.

	2007	2008	2009	2010	Total
N	280	299	591	788	1958
Mean of R&D Expenditure (ten-thousand-yuan)	3320	3740	4340	5390	4530
N	280	299	545	626	1750
Mean of R&D Intensity (%)	1.0138	0.9060	1.8951	2.1918	1.6912

Table 5
R&D intensity: statistics by industry.

	N^a	n^b	Mean	Min (%)	Max (%)
INDA	125	32	0.4415	0.0018	1.9167
INDB	149	29	0.8716	0.0007	2.5814
INDC	3420	1560	1.3333	0.00006	65.3549
INDD	245	29	0.104	0.0021	1.5055
INDE	138	27	0.7963	0.0005	3.3392
INDF	258	8	0.1542	0.0082	0.3807
INDG	371	176	2.6709	0.0161	31.0237
INDH	358	27	0.5496	0.0031	3.0742
INDJ	332	12	0.0534	0.0047	0.2677
INDK	190	15	1.5237	0.007	4.4692
INDL	41	3	29.9983	0.0225	46.0365
INDM	272	40	0.3669	0.007	1.3709
Total	5899	1958	1.4087	0.0018	1.9167

[a] *N* denotes the number of observations in full sample (5899) by industry.
[b] "*n*" denotes the number of observations in sub-sample (1958) by industry.

are only 693 firms without executive networks in the full sample (5899), which demonstrates the commonness of executive networks in listed companies (distribution structure of executive networks is shown in Table 6).

Table 7 presents correlation analysis between the major variables. There is a significant positive correlation between R&D intensity (RD) and executive networks (CS, FNET), which means establishment of this network will encourage enterprises to increase investment in R&D. Also, there is a significant positive correlation between R&D intensity (RD) and the efficiency of government governance (MKT), which means that government institutional arrangements and the effectiveness of governance have an important impact on R&D decision-making and create a favorable external institutional environment for enterprises' R&D

Table 6
Structure of executive networks.

CS	*N*	Proportion (%)	CS	*N*	Proportion (%)
Panel A: Distribution of interlocking managers					
0	693	11.75	9	18	0.31
1	1358	23.02	10	18	0.31
2	1414	23.97	11	11	0.19
3	975	16.53	12	3	0.05
4	604	10.24	13	1	0.02
5	387	6.56	14	1	0.02
6	221	3.75	15	1	0.02
7	125	2.12	19	1	0.02
8	68	1.15			
FNET	*N*	Proportion	FNET	*N*	Proportion
Panel B: Distribution of interlocking companies					
0	693	11.75	11	65	1.10
1	823	13.95	12	45	0.76
2	855	14.49	13	30	0.51
3	726	12.31	14	29	0.49
4	739	12.53	15	12	0.20
5	599	10.15	16	9	0.15
6	437	7.41	17	5	0.08
7	313	5.31	18	5	0.08
8	230	3.90	19	1	0.02
9	166	2.81	20	3	0.05
10	113	1.92	22	1	0.02

Table 7
Correlation coefficients between the main variables.

	RD	MKT	CS	FNET	STATE
RD	1	0.0294**	0.0293**	0.0120	−0.0486***
MKT	0.0993***	1	0.1110***	0.1391***	−0.1474***
CS	0.0097	0.1009***	1	0.8383***	0.2432***
FNET	0.0410***	0.1321***	0.7904***	1	0.1796***
STATE	−0.1241***	−0.1668***	0.2201***	0.1648***	1

The lower left part is Pearson correlation coefficients, the upper right part is Spearman correlation coefficients.
* Statistical significance at the 10% level.
*** Statistical significance at the 1% level.
** Statistical significance at the 5% level.

activities. The fact that R&D intensity (RD) and the nature of property rights (STATE) are significantly negatively correlated means that the R&D intensity of non-state-owned enterprises is higher than that of state-owned enterprises, and compared with state-owned enterprises, and non-state-owned enterprises without protective policy advantages are more motivated to enhance their own core competitiveness through increased research and development investment.

4.2. Empirical results

4.2.1. Tests of governance and executive networks on R&D

Table 8 shows regression results between R&D intensity and size of executive networks and governance efficiency respectively.[8] In Column 1, governance efficiency has a significant positive effect on R&D intensity

[8] Innovation expenditures disclosed in items ''development expenditure'', ''management expense'' and ''other cash paid relating to operating activities'' in ''Notes to Financial Statements'' have different emphases and refer to different R&D expenses. We test with all these three types of data and find the results remain unchanged.

Table 8
Regression results.

Variables	(1)	(2)	(3)	(4)	(5)
GOV	0.097***			0.0881**	0.093***
	(0.023)			(0.037)	(0.035)
CS		0.081***		0.059	
		(0.024)		(0.105)	
FNET			0.052***		0.054
			(0.014)		(0.067)
GOV * CS				0.002	
				(0.012)	
GOV * FNET					−0.001
					(0.007)
AGE	−0.067***	−0.072***	−0.070***	−0.070***	−0.070***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
LEV	0.397	0.393	0.381	0.430	0.418
	(0.289)	(0.290)	(0.289)	(0.289)	(0.289)
MB	0.048***	0.046***	0.045***	0.047***	0.046***
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
ROA	5.173***	5.371***	5.338***	5.173***	5.146***
	(0.936)	(0.935)	(0.934)	(0.934)	(0.934)
SHRZ	0.059	0.069	0.068	0.063	0.061
	(0.081)	(0.081)	(0.081)	(0.081)	(0.081)
IIS	0.343	0.256	0.289	0.276	0.306
	(0.249)	(0.251)	(0.250)	(0.250)	(0.249)
SIZE	−0.084*	−0.117**	−0.113**	−0.121**	−0.116**
	(0.047)	(0.048)	(0.048)	(0.048)	(0.048)
DCEO	0.185	0.271**	0.270**	0.213*	0.212*
	(0.114)	(0.114)	(0.114)	(0.115)	(0.114)
Constant	−0.953	0.549	0.445	−0.254	−0.417
	(1.035)	(1.033)	(1.026)	(1.091)	(1.070)
YEAR	Controlled				
INDUSTRY	Controlled				
N	5899	5899	5899	5899	5899
Chi^2	1491***	1485***	1486***	1501***	1501***
Pseudo-R^2	0.118	0.117	0.117	0.118	0.118

Standard errors are in brackets.
*** Statistical significance at the 1% level.
** Statistical significance at the 5% level.
* Statistical significance at the 10% level.

at the level of 1%, i.e. companies located in areas with more efficient governance do invest more in R&D activities. The relatively weak innovation capacity during China's economic transition and the support of government policy pose constraints to enterprises' self-innovation. In order to encourage their self-innovation enthusiasm and promote regional economic growth, local governments provide preferential tax and subsidy policies. Regions with more efficient governance generally possess more resources and more effective policy formulation and execution to support enterprises' R&D. Therefore, their economic strength and core competitiveness are effectively enhanced. In Column 2, R&D intensity has a significant positive relationship with executive networks at the level of 1%, i.e. the larger the listed companies' executive networks are, the stronger its R&D intensity. This demonstrates that social networks via executives' external positions do provide more abundant resources, which helps the company reduce transaction costs, optimize resource allocation and enhance core competitiveness. As China is currently experiencing economic transition and has not yet formed a relatively perfect market and institutional environment, the overall social technological innovation ability still lags behind developed countries and R&D capacity remains the bottleneck for the sustainable development of enterprises. Therefore, active and independent innovation and effective access to technological resources are still essential for enterprises to pursue long-term value, growth and sustainability. This executive network opens up new opportunities to listed companies, not only arousing their

Table 9
Regression results based on the nature of property rights.

Variables	(1)	(2)	(3)
GOV	0.165***		
	(0.036)		
CS		0.126***	
		(0.040)	
FNET			0.0952***
			(0.023)
STATE	1.154***	0.334**	0.431***
	(0.435)	(0.152)	(0.146)
GOV * STATE	−0.097**		
	(0.047)		
CS * STATE		−0.075	
		(0.048)	
FNET * STATE			−0.072**
			(0.029)
AGE	−0.069***	−0.075***	−0.073***
	(0.011)	(0.011)	(0.010)
LEV	0.339	0.365	0.340
	(0.290)	(0.290)	(0.290)
MB	0.049***	0.047***	0.045***
	(0.015)	(0.015)	(0.015)
ROA	5.406***	5.567***	5.530***
	(0.945)	(0.943)	(0.941)
SHRZ	0.094	0.10	0.099
	(0.083)	(0.083)	(0.082)
IIS	0.290	0.225	0.256
	(0.250)	(0.251)	(0.250)
SIZE	−0.106**	−0.125**	−0.120**
	(0.048)	(0.049)	(0.048)
DCEO	0.217*	0.302***	0.304***
	(0.116)	(0.115)	(0.115)
Constant	−1.208	0.605	0.417
	(1.084)	(1.045)	(1.040)
YEAR	Controlled		
INDUSTRY	Controlled		
N	5899	5899	5899
Chi^2	1503***	1489***	1495***
Pseudo-R^2	0.119	0.117	0.118

Standard errors are in brackets.
*** Statistical significance at the 1% level.
** Statistical significance at the 5% level.
* Statistical significance at the 10% level.

enthusiasm but also offering diversified access to resources and it is especially crucial for listed companies lacking technological innovation ability to enhance their core value. Columns 4 and 5 show that there are no significant relationships between the interaction of these two influencing factors and R&D intensity. Therefore, informal and formal institutional arrangements affect R&D activities with their own unique mechanism, which means the two mechanisms are parallel.

All regression results show that enterprise Age and R&D intensity have a significant negative correlation at the level of 1%, namely the younger the enterprise is, the stronger the R&D intensity will be, which is consistent with Ahuja and Lampert (2001). Older enterprises tend to rely on their existing growth opportunities and rest on their laurels; thus, they fall into the trap of innovation restriction and gradually lose their adaptability to their unpredictable competitive environment. MB and R&D intensity have significant positive correlations at the level of 1%, implying that high-growth companies are more motivated in R&D investment to advance their core values and promote fast development. ROA and R&D intensity have a significant positive correlation

Table 10
Two-stage regressions using instrumental variables.

Variables	(1)	(2)
CS	0.0674**	
	(0.0306)	
FNET		0.0560***
		(0.0198)
AGE	−0.144***	−0.142***
	(0.0113)	(0.0113)
LEV	−0.454	−0.452
	(0.312)	(0.311)
MB	0.0560***	0.0547***
	(0.0164)	(0.0164)
ROA	5.440***	5.398***
	(0.969)	(0.968)
SHRZ	0.194**	0.193**
	(0.0879)	(0.0878)
IIS	0.0762	0.0997
	(0.274)	(0.272)
SIZE	−0.150***	−0.157***
	(0.0525)	(0.0522)
DCEO	0.491***	0.497***
	(0.122)	(0.121)
Constant	3.175***	3.231***
	(1.116)	(1.107)
YEAR	Controlled	
INDUSTRY	Controlled	
N[a]	4198	4198
Chi^2	1217***	1221***
chi^2_exog	0.141	0.924
p_exog	0.707	0.336

Standard errors are in brackets.
* Statistical significance at the 10% level
*** Statistical significance at the 1% level.
** Statistical significance at the 5% level.
[a] Data on dependent variables in the second stage regression model are from 2008 to 2010 only, data of year 2007 are not included, and thus the sample size is reduced.

at the level of 1%, which means higher profitability provides strong financial support for R&D investment. SHRZ and R&D intensity have a significant positive correlation. Companies with CEO duality have higher R&D intensity, which implies that the CEO taking the position as chairman will exercise more influence and control over the enterprise, gain more resources and autonomy for innovation, which prompts him to exert his talent and entrepreneurship. Meanwhile, it facilitates the communication between management and shareholders to better formulate and implement its R&D strategy. This conclusion also provides new empirical evidence to "modern stewardship theory".

4.2.2. Regressions based on ownership classification

Based on the results in Table 8, this paper tests the interaction effects of government governance, executive networks and property rights respectively, which are shown in Table 9. In column 1, the interaction coefficient of government governance and property rights is significantly negative at the level of 5%, indicating that compared to state-owned enterprises, governance efficiency exerts greater impact on R&D investment in non-state-owned enterprises. As allocation of government resources between SOEs and non-SOEs is sequential, improvement of governance efficiency can effectively protect fairness, and its impact on corporate R&D investment in the non-state-owned enterprises is more obvious. Column 3 shows the interaction coefficient of executive networks and property rights is significantly negative at the level of 5%, i.e. compared

Table 11
Alternative government governance variables.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
CS		−0.0992			0.0281	
		(0.179)			(0.0580)	
FNET			−0.0862			0.0258
			(0.111)			(0.0364)
GOV1	0.187***	0.141**	0.132**			
	(0.0364)	(0.0559)	(0.0535)			
GOV1c				0.0500***	0.0317	0.0356
				(0.0146)	(0.0225)	(0.0217)
CS * GOV1		0.0194				
		(0.0195)				
CS * GOV1c					0.00673	
					(0.00725)	
FNET * GOV1			0.0148			
			(0.0121)			
FNET * GOV1c						0.00317
						(0.00453)
AGE	−0.0697***	−0.0725***	−0.0706***	−0.0696***	−0.0724***	−0.0703***
	(0.0103)	(0.0103)	(0.0103)	(0.0103)	(0.0103)	(0.0103)
LEV	0.397	0.429	0.417	0.380	0.418	0.404
	(0.289)	(0.289)	(0.288)	(0.289)	(0.289)	(0.289)
MB	0.0488***	0.0489***	0.0478***	0.0472***	0.0471***	0.0461***
	(0.0145)	(0.0145)	(0.0145)	(0.0145)	(0.0145)	(0.0145)
ROA	5.121***	5.127***	5.076***	5.236***	5.252***	5.202***
	(0.936)	(0.934)	(0.933)	(0.936)	(0.934)	(0.933)
SHRZ	0.0633	0.0669	0.0648	0.0631	0.0667	0.0647
	(0.0810)	(0.0808)	(0.0807)	(0.0810)	(0.0809)	(0.0808)
IIS	0.310	0.251	0.282	0.330	0.271	0.297
	(0.249)	(0.250)	(0.249)	(0.250)	(0.250)	(0.249)
SIZE	−0.0763	−0.115**	−0.110**	−0.0780*	−0.117**	−0.112**
	(0.0466)	(0.0479)	(0.0475)	(0.0466)	(0.0480)	(0.0476)
DCEO	0.187	0.217*	0.214*	0.204*	0.236**	0.233**
	(0.114)	(0.114)	(0.114)	(0.114)	(0.114)	(0.114)
Constant	−1.881*	−0.811	−0.863	−0.502	0.288	0.131
	(1.074)	(1.162)	(1.141)	(1.022)	(1.049)	(1.038)
YEAR	Controlled					
INDUSTRY	Controlled					
N	5899	5899	5899	5899	5899	5899
Chi^2	1501	1512	1513	1485	1496	1497
Pseudo-R^2	0.118	0.119	0.119	0.117	0.118	0.118

Standard errors are in brackets.
*** Statistical significance at the 1% level.
** Statistical significance at the 5% level.
* Statistical significance at the 10% level.

to state-owned enterprises, non-state-owned enterprises' executive networks have a more prominent impact on enhancing R&D investment, which suggests that non-state-owned enterprises with relatively scarcer resources will actively use informal institutional arrangements to ease pressure on resource constraints when resources cannot be effectively obtained through formal institutional arrangements.

4.3. Robustness tests

5.5.1. Endogenous executive networks

Companies' R&D expenditure is affected by information diffusion, and the role of information is usually hard to observe and quantify, so we deal with it as a noise. Moreover, enterprises with stronger technological innovation abilities and better external images are deemed to have more qualified management members, who

Table 12
Indirect effect of monopoly and bankruptcy risk.

Variables	(1)	(2)	(3)	(4)
CS	0.128***		0.0827***	
	(0.0246)		(0.0245)	
FNET		0.0630***		0.0530***
		(0.0150)		(0.0150)
Monopoly	−1.745***	−1.604***		
	(0.358)	(0.351)		
CS * Monopoly	−0.0924			
	(0.0947)			
FNET * Monopoly		−0.0938		
		(0.0641)		
Bankruptcy			−0.441*	−0.508**
			(0.246)	(0.240)
CS * Bankruptcy			−0.0237	
			(0.0772)	
FNET * Bankruptcy				0.0004
				(0.0472)
AGE	−0.107***	−0.103***	−0.0678***	−0.0656***
	(0.0102)	(0.0101)	(0.0104)	(0.0104)
LEV	−0.228	−0.264	0.559*	0.550*
	(0.287)	(0.287)	(0.298)	(0.298)
MB	0.0477***	0.0463***	0.0580***	0.0570***
	(0.0148)	(0.0148)	(0.0151)	(0.0151)
ROA	4.645***	4.605***	4.439***	4.383***
	(0.970)	(0.970)	(1.049)	(1.048)
SHRZ	0.126	0.123	0.0776	0.0764
	(0.0838)	(0.0838)	(0.0814)	(0.0813)
IIS	0.407	0.487*	0.223	0.253
	(0.257)	(0.257)	(0.251)	(0.251)
SIZE	−0.231***	−0.214***	−0.132***	−0.130***
	(0.0480)	(0.0478)	(0.0489)	(0.0486)
DCEO	0.452***	0.444***	0.265**	0.265**
	(0.118)	(0.118)	(0.114)	(0.114)
Constant	4.685***	4.338***	0.813	0.732
	(1.012)	(1.007)	(1.046)	(1.038)
YEAR	Controlled			
INDUSTRY	Controlled			
N	5899	5899	5866	5866
Chi^2	721.8	712.7	1491	1493
Pseudo-R^2	0.0569	0.0562	0.118	0.118

Standard errors are in brackets.
*** Statistical significance at the 1% level.
** Statistical significance at the 5% level.
* Statistical significance at the 10% level.

are more apt to be employed in other listed companies, leading to the formation of executive networks. For these reasons, there is inevitably an endogenous relationship between the random disturbance variables and the executive network variables. Therefore, in order to eliminate the impact of endogeneity, this paper selects the lagged data of executive networks (CS_{t-1}, $FNET_{t-1}$), companies cross-listed as B-shares or H-shares (CROSSLIST, cross-listed is valued 1, 0 otherwise) and the scale of executives in listed companies (NM) as instrumental variables, and uses Tobit models to conduct two-stage regressions. The regression results are consistent with the above ones, and the indicator detecting endogeneity chi^2_exog[9] does not reject the null hypothesis. Namely, the instrumental variables effectively eliminate endogeneity (Table 10).

[9] In STATA software, the null hypothesis of indicator "chi^2_exog" is: instrumental variables are exogenous, "p_exog" refers to "p-value" of this indicator.

Table 13
Regression results after excluding monopoly companies.

Variables	(1)	(2)
CS	0.183***	
	(0.0416)	
FNET		0.117***
		(0.0246)
STATE	0.362**	0.513***
	(0.158)	(0.152)
CS * STATE	−0.0939*	
	(0.0502)	
FNET * STATE		−0.0934***
		(0.0302)
AGE	−0.115***	−0.111***
	(0.0104)	(0.0103)
LEV	−0.0770	−0.131
	(0.291)	(0.290)
MB	0.0534***	0.0522***
	(0.0150)	(0.0150)
ROA	4.906***	4.884***
	(0.991)	(0.991)
SHRZ	0.160*	0.163*
	(0.0873)	(0.0871)
IIS	0.316	0.387
	(0.262)	(0.261)
SIZE	−0.316***	−0.297***
	(0.0494)	(0.0492)
DCEO	0.501***	0.495***
	(0.121)	(0.121)
Constant	−1.944***	−1.912***
	(0.160)	(0.160)
YEAR	Controlled	
INDUSTRY	Controlled	
N	5728	5728
Chi^2	1489***	1495***
Pseudo-R^2	0.117	0.118

Standard errors are in brackets.
*** Statistical significance at the 1% level.
** Statistical significance at the 5% level.
* Statistical significance at the 10% level.

4.3.2. Alternative variables and sample segments

Given a large quantity of indicators of local governance level and efficiency, this paper attempts to introduce two sub-indexes "1 relationship between government and the market" and "1c reducing government intervention in companies" as proxy variables for the levels of governance (see Table 11). The basic conclusions are not affected.

State-owned enterprises have a relatively small bankruptcy risk and can survive without innovation; therefore, they lack the motivation for technological innovation. Among them, consensus on correlation between monopolized industries and technological innovation has not been reached yet and is to be tested. Therefore, Tables 12 and 13 test the relationship from perspectives of the nature of corporate monopoly and bankruptcy risk. Referring to Qiu et al.'s (2010) definition, we add a dummy variable "monopoly or not (Monopoly)" to the regression model and take into consideration the impact of CS * Monopoly (FNET * Monopoly). Regarding bankruptcy risk, although this article has excluded observations labeled with ST or PT that year, to be safe, we refer to Altman's (1968) definition on "bankruptcy Z value" and add a dummy variable "bankruptcy or not (Bankruptcy)" to the regression model and take into consideration the interaction effect (CS * Bankruptcy, FNET * Bankruptcy). The results show that there is no significant

Table 14
Test of control variables in high-tech innovative companies.

Variables	(1)	(2)	(3)	(4)	(5)
CS	0.0852***			0.0202	
	(0.0230)			(0.103)	
FNET		0.0489***			0.0380
		(0.0140)			(0.0652)
GOV			0.0677***	0.0461	0.0583*
			(0.0226)	(0.0360)	(0.0347)
CS * GOV				0.00685	
				(0.0112)	
FNET * GOV					0.000838
					(0.00695)
Innovative	1.300***	1.288***	1.265***	1.273***	1.261***
	(0.0991)	(0.0990)	(0.0995)	(0.0994)	(0.0993)
AGE	−0.0593***	−0.0573***	−0.0553***	−0.0581***	−0.0559***
	(0.0102)	(0.0102)	(0.0102)	(0.0102)	(0.0102)
LEV	0.225	0.212	0.218	0.253	0.239
	(0.284)	(0.284)	(0.284)	(0.284)	(0.284)
MB	0.0470***	0.0459***	0.0481***	0.0480***	0.0470***
	(0.0142)	(0.0142)	(0.0142)	(0.0142)	(0.0142)
ROA	4.466***	4.447***	4.350***	4.356***	4.333***
	(0.918)	(0.917)	(0.920)	(0.917)	(0.917)
SHRZ	0.0267	0.0257	0.0199	0.0241	0.0222
	(0.0793)	(0.0793)	(0.0794)	(0.0793)	(0.0792)
IIS	0.139	0.179	0.227	0.157	0.193
	(0.245)	(0.244)	(0.244)	(0.245)	(0.244)
SIZE	−0.0663	−0.0592	−0.0309	−0.0709	−0.0622
	(0.0472)	(0.0469)	(0.0459)	(0.0472)	(0.0469)
DCEO	0.196*	0.194*	0.129	0.161	0.156
	(0.111)	(0.111)	(0.112)	(0.112)	(0.112)
Constant	−0.812	−0.972	−2.057**	−1.190	−1.486
	(1.017)	(1.011)	(1.019)	(1.072)	(1.053)
YEAR	Controlled				
INDUSTRY	Controlled				
N	5899	5899	5899	5899	5899
Chi^2	1657	1655	1652	1665	1662
Pseudo-R^2	0.131	0.130	0.130	0.131	0.131

Standard errors are in brackets.
*** Statistical significance at the 1% level.
** Statistical significance at the 5% level.
* Statistical significance at the 10% level.

correlation between executive networks and Monopoly or executive networks and Bankruptcy, indicating that monopoly industries and bankruptcy risk have no effect on the network. Thus, the basic conclusions remain unaffected.

Moreover, considering the relatively high R&D expenditure of high-tech innovation enterprises, Table 14 identifies "high-tech innovation enterprises" according to RESSET database's definition standards[10] and then introduces a dummy variable "Innovative" in the regression as a control variable (high-tech innovation enterprises are valued 1, 0 otherwise). The conclusions remain consistent.

Regions with high efficiency are often economically developed and local governments tend to provide more financial support for technological innovation of enterprises. Therefore, in order to testify that the positive

[10] In RESSET database, enterprises are divided into seven categories: 1. High-tech enterprises; 2. Tech enterprises; 3. Torch Plan; 4. 863 plan; 5. Agricultural industrialized key state enterprises; 6. Innovative enterprise; 7. Key software enterprises within state planning. This paper identifies all these types as high-tech innovative enterprises except category 5.

Table 15
Instrumental variables of government's science and technology expenditure.

Variables	(1)	(2)	(3)
GOV	0.0173***	0.0179***	0.0265***
	(0.0066)	(0.0062)	(0.0062)
CS	0.118***		
	(0.0394)		
FNET		0.0818***	
		(0.0249)	
CS * GOV	−0.00232		
	(0.0017)		
FNET * GOV		−0.00165*	
		(0.0010)	
STATE			0.690***
			(0.166)
GOV * STATE			−0.0236***
			(0.0070)
AGE	−0.0693***	−0.0673***	−0.0663***
	(0.0104)	(0.0104)	(0.0106)
LEV	0.458	0.450	0.384
	(0.290)	(0.290)	(0.290)
MB	0.0458***	0.0443***	0.0477***
	(0.0145)	(0.0145)	(0.0145)
ROA	5.235***	5.237***	5.457***
	(0.934)	(0.933)	(0.944)
SHRZ	0.0651	0.0640	0.0921
	(0.0809)	(0.0809)	(0.0826)
IIS	0.282	0.314	0.328
	(0.250)	(0.250)	(0.250)
SIZE	−0.120**	−0.120**	−0.104**
	(0.0480)	(0.0476)	(0.0476)
DCEO	0.216*	0.217*	0.213*
	(0.115)	(0.115)	(0.116)
Constant	0.130	0.0882	−0.351
	(1.046)	(1.031)	(1.037)
YEAR	Controlled		
INDUSTRY	Controlled		
N	5899	5899	5899
Chi^2	1148***	1150***	1148***
chi^2_exog	2.435	2.659	3.675
p_exog	0.119	0.103	0.0552

Standard errors are in brackets.
*** Statistical significance at the 1% level.
** Statistical significance at the 5% level.
* Statistical significance at the 10% level.

impact on enterprises' technological innovation activities originates from local governance efficiency rather than financial support, we introduce annual S&T financial expenditure data of provincial governments from the Zhonghong Database (FISCAL) as an instrumental variable of government governance. The test results remain robust (see Table 15).

4.3.3. Alternative regression methods

In order to avoid sample selection bias, we use a Tobit model in our empirical testing and regard corporate R&D expenditure as zero when there is no relevant data disclosure. However, the number of observations available accounts for about 1/3 of the total sample number, so when doing the robustness test, we consider applying OLS regression models to test this sub-sample. The test results are shown in Table 16. Size of executive networks and R&D intensity are significantly positively correlated at the level of 1%, which is consistent

Table 16
OLS regression results.

Variables	(1)	(2)	(3)	(4)	(5)
GOV	0.00599**			0.00593	0.00695*
	(0.0026)			(0.0042)	(0.0039)
CS		0.0377*		0.0485	
		(0.0204)		(0.0301)	
FNET			0.0382***		0.0447**
			(0.0127)		(0.0194)
GOV * CS				0.000609	
				(0.0012)	
GOV * FNET					0.000499
					(0.0007)
AGE	−0.0804***	−0.0826***	−0.0813***	−0.0937***	−0.0916***
	(0.0094)	(0.0094)	(0.0093)	(0.0091)	(0.0089)
LEV	−0.308	−0.313	−0.308	−0.477*	−0.483*
	(0.277)	(0.277)	(0.277)	(0.271)	(0.270)
MB	0.0459***	0.0461***	0.0454***	0.0426***	0.0413***
	(0.0142)	(0.0143)	(0.0143)	(0.0145)	(0.0145)
ROA	6.971***	7.040***	7.050***	6.137***	6.133***
	(0.868)	(0.870)	(0.869)	(0.863)	(0.860)
SHRZ	0.277***	0.280***	0.278***	0.271***	0.267***
	(0.0773)	(0.0774)	(0.0774)	(0.0786)	(0.0786)
IIS	0.124	0.0589	0.0673	0.0519	0.0769
	(0.229)	(0.229)	(0.229)	(0.235)	(0.235)
SIZE	−0.220***	−0.237***	−0.248***	−0.263***	−0.268***
	(0.0458)	(0.0463)	(0.0462)	(0.0455)	(0.0451)
DCEO	0.333***	0.374***	0.382***	0.472***	0.477***
	(0.122)	(0.121)	(0.120)	(0.126)	(0.125)
Constant	6.176***	6.685***	6.850***	7.782***	7.815***
	(0.977)	(0.977)	(0.974)	(0.977)	(0.957)
YEAR	Controlled				
INDUSTRY	Controlled				
N	1750	1750	1750	1750	1750
F value	23.45	22.77	23.05	33.98	34.67
Adjusted-R^2	0.299	0.298	0.300	0.243	0.245

Standard errors are in brackets.
*** Statistical significance at the 1% level.
** Statistical significance at the 5% level.
* Statistical significance at the 10% level.

with our previous conclusions; governance quality and R&D intensity are significantly positively correlated at the level of 5%. Thus, the conclusions still support the above hypotheses.

5. Conclusion

In the competitive context of accelerated integration of the global economy, enterprises increasingly rely on innovation ability to survive and develop. R&D as a crucial form of firm innovation is critical in continuously improving and maintaining the enterprises' and even the country's competitive advantage. However, R&D activity is full of uncertainty and risk. On the one hand, the huge R&D investment and the high uncertainty of the market and technology are formidable. On the other hand, enterprises have to invest in R&D to gain market opportunities and high profits under the pressure of competition. Therefore, it is necessary to acquire resources to provide funds for corporate R&D activities and effectively reduce the risk. Based on the institutional arrangements perspective, this paper uses listed companies' data from 2007 to 2010 and finds that both informal and formal institutional arrangements can supply resources to corporate R&D activities, thereby verifying that executive network size and the efficiency of government governance are vital factors

influencing R&D decision-making. Informal institutional arrangements are an effective supplement for an imperfect formal system. They can improve the ineffectiveness of an imperfect formal system. The difference is that companies get more technical information through executive networks, but more policy and funding support from government.

Meanwhile, further research also shows that, compared to non-state-owned enterprises, government governance and executive networks have a weaker effect on the R&D expenditures of state-owned enterprises. Compared to non-board-listed companies, government governance (executive networks) has a stronger (weaker) effect on the R&D expenditures of board-listed enterprises. The findings show that long-standing monopoly and scale advantages have formed state-owned enterprises' technical dominance to a certain extent; thus, they place less emphasis on the external environment and external networks than private enterprises. Similarly, due to its size, industry characteristics and other factors, enterprises in small and medium sectors are subject to stricter management by regulatory agencies, and therefore their motivation for building an executive network is more intense.

The limitations of this paper lie in the data and market process index. The workload of data collection and selection is enormous, and updating of the data is still continuing. In 2012, our country embarked on a comprehensive and deepening national reform, which may have an impact on our original data. But given the timing effect, our results suffered limited impact. Of course, influenced by reform, changes and impacts of future government governance and executive networks should be more interesting topics. Meanwhile, there lies a certain degree of error in employing the overall market process index as a proxy for local governance efficiency. So we chose many more alternative indicators to substitute for this proxy, but pinning down a relatively precise indicator of local government governance remains a key issue.

Acknowledgments

This study was sponsored by Humanity and Social Science Youth foundation of Ministry of Education of China (15YJC790137), Innovation Program of China Shanghai Municipal Education Commission (13YS117). National Natural Science Foundation of China for Young Scholars (71402169). Social Science Fund of China Zhejiang Province (14NDJC166YB). Natural Science Foundation of China Zhejiang Province (LQ14G020009).

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