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AN ANALYSIS OF THE EFFECTS OF THE PROBABILITY OF INFORMED TRADING (PIN) ON CORPORATE DIVERSIFICATION DISCOUNT AND CEO PAY-PERFORMANCE SENSITIVITY: EVIDENCE FROM CHINA

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MPHIL

LINGNAN UNIVERSITY

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by

JIN Man

A thesis submitted in partial fulfillment

of the requirements of the Degree of

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ABSTRACT

An analysis of the effects of the probability of informed

trading (PIN) on corporate diversification discount

and CEO pay-performance sensitivity:

Evidence from China

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Master of Philosophy

This thesis includes estimating the probability of informed trading, PIN, developed by Easley, Kiefer and O'Hara (1996, 1997a, 1997b), for a large sample of listed firms in China from 2002 to 2008, and I use PIN to explore two independent research questions in corporate finance.

First, the probability of informed trading is applied to explain the discount in value for firms with diversified business operations. Although aiming to increase firm value, the corporate diversification decision usually results in a firm value discount, for a variety of reasons, one of which is the transparency problem. My study directly tests the relation between the information asymmetry revealed from the stock market and the firm value discount due to diversification decision. The results show that the corporate diversification decisions result in a lower firm value in China, mainly because the diversified firms suffer from a higher level of information asymmetry or a lower level of transparency. After controlling for the measure of information asymmetry, the strategy of diversification itself does not reduce firm value.

Second, the probability of informed trading is applied to explain the pay-performance sensitivity of CEO compensation in Chinese listed firms. The pay-performance sensitivity measures the change in managerial compensation based on the change in shareholder wealth. A higher information asymmetry helps and encourages shareholders to spend more on incentivizing the management team. My results show that higher level information asymmetry is associated with higher pay-performance sensitivity of CEOs in China. The result also holds if information asymmetry is approximated by analysts' forecast errors.

According to the estimates of PIN in this thesis, Chinese firms are shown to exhibit a higher level of information asymmetry than what has been found in the U.S. market. The thesis ends with a brief discussion of the results and what future research could follow.

DECLARATION

I declare that this is an original work based primarily on my own research, and I warrant that all citations of previous research, published or unpublished, have been duly acknowledged.

(JIN Man)

July 31, 2011

CERTIFICATE OF APPROVAL OF THESIS

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An analysis of the effects of the probability of informed trading (PIN) on corporate diversification discount and CEO pay-performance sensitivity: Evidence from China

Chapter 1. Introduction

Information asymmetry is a core concept in economic and financial theory and is a key concept of the risk and uncertainty faced by investors in all of the world's financial markets. However, information asymmetry is unobservable and, until recently, there has been no satisfactory proxy of it. In a series of paper in the 1990s, Easley et al. (1996, 1997a, 1997b) developed a new approach to measure information asymmetry based on market price data that is called the *probability of informed trading* (PIN). PIN is now well accepted and has been applied to various research studies on the stock markets in the U.S. (e.g., Easley et al., 1998; Easley et al., 2002; Vega, 2006; Yan and Zhang, 2010), in Europe (e.g., Borisova and Yadav, 2008), in Hong Kong (e.g., Cai et al., 2006; Wong et al., 2008), and in Taiwan (e.g., Lu and Wong, 2008). In this study, I extend the research on the probability of informed trading to China's stock markets and investigate the informational role on two individual topics; they are: the effect of information asymmetry on the diversification discount and the effect of information asymmetry on managerial incentives. Although, previous researches have estimated the PIN in China (e.g., Chan et al., 2008; Copeland et al., 2009), they focus on certain time periods or on a single stock exchange. I use high frequency data and estimate PIN for 1,762 firms including both A-shares and B-shares listed on the Shanghai Stock Exchange (SHSE

hereafter) and the Shenzhen Stock Exchange (SZSE hereafter) for seven years from 2002 to 2008.

With PIN as a proxy of information asymmetry, I perform two independent research studies to evaluate the informational role of stock prices in China: the effect of information asymmetry on the diversification discount and the effect of information asymmetry on managerial incentives. For the first research study presented in Chapter 3, I test the relation between information asymmetry and firm diversification and find that diversified firms have higher information asymmetry than focused firms. Furthermore, the lack of transparency directly leads diversified firms to be valued less by the investors when compared with non-diversified firms. Consequently, information asymmetry is responsible for the diversification discount in China. For the second research study presented in Chapter 4, I investigate the effect of PIN on managerial incentives based on the analysis of Holmstrom and Tirole (1993). The results support the important role of information on the executive compensation contract, and show that a higher CEO's pay-performance sensitivity is shown to be related with higher PIN. After controlling for endogeneity, the relation between the level of information asymmetry and managerial pay-performance sensitivity is still significantly positive.

My studies use data from China's stock markets while the literature starts from tests applied to the U.S. data. The case of China is potentially more interesting, because the Chinese markets have a number of features which make them different from the matured financial markets. Previous studies (e.g., Copeland et al., 2009) suggest that information asymmetry is more serious in transition markets, such as in China, than in developed markets, for a variety of reasons. First, the Chinese stock markets are dominated by individual investors, who are in the disadvantaged position

in obtaining and processing information compared to institutional investors. In the U.S., stock markets are largely influenced by institutional investors. Secondly, the market mechanism adopted by the Chinese stock exchanges, including the lunch break, short sales constraints and daily price limits, might hinder information from being revealed and slow down the price discovery process. Thirdly, the corporate structure of Chinese listed firms also makes them different from those in the developed economies. All of China's listed firms have a controlling or major shareholder, who is often the regional or the central government. Government control and the political connection between the firms and the state might affect the firm's level of information asymmetry and other corporate decisions, including the diversification decision and managerial compensation. Hence, I explicitly evaluate the effects of governmental influence and find it does play a significant role.

The rest of my thesis is organized as follows. Chapter 2 contains a brief overview of the Chinese stock markets. Chapter 3 and Chapter 4 are two independent chapters investigating the two different research questions. Chapter 3 presents the analysis on the role of information asymmetry on the diversification discount. Chapter 4 discusses the effect of stock price informativeness on managerial incentives. Chapter 5 summarizes the main findings of the paper.

References

Borisova, Ginka, and Pradeep K. Yadav. 2008. How does Privatization affect Information Asymmetry? Evidence from the European Union. Working Paper, Iowa State University and Oklahoma University

Cai, Jinghan, Yuming Li, and Le Xia. 2006. Liquidity, Information Asymmetry and Short Sales Constraints: Evidence from the Hong Kong Stock Market. Working Paper, California State University and University of Hong Kong.

Chan, K.L, Albert J. Menkveld, and Zhishu Yang. 2008. Information Asymmetry and Asset Prices: Evidence from the China Foreign Share Discount. *The Journal of* Finance 63, no. 1: 159-196.

Copeland, Laurence, Woon K. Wong, and Yong Zeng. 2009. Information-based trade in the Shanghai stock market. *Global Finance Journal* 20, no. 2: 180-190.

Easley, David, Soeren Hvidkjaer, and Maureen O'Hara. 2002. Is Information Risk a Determinant of Asset Returns? *The Journal of Finance* 57, no. 5: 2185-2221.

Easley, David, Nicholas M. Kiefer, and Maureen O'Hara. 1996. Cream-Skimming or Profit-Sharing? The Curious Role of Purchased Order Flow. *Journal of Finance* 51, no. 3: 811-33.

Easley, David, Nicholas M. Kiefer, and Maureen O'Hara. 1997a. The information content of the trading process. *Journal of Empirical Finance* 4, no. 2-3: 159-186.

Easley, David, Nicholas M., Kiefer, and Maureen O'Hara. 1997b. One day in the life of a very common stock. *Review of Financial Studies* 10, no. 3: 805 -835.

Easley, David, Maureen O'Hara, and Joseph Paperman. 1998. Financial analysts and information-based trade. *Journal of Financial Markets* 1, no. 2: 175-201.

Holmström, Bengt, and Jean Tirole. 1993. Market Liquidity and Performance Monitoring. *The Journal of Political Economy* 101, no. 4: 678-709.

Lu, Ralph C., and Woon K. Wong. 2008. Probability of Information-Based Trading as a Pricing Factor in Taiwan Stock Market. Working Paper, Ming Chuan University and Tamkang University.

Vega, Clara, 2006, Stock Price Reaction to Public and Private Information. *Journal of Financial Economics* 83, no. 1: 103-133.

Wong, Jun, Steven X. Wei, and Bohui Zhang. 2008. Short Sale Constraints and Price Informativeness. Working Paper, Hong Kong Polytechnic University and The University of New South Wales.

Yan, Yuxing, and Shaojun Zhang. 2010. An Improved Estimation Method and Empirical Properties of the Probability of Informed Trading. Working Paper, University of Pennsylvania and Nanyang Technological University.

Chapter 2. Overview of China's stock market

There are two stock exchanges operating independently in mainland China, the Shanghai Stock Exchange (SHSE hereafter) and the Shenzhen Stock Exchange (SZSE hereafter), which were established respectively in December 1990 and July 1991. Two categories of stocks are listed and traded on SHSE and SZSE: A-shares and B-shares. A-shares are traded in the local Renminbi Yuan (RMB hereafter) currency, while B-shares are traded in U.S. dollars in SHSE and in Hong Kong dollars in SZSE. Initially, trading in A-shares is restricted to Chinese citizens only while B-shares are available to both the domestic (since 2001) and foreign investors. Since December 2002, foreign investors are allowed (with limitations) to trade the A-shares under the Qualified Foreign Institutional Investor (QFII) program[1]. The majority of A-shares are issued by State Owned Enterprises (SOE hereafter), whose share ownership can be classified as: (1) state shares, held by the government through a designated government agency; (2) legal shares, held by legal entities, such as enterprises and other economic entities, but not individuals; and (3) public shares, traded by individuals. B-shares are all ordinary shares and the owners of B-shares have the same voting rights and dividends as the owners of A-shares.

The two stock exchanges have grown rapidly since trading started in 1990. By the end of 2010, the SHSE had become the fifth largest stock exchange in the world with 900 listed companies. The SHSE and SZSE together list more than 2,000 companies with a combined market capitalization of US$4.0 trillion (2010), which exceeds the market capitalization of the Tokyo Stock Exchange (US$3.7 trillion). China's stock market is now the second largest market in the world. More and more

[1]The QFII program was officially launched in 2003.

international investors are turning to China because of its abundant business opportunities. Concomitantly, there has been a big increase in the demand for research on China's financial markets and listed companies.

Table 1 presents some statistics obtained from the webpage of the two stock exchanges in China from 2002 to 2008. The number of listed companies has grown steadily over the years. From 2002 to 2005, the market price declined slightly. This was followed by a bull market run in 2006 and 2007 where stock prices surged threefold. Starting in 2008, market prices dropped.

[TABLE 1 HERE]

The SHSE and SZSE in China are purely order-driven markets without marketmakers. Both of them run electronic automated trading systems, which are open from Monday to Friday. The trading day begins with centralized competitive pricing in call auctions from 09:15 am to 09:25 am and continues with consecutive bidding from 09:30 am to 11:30 am. After a lunch break of one and a half hours, the consecutive trading in the afternoon session starts from 13:00 and finishes at 15:00. As regards to market transparency, the best five bid and ask prices and corresponding depths of the book are revealed continuously to the public investors. The minimum price variation unit is 0.01 RMB and the minimum trading quantity is one lot of 100 shares. A call auction is conducted in the first session from 09:15 am to 09:25 am to generate opening prices. The open call auction is then followed by continuous double auctions, where submitted buy and sell limit orders are matched through the price and time priority rules, and trades take place when orders are matched. Unless cancelled, the unmatched orders remain in the order queues in the limit order book until the market closes.

Most trading accounts in the SHSE and SZSE belong to individual investors. In China, as shown in Ng and Wu (2007), only the trading activities of institutions and of a small group of wealthiest individuals can affect future stock volatility, while those of ordinary individual investors at large can not. In order to protect the retail investors from extreme and adverse price movements, short sales are prohibited, and a daily price limit of 10% is imposed on the fluctuations of stock price from the previous day's closing price. However, short sale constraints and daily price limits can prevent information from being fully revealed. According to Wong et al. (2008), informed traders with negative news tend to use short sales. They show that in the Hong Kong stock market, the level of informed trades based on negative news is lower when the stocks are not allowed to be short sold. In other words, the short sale constraints tend to hinder negative information from being fully incorporated into prices. The event study of Cai et al. (2006) also shows that after the removal of the short sale constraints in Hong Kong, there are more informed trades in the stock market. The price limit rule is also found to reduce information efficiency in China (Wong et al., 2009), as the bid-ask spread is wider when the stock price approaches to the floor limits than in the normal market condition. They conjecture that this is due to the panic selling activities of uninformed investors when a stock price falls towards its floor limit.

Many listed firms in China are controlled or owned by the government. This state ownership of shares might impact managerial incentives and intensify the conflicts between management and investors due to political connections. In firms controlled by private blockholders, a CEO's pay is more sensitive to the change in stockholders' wealth when compared to that in firms controlled by a state agency (Firth et al., 2006). Moreover, firms ultimately owned by the government are less

likely to diversify and perform worse than those owned by private blockholders (Lin and Su, 2008).

China's financial markets are growing very fast. The introduction of new products, especially the exchange-traded index derivatives, and the revisions and development of financial regulations will surely attract the attentions of more and more market practitioners and academic researcher around the world. I believe my thesis makes a good contribution to the literature and has a resonance for other emerging markets that are transiting from state control to a market based economy.

References

Cai, Jinghan, Yuming Li, and Le Xia. 2006. Liquidity, Information Asymmetry and Short Sales Constraints: Evidence from the Hong Kong Stock Market. Working Paper, California State University and University of Hong Kong.

Firth, Michael, Peter M.Y. Fung, and Oliver M. Rui. 2006. Corporate performance and CEO compensation in China. *Journal of Corporate Finance* 12, no. 4: 693-714.

Lin, Chen, and Dongwei Su. 2008. Industrial diversification, partial privatization and firm valuation: Evidence from publicly listed firms in China. *Journal of Corporate Finance* 14, no. 4: 405-417.

Ng, Lilian, and Fei Wu. 2007. The trading behavior of institutions and individuals in Chinese equity markets. *Journal of Banking & Finance 31*, no. 9: 2695-2710.

Wong, Jun, Steven X. Wei, and Bohui Zhang. 2008. Short Sale Constraints and Price Informativeness. Working Paper, Hong Kong Polytechnic University and The University of New South Wales.

Wong, W.K, Bo Liu, and Yong Zeng. 2009. Can price limits help when the price is falling? Evidence from transaction data on the Shanghai Stock Exchange. *China Economic Review*, no. 1:91-102.

Chapter 3. Information asymmetry and the diversification discount: evidence from listed firms in China

3.1 Introduction

Diversification (multi-segment) is a form of corporate strategy for a company, which seeks to increase profitability through greater sales volume obtained from new product lines and new markets. However, an extensive literature from the U.S. has shown that, on average, diversification is a value-decreasing activity and firms with multi-segment businesses sell at a discount to non-diversified firms[2] (e.g. Myers and Majluf, 1984; Scharfstein, 1998; Jensen, 1986; Gilson et al., 2001). Previous studies have examined differences in firm characteristics such as the size, profitability and leverage to help explain the different valuation of the diversified firms and focused firms. There is less empirical evidence on why this discount exists. One possible explanation for a discount is that corporate diversification is associated with a higher level of asymmetric information due to the decrease of transparency (Hadlock et al., 2001). I extend previous research by examining the relation between diversification discount and the level of information asymmetry for the firms listed in China's stock market. I argue that the accounting figures for diversified firms are less transparent and less informative than those for focused firms because of the aggregated nature of diversified firms' consolidated accounting reports. Thus, investors tend to give lower valuation to diversified firms.

[2] There is an active debate on how diversification affects firm value in pervious literatures. Some support that diversification is value-destroying and will lead to a loss of firm value, particularly for the firms in the U.S.. In contrast, some argue that diversification is a value-enhancing activity. Lin and Su (2008) suggest that diversified firms have significantly higher Tobin's q than non-diversified firms in China, and the valuation of diversification depends on government control. I will explicitly describe the arguments of both sides in the coming literature review part and explain why I believe there is a diversification discount in China in the part of empirical analysis.

This chapter aims to answer the question of whether corporate diversification directly causes firm value discounts or does it lead to discounts indirectly through influencing the firm's level of information asymmetry, using data from Chinese listed firms. I expect that increased information asymmetry in multi-segment firms is responsible for the diversification discount.

Prior empirical evidence shows that diversification activity can profoundly affect firm value, but has shed less light on how this happened. Thomas (2002) claims that diversified firms are subject to larger asymmetric information problems and lower transparency than non-diversified firms. Thomas and Fee (2000) using data from the U.S. show that diversified firms with high levels of information asymmetry trade at a significant discount to firm value. Therefore, I directly examine the characteristics of diversified firms, especially the level of information asymmetry and its effects on the firm value discount in China. My study differs from Thomas (2002) and Thomas and Fee (2000) in that, for the first time, I apply the effect of information asymmetry on diversification discount to firms listed in China over a long time period and for a large sample size.

China offers a unique economic and financial environment to address this issue. First of all, China's financial market are less fully developed and largely segmented from the rest of the world. Lin and Su (2008) suggest China's financial market is characterized by a lack of reliable information and a high degree of information asymmetry. In addition, the Chinese government retains a lot of direct control over large firms. In particular, most listed firms in China have a controlling shareholder, who is the central or regional government. This political influence will have repercussions for a firm's strategies including diversification and new product development. Accordingly, I first examine whether the diversified firms trade a

lower price or price-multiple than non-diversified firms in China. Second, if a diversification discount exists, I will investigate if this is due to information asymmetry.

In this paper, I use the probability of informed trading (PIN)[3] as the proxy for information asymmetry and use Tobin's Q as the proxy of firm value. To measure the level of diversification, I adopt the dummy variable (DIV) and sales-based Herfindahl index (HI). By comparing the mean differences in Tobin's Q between diversified firms and non-diversified firms, I find that diversified firms are valued less by the market compared with focused firms. The regression results indicate that diversified firms have more severe information asymmetry problems after controlling for the differences in other firm characteristics. Furthermore, I confirm a significant relation between information asymmetry and the diversification discount, indicating that information asymmetry can explain the loss of firm value for conglomerates. The results remain significant in my robustness tests when an alternative econometric model is applied. Other features of diversified firms are also found in this paper, in particular, diversified firms, on average, have smaller firm size, lower stock price volatility, lower growth of assets, lower return on assets, lower state ownership, lower institutional ownership and lower ownership concentration, but have longer firm listing history when compared with individual focused firms.

The rest of this chapter proceeds as follows. In Section 2, I introduce the background literature. In Section 3, I describe the data sample and the variables. Section 4 shows some preliminary results and analysis on diversified firms. Section 5 provides the main results. Section 6 includes robustness test. Section 7 concludes with a summary of the findings.

[3] The PIN estimates will be explicitly introduced in the following section.

3.2 Literature review

There is an active debate on how diversification affects firm value. One argument is that conglomerates create value for the company. Firstly, diversification can be a source of extra value resulting from the increase of the firm's debt capacity (Lewellen, 1971) and the decrease of the variation in cash flow (Amit and Livnat, 1988). Secondly, diversified firms have higher efficiency in resource allocation through the internal capital markets (Weston, 1969; Williamson, 1983). Thirdly, diversification may create shareholder value by mitigating risks in product, labor and financial markets (Amihud and Lev, 1981; Martin and Sayrak, 2003). Finally, diversification is also beneficial in terms of economies of scope (Panzar and Willig, 1981; Teece, 1980; Teece 1982). The above theories are supported by empirical evidence. Villalonga (2004) finds that the diversified firms in the U.S. trade at a significant premium using census data at the establishment level.

On the other hand, some researchers claim that the diversification is value-destroying due to inefficient internal capital markets (Scharfstein, 1998; Scharfstein and Stein, 2000; Rajan, Servaes and Zingales, 2000), increased agency problems (Jensen, 1986), information asymmetry between the managers and outside investors (Myers and Majluf, 1984), and a lack of financial analysts' specialization in conglomerates (Gilson et al., 2001). Early empirical studies support the diversification discount theory using samples from all over the world. Lang and Stulz (1994) and Berger and Ofek (1995) find a valuation discount for U.S diversified companies. Lins and Servaes (1999, 2002) find a significant discount for diversified firms in Japan, the United Kingdom and a number of East Asian countries. In China, Zhang et al. (2005) and Hong et al. (2006) find that the diversified firms have lower

stock market valuations than focused firms and the loss of firm value becomes more severe after controlling for the endogeneity problem.

A large academic literature has explored extensively the information asymmetry revealed from the trading actions of investors. On one hand, some research focuses on the determinants of the asymmetric information theoretically and empirically (e.g., Easley et al., 1998; Aslan et al., 2008; Bardong et al., 2009). In summary, information asymmetry measures in the U.S. are shown to be significantly and positively related with trading volumes, return on assets and negatively related with firm size, firm age and Tobin's Q. The estimated PINs are also shown to be higher for firms in the industries of Oil and Petroleum Products, Construction, Textiles and Retail in the U.S. market (Aslan et al., 2008). In a search for the factors leading to information asymmetry, other research focuses on some particular firm-specific factors. Also for the U.S. market, Brown et al. (2009) find that information asymmetry decreases (increases) immediately following positive (negative) earnings surprises. Borisova and Yadav (2010) apply the measures of information asymmetry to firms in European Union and find that firms in which the government still retains a stake after privatization exhibit a lower level of information asymmetry than do the fully privatized peer firms.

Another stream of the literature applies informed trading to asset pricing. Easley et al. (2002) considers the effect of information asymmetry on a stock's required returns and find that stocks in the U.S. market with higher PINs consistently generate higher excess returns than those with lower PINs. The price risk of information asymmetry is also tested for stocks traded in China. Chan et al. (2008) show that the measures of information asymmetry explain a significant portion of the cross-sectional variation in the foreign share discounts. Therefore, foreign investors

demand a higher rate of return as compensation for bearing a higher information risk when investing stocks in China. Extending research on U.S. stocks to the A-shares traded on the SHSE, Copeland et al. (2009) find that the PINs significantly explain the returns even after controlling for the Fama-French (1992) three factors[4].

Some previous literature also has directly tested the relationship between information asymmetry and diversification. Krishnaswami and Subramaniam (1999) find that firms that engage in spin-offs have a higher level of information asymmetry compared with their industry- and size-matched counterparts. Thomas (2002) examines the relation between corporate diversification and information asymmetry using analyst's forecasts and abnormal returns associated with earnings announcement as proxies of asymmetric information. He finds that greater diversification is not associated with increased asymmetric information in the U.S. market. Clarke et al. (2004) conclude that there are potential information benefits of diversification since asymmetric information regarding each segment's performance is diversified away across segments. They also provide empirical evidence in the U.S. supporting the notion that the level of information asymmetry reduces after diversification. Although there is no evidence of a positive relation between diversification and asymmetric information in Thomas and Fee (2000), it suggests that diversified firms with high levels of information asymmetry trade at a significant discount to firm value. I extend previous research by examining the relation between the diversification discount and the level of information asymmetry in China.

[4] A similar study of Lu and Wong (2008) finds that information risk is priced for the stocks traded on theTaiwan stock exchange.

3.3 Data and variables

This section introduces the data selection as well as the methodology that I employ to construct the estimates of diversification, the measures of information asymmetry and the control variables.

3.3.1 Data

A firm is required to disclose the results of its individual business segments if any segment contributes 10% or greater of total sales. Following Lin and Su (2008), firms with two or more segments are considered to be diversified or multi-segment firms. Firms, for which one segment accounts for more than 90% of sales, are undiversified or single-segment firms. The accounting information, industrial sector data and stock returns data are from the Wind Financial Database (WindDB) and the China Stock Market and Accounting Research (CSMAR) database.

The intraday data used to estimate PIN are extracted from the high frequency database of SinoFin, and consist of all time-stamped trades and quotes from January 2002 to December 2008 for A-(local) and B-(foreign) shares traded on the SHSE and SZSE in China. Following Chan et al. (2008), I exclude the days when trading was halted (i.e. when shares reach the price limit of a 10% change with respect to the previous day's close price), and those trading days with less than 100 transactions, and I exclude the first and last fifteen minutes of each trading session during the day. Following Easley et al. (2002), we require a minimum of 60 trading days in one year.

The sample of annual PIN estimates initially includes 1,869 firms during the period from 2002 to 2008. I exclude 30 financial firms because they are subject to very specific regulations and have very special characteristics that make them very different to other firms. I also exclude the observations when data about

diversification are not available and exclude the observations in 2002 when the data of the corporate ownership concentration are not available. Due to the unavailability of some financial data, the final sample consists of 1,131 different firms with a total of 5,377 firm-years observations from 2003 to 2008.

3.3.2 Measuring information asymmetry

Information asymmetry is estimated according to the microstructure model proposed in a series of papers by Easley et al. (1996, 1997a, 1997b), which provides a measure of the probability of information based trading PIN. In their model, marketmakers, through observing market data, update their beliefs of the probability of the trade based on private information and then set the new price. Therefore, over time stock prices converge to the true value of an asset (i.e. the firm) and reflect full information. The model of PIN allows us to make inferences of the unobservable informed trading using the observable trade and quotation data.

According to the setting of the model, a new information event occurs at the beginning of a trading day with a probability of α. If the event occurs, good news happens with a probability of $(1-\delta)$ and bad news happens with a probability of δ. Whether there is new information at the beginning of the trading day and whether the news is good or bad are chosen by nature. Throughout the trading day, trades are assumed to arrive following Poisson processes. Orders from informed traders arrive at a rate of μ (only on information event days). Informed traders buy if the event is good and otherwise sell. Buy orders from uninformed traders arrive at a rate of ε_b, and sell orders from uninformed traders arrive at a rate of ε_s. Easley et al. (1996, 1997a, 1997b) show that the unobservable parameter set, $\theta=(\alpha, \delta, \mu, \varepsilon_b, \varepsilon_s)$, reflecting the information structure of trades, can be estimated via maximum likelihood.

For a single trading day *i*, the likelihood function is:

$$L(\theta|B_i,S_i) = \alpha(1-\delta)e^{-(\mu+\varepsilon_b)}\frac{(\mu+\varepsilon_b)^{B_i}}{B_i!}e^{-\varepsilon_s}\frac{{\varepsilon_s}^{s}}{S_i!}$$

$$+\alpha\delta e^{-\varepsilon_b}\frac{{\varepsilon_b}^{B_i}}{B_i!}e^{-(\mu+\varepsilon_s)}\frac{(\mu+\varepsilon_s)^{S_i}}{S_i!}$$

$$+(1-\alpha)e^{-\varepsilon_b}\frac{{\varepsilon_b}^{B_i}}{B_i!}e^{-\varepsilon_s}\frac{{\varepsilon_s}^{S_i}}{S_i!} \qquad eq.(3.1)$$

where B_i and S_i denote respectively the total number of buyer-initiated and seller-initiated trades for day *i* and $\theta=(\alpha, \delta, \mu, \varepsilon_b, \varepsilon_s)$ is the parameter vector.

Assuming that trading days are independent, Easley et al. (2002) give the likelihood function for a period of *I* trading days as follows:

$$L(\theta|M) = \prod_{i=1}^{I} L(\theta|B_i,S_i) \qquad eq.(3.2)$$

where $M = ((B_1,S_1),...,(B_I,S_I))$ represents the dataset during the *I* trading days. Maximizing (3.2) by using the dataset *M* can provide the estimates of the parameters.

The probability that the trade is information-based, PIN, is derived as follows:

$$PIN = \frac{\alpha\mu}{\alpha\mu+\varepsilon_b+\varepsilon_s} \qquad eq.(3.3)$$

where $\alpha\mu$ is the daily arrival of informed trades and $(\alpha\mu+\varepsilon_b+\varepsilon_s)$ is the arrival of both informed and uninformed trades. The PIN variables provide a direct measure of the risk derived from information-based trading and reflect the level of information asymmetry. PIN has been widely applied to the stocks in different countries over different time periods for various research questions in the previous literature[5].

[5] The PIN estimates have been applied to the stocks listed in the NYSE that operates with a specialist system [see Easley, Hvidkjaer and O'Hara (2002), Bardong et al. (2009) and others]. It has also been applied by other researchers to stock markets that are order-driven without marketmakers. For example, Borisova and Yadav (2008) use PIN for stocks in European countries; Copeland et al. (2009) and Chan et al. (2010) use PIN for stocks in mainland China; and Lu and Wong (2008) use PIN for stocks in Taiwan stock market. In an order-driven market, the uninformed trader, similar to a marketmaker in the specialist system, serves as the liquidity provider to the liquidity demander who is an informed trader.

In order to estimate PIN, the daily number of buys (B_i) and sells (S_i) are required. However, the dataset records the intraday trades and quotations without showing whether each trade is initiated by a buy or a sell. Following Easley et al. (2002), I use the standard Lee and Ready (1991) algorithm to classify the trades as buys or sells. The algorithm classifies any trade with a trading price higher (lower) than the immediate midpoint of the bid and ask as a buyer-initiated (seller-initiated) trade. For a trade happening at the midpoint, it is classified as a buy (sell) if its price is higher (lower) than the most recent but different trading price[6]. Following Lee and Ready (1991), I adopt a five-second lag of the recorded quotation time to adjust for the difference between the recording times of the trades and of the quotes.

The maximization of the likelihood function, (3.2), starts from self-selected starting values for the five parameters. Following Yan and Zhang (2010), Venter and Jongh (2004) and Borisova and Yadav (2010), I specify 125 sets of starting values for the five parameters. The maximization is performed based on each set of the acceptable starting values and then the one that achieves convergence and generates the highest value of the likelihood function is used.

Table 2 provides the summary statistics of the annual estimates of PIN and its parameter measures for all shares traded on the SHSE and SZSE during the period from January 2002 to December 2008. Panel A presents the statistics of PIN. Overall, the mean (median) PIN is 0.23 (0.22) and the standard deviation is 0.08. The average estimate of PIN across all firms is 0.215 in 2002 and it remains at a relatively high level in the following four years. In 2007 and 2008, there is a substantial reduction in the average PIN. One possible explanation is that starting from the bull market in 2006, more uninformed investors join the financial market. In that case, the arrival

[6] If the trading price equals the previous trading price, I will revert to additional lags. The maximum number of lags is two in our study.

rates of uninformed investors (both buyers and sellers) substantially increase. This explanation is supported by evidence from the average arrival rates of uninformed buyers (ε_b) and sellers (ε_s), which are respectively 73.91 and 78.65 in 2006, and are almost tripled up to 232.32 and 240.71 in 2007. The arrival rate of informed investors (μ) increases too but at a lower percentage rate from 2006 to 2007. In addition to the stimulus from the bull market, the reform of non-tradable shares [7]could also attract individual investors to join the market and then raise the arrival rate of uninformed investors after 2006. By the end of 2006, 1,301 listed companies on mainland markets have undergone or already completed their non-tradable share reforms, accounting for 97 percent of the total companies that need to be reformed. The aim of the reform is to change the situation of two kinds of stocks and pricings co-existing in the same market and to strengthen the common interests of all shareholders. In other words, it protects the interests of individual investors and makes the financial markets more attractive to them. Therefore, the reform of non-tradable shares is probably responsible for the higher arrival rate of uninformed investors and lower PIN in 2007 and 2008. However, since there is no data precisely capture the process of each firm in its reform of non-shares, we can not empirically evaluate the effect of this reform towards my results. Moreover, the average PIN in the SZSE is significantly higher than the one for the SHSE at the 5% level.

Panel B in Table 2 shows the statistics of the estimated parameters that are used to calculate PIN over the entire sample period. The mean (median) of α, the

[7]Not all the shares in a company incorporated in China that are listed on a stock exchange are freely tradable. The split share structure of the Chinese public securities market refers to the existence of a large amount of non-tradable shares, including state-owned shares and legal person shares of a listed Chinese company. Only about one-third of the shares in a listed Chinese company are freely tradable. The China Securities Regulatory Commission (CSRC) in 2005 published the guidance notes on the split share structure reform of listed companies or the reform of non-tradable shares. The reform is designed to float the non-tradable legal person shares through the open market. Such legal person shares could, under the reform program, be converted to tradable A-shares. The converted A-shares are subject to a lockup period.

probability of an information event in a day, is 0.287 (0.266), and the mean (median) δ is 0.362 (0.227), indicating that most of the information is good news.

[TABLE 2 HERE]

According to Chan et al. (2008), the average level of the PIN estimate is higher for the B-shares than for the A-shares due to the small amount of uninformed trades in the B-shares market. I analyze firms that have both A-shares and B-shares in one sample. In Table 3, the PIN statistics of B-shares versus the corresponding A-shares are presented. The differences in PIN between A-shares and B-shares are not consistently positive or negative over years. In most years, the PIN estimate is higher for B-shares than the A-shares, because the PIN parameters, ε_b and ε_s, are significantly higher for A-shares than for B-shares. The difference in ε_b and ε_s between A-shares and B-shares are significantly and positively different from zero at the 1% level for all years in both exchanges. As pointed out by Chan et al. (2008), the higher information asymmetry in the B-shares market is attributed to the relatively low number of uninformed trades. However, the PIN estimate and its parameters in my study are not directly comparable to those in Chan et al. (2008). They focus on the event when Chinese citizens are allowed to trade B-shares in March 2001 using the monthly PIN from January 2000 to November 2001, while my data start from 2002.

[TABLE 3 HERE]

Lin and Su (2008) claims that China's financial markets are less fully developed and largely segmented from the rest of the world. They are characterized by a lack of reliable information and a high degree of information asymmetry. Comparing my estimates with the estimates of PIN in other regions, the Chinese firms are shown to have a higher level of information asymmetry. In Easley et al.

(2002), the mean, median and maximum of PIN in the U.S. from 1983 to 1998, are respectively 0.191, 0.185 and 0.530. In Taiwan, the PIN statistics from 1997 to 2005, reported by Lu and Wong (2008), have a mean of 0.20 and a median of 0.18. Different from our study, Copeland et al. (2009) estimate the monthly PIN in the SHSE from 2001 to 2006 and find an average of 0.114.

3.3.3 Measuring diversification and firm value

I construct two alternative proxies for firm diversification following Lin and Su (2008). The first one is the dummy variable, DIV, which is coded 1 for a multi-segment firm and coded 0 for a single-segment firm. The other measure for diversification is a sales-based Herfindahl index (HI) defined as below:

$$HI_i = \sum_k \left(\frac{SALES_{k,i}}{Total(SALES)_i}\right)^2 \qquad eq.(3.4)$$

where $SALES_{k,i}$ refers to the annual sales revenue of sector k in firm i and $Total(SALES)_i$ represents the yearly total sales revenue of firm i. HI is inversely related to the degree of diversification.

To measure firm value, I use Tobin's Q (Q), defined as the sum of market value of equity[8] and book value of total debt divided by book value of total assets (Lang and Stulz, 1994; Lin and Su, 2008).

3.3.4 Control variables

Previous literature has documented alternative explanations for the diversification discount and firm value. In this paper, I also include some control variables to examine the incremental explanatory power of information asymmetry.

[8] A large percentage of total outstanding shares are non-tradable shares in China. I use the sum of the net asset value of non-tradable shares and the market capitalization of tradable shares, as the market value of equity.

A number of studies argue that the type of ownership structure can have an impact on firm performance in China because of the complex agency problems and soft budget constraints (Sun and Tong, 2003; Wei et al., 2005). Firstly, I include the state ownership (*STATE*) as well as a *GOV* dummy variable to control for the state agency effect. *STATE* is the percentage of shares held by the state agency while *GOV* is a dummy variable coded 1 if the firm is a State Owned Enterprise and coded 0 otherwise. Firth et al. (2006) indicates that a distinct characteristic of Chinese firms is that they have one dominant shareholder whose ownership is much higher than the next largest shareholder. Hence, to control for the influence of ownership structure, I include the measure of ownership concentration (*SHRCR*), which is the ownership of the largest shareholder, and the institutional ownership *(INS*), which is the institutional holdings as a percentage of the total number of shares outstanding.

Because larger firms are more likely to diversify, I use the natural logarithm of the market value of equity (*SIZE*) to capture the effect of size. Based on Clarke et al. (2004), I use the annualized standard deviation of daily stock price returns (*VOLATILITY*) to capture the effect of return volatility. As the growth opportunities of firms are positively related with firm value (Stowe and Xing, 2006), I use the percentage change in total assets (*TAGrow*) and the ratio of intangible assets to total assets (*INTANG*) to capture the growth of the firms. I use the dummy variable (*EXCHANGE*) to capture the variation across stock exchanges, which is coded 1 if the firm is listed on the SHSE and coded 0 if listed on SZSE. In order to capture the variation across industries, I include industry dummy variables. According to the two-digit industry code of CSRC (China Securities Regulation Commission), 13 industries are considered. Other control variables include the number of years after

the firm went public (*AGE*), leverage (*LEVERAGE*) (Doukas and Pantzalis, 2003; Clarke et al., 2004), return on assets (ROA) and the year dummies.

3.3.5 Summary statistics

Table 4 presents the summary statistics of the annual estimates of diversification, firm value, and other firm-level and industry-level control variables over the period from January 2003 and December 2008. Within the total 1,131 firms in the sample, the number of diversified firms increases from 379 in 2003 to 543 in 2008. Among all the 5,377 firm-years observations, 2,979 are multi-segment firms which make up 55% of the total sample. On average, 70% of the total observations are controlled by the state and 54% of the total observations are from SHSE.

[TABLE 4 HERE]

3.4 Preliminary evidence of the effect of diversification on firm performance

Table 5 shows the correlation analysis of information asymmetry, PIN, and the explanatory variables. The results in Table 5 show that the stocks with higher information asymmetry (higher PIN) have significantly higher state ownership and ownership concentration, and have lower firm size, stock return volatility, growth opportunity (lower TAGrow and INTANG), institutional ownership and the numbers of years since going public. Table 5 also indicates that diversified firms have smaller size, volatility, growth of assets, state ownership, institutional ownership and ownership concentration compared to focused firms. The correlation analysis shows that it is important to control for these variables when relating PIN to diversification and firm valuation.

[TABLE 5 HERE]

Table 6 provides summary statistics for the sample divided into diversified and non-diversified firms. As shown in the table, the average Tobin's Q of non-diversified firms is significantly higher than that of diversified firms, indicating that diversification is value-destroying. Moreover, the average ROA for single-segment and multi-segment firms are 0.0525 and 0.044, respectively. The t-statistics for the difference in sample means is significant at the 1% level, indicating that diversified firms are less profitable. The statistics in Table 6 also show that diversified firms differ substantially from focused firms in respect of other variables. In particular, the diversified firms overall have significantly lower volatility, growth of assets, state ownership, institutional ownership and ownership concentrations; but higher PIN measures than focused firms. At the same time, diversified firms are older and smaller in terms of firm size than the single segment firms.

[TABLE 6 HERE]

In China, most listed firms have a controlling shareholder that influences its strategies and policies. The central or regional government is often the ultimate owner of the controlling stake. In other cases, the controlling shareholder is a State Owned Enterprise or a private blockholder. The different types of controlling investor have different objectives and incentives, which will affect the corporate decision to diversify. Therefore, I explore the differences in ownership and assess their implications for diversification and firm valuation.

Table 7 partitions the sample along two dimensions: diversified versus non-diversified and government controlled versus non-government controlled. The means of the four sub-samples are presented. For each variable of interest, the top two cells are for government-controlled firms, partitioned by whether the firms are diversified or not. The lower two cells are for non-government-controlled firms partitioned also

by diversification. Surrounding these four cells are the t-statistics that test for the differences in sample means for the rows and columns. Consistent with Table 6, multi-segment firms have significantly lower Tobin's Q than single-segment firms for non-government-controlled firms and lower ROA for the government-controlled firms. In comparison, non-government-controlled firms have significantly higher Tobin's Q than government-controlled firms no matter whether they are diversified or not. These results suggest that government control is an important factor when testing the effect of diversification on firm value. However, government control exerts a non-significant influence on the PIN variable.

Table 7 also shows that, after controlling for the identity of the ultimate owner, multi-segment firms have lower asset growth, institutional ownership, state ownership and ownership concentration but a longer history, than the single-segment firms. Controlling for diversification status, government-controlled firms have higher firm size, return on assets, institutional ownership, state ownership, asset growth and ownership concentration, but lower stock return volatility and leverage, than the non-government-controlled firms.

[TABLE 7 HERE]

3.5 Regression analysis

The previous summary statistics and comparisons show that diversified firms have lower firm values. However, the cause of the discount needs to be investigated. In this section, I test whether information asymmetry can explain the diversification discount in firm value.

3.5.1 Econometric specification and testable hypotheses

I specify the regression models measuring the interaction between information asymmetry and firm diversification discount as follows:

$$Q_{i,t} = \alpha_0 + \alpha_1 DIV_{i,t} + \alpha_2 SIZE_{i,t} + \alpha_3 VOLATILITY_{i,t} + \alpha_4 TAGrow_{i,t} + \alpha_5 INTANG + \alpha_6 LEVERAGE_{i,t} + \alpha_7 STATE_{i,t} + \alpha_8 GOV_{i,t} + \alpha_9 INS_{i,t} + \alpha_{10} SHRCR_{i,t} + \alpha_{11} AGE_{i,t} + \sum_k \varphi_k \, Industry\ Dummies + \sum_t \phi_t \, Year\ Dummies + \varepsilon_{i,t}$$

eq.(3.5.1)

$$Q_{i,t} = \omega_0 + \omega_1 DIV_{i,t} + \omega_2 PIN_{i,t} + \omega_3 SIZE_{i,t} + \omega_4 VOLATILITY + \omega_5 TAGrow_{i,t} + \omega_6 INTANG + \omega_7 LEVERAGE_{i,t} + \omega_8 STATE_{i,t} + \omega_9 GOV_{i,t} + \omega_{10} INS_{i,t} + \omega_{11} SHRCR_{i,t} + \omega_{12} AGE_{i,t} + \sum_k \varphi_k \, Industry\ Dummies + \sum_t \phi_t \, Year\ Dummies + \varepsilon_{i,t}$$

eq.(3.5.2)

The definitions and the estimation details of the variables are discussed in section (3.3). I also run the same set of regressions by replacing the dummy variable, DIV, by HI that is inversely related with the level of diversification. The two regressions are used to test the effect of information asymmetry on the diversification discount.

According to the previous literature, diversification destroys firm value for many reasons, such as the inefficient allocation of capital among divisions (Lamont, 1997; Shin and Stulz, 1998), complete insensitivity of CEO turnover to the stock price performance (Berry et al., 2006) and others. Therefore, in eq. (3.5.1), a significantly negative α_1, indicates that a higher degree of diversification is related with a loss of firm value (i.e. a lower Tobin's Q). According to Habib et al. (1997)

and Nanda and Narayanan (1999), diversification could result in a higher level of asymmetric information problems, due to the lack of transparency, and, thus, the information asymmetry may be the incremental factor that makes diversified firms to be valued even less. If this is true, the significant estimate of α_1 in eq. (3.5.1) could be a reflection of asymmetric information. According to the results in Tables 5 and 6, the PIN estimates are positively related with the firms' diversification decisions.

Based on the above consideration, I add PIN, as the proxy of information asymmetry, in eq. (3.5.2) to test the effect of price informativeness on diversification discount. If ω_2 is significantly negative related with Tobin's Q while ω_1 is no longer significant, I will conclude that information asymmetry directly leads to the diversification discount. In other words, diversification does not affect firm value directly but affects it through the channel of information asymmetry. Diversified firms suffer from a higher level of asymmetric information that leads to the loss of firm value.

Specifically, using the econometric specification in eq.(3.5.1) and (3.5.2), I test the following hypothesis:

H_0: $\alpha_1=0$, $\omega_1\neq0$, or $\omega_2=0$.

H_1: $\alpha_1\neq0$, $\omega_1=0$ and $\omega_2\neq0$.

3.5.2 Regression results

Table 8 shows the regression results defined by eq. (3.5.1) and eq. (3.5.2). The regression results in the columns (1) and (4) are based on eq. (3.5.1), where the diversification is measured by DIV in column (1) and by HI in column (4). Accordingly, the results in the columns (2) and (5) are based on eq. (3.5.2) using two different proxies of diversification, DIV and HI, respectively. Additionally, I include

the interaction terms in columns (3) and (6), DIV×PIN (HI×PIN), measure the effects of the interplay between diversification and information asymmetry on the firm value. Moreover, to control for the causality problem, one-year lagged Tobin's Q is used as the dependent variable in columns (7) and (8) and the regression results are defined by eq. (3.5.1) and eq. (3.5.2) too. According to the regression results, multi-segment firms have lower Tobin's Q than single-segment firms, as the coefficient estimates for DIV are significantly negative at the 1% level and the coefficient estimates for HI are significantly positive at the 5% level. The results are consistent with the previous literature that diversification leads to a firm value discount using the U.S. data (e.g., Myers and Majluf, 1984; Gilson et al., 2001; Jensen, 1986).

I next test whether the effect of diversification on firm value is subsumed by information asymmetry through regression equation (3.5.2). The results are shown in the columns (2), (3), (5) and (6), where diversification is measured by DIV in columns (2) and (3) and by HI in columns (5) and (6). After adding PIN as an explanatory variable for Tobin's Q, the coefficient estimates for DIV and HI become insignificant while the coefficient estimates of PIN are all significantly negative at the 1% or 5% level indicating that the increased information asymmetry is directly responsible for the diversification discount, however, the diversification strategy itself can not destroy firm value. In columns (3) and (6) with the extra interaction term, DIV×PIN (HI×PIN) is negatively (positive) significant, indicating that the effect of information asymmetry (PIN) on firm value (Q) varies with the diversification degree. More specifically, the negative effect of PIN on Q rises as the firm's diversification degree increases. In other words, the more diversified the firm is, the greater damage on firm value will be caused by the increased information

asymmetry. At the same time, the sign and significance of other variables remain similar as before.

To control the problem of causality, I lag the entire independent variables one year in the last two columns and use Q_{t+1} as the dependent variable. The results are consistent with pervious hypothesis, as the coefficient estimate of DIV is negatively significant with Q but becomes insignificant after adding PIN as the proxy of information asymmetry. The results suggest that the increased information asymmetry is responsible for the diversification discount after considering the problem of causality.

The regression results also show that the government controls reduce a firm's Tobin's Q as the coefficient estimates for GOV are all significantly negative. These results are consistent with the prediction that political influence will detract from firm value, and consistent with the analysis in Table 7. On average, firms that are smaller in size, older in corporate history, higher institutional ownership, higher leverage and lower ownership concentration are related to with higher Tobin's Q.

[TABLE 8 HERE]

In considering the variations of stock exchanges, I divide the sample into firms listed on the SHSE and firms listed on the SZSE and check the effect of information asymmetry on diversification discount following the above econometric specification. The regression results in columns (1) and (3) of Table 9 are based on eq. (3.5.1) by using data from the SHSE and the SZSE respectively. According to the results, diversified firms have lower Tobin's Q than non-diversified firms, as the coefficient estimates for DIV are significantly negative. This conclusion is consistent with the one in Table 8 where the sample includes the whole market. The regression results in columns (2) and (4) are based on eq. (3.5.2) using data from the two stock

exchanges separately. After adding PIN as an explanatory variable for Tobin's Q, the coefficient estimates of DIV become insignificant while the coefficient estimates of PIN are all significantly negative at the 1% level. The results suggest that the increased information asymmetry level is responsible for the diversification discount which is consistent with the conclusion in Table 8 while the adjusted R-square is higher in the SZSE than that in the SHSE. Moreover, I also exclude 251 observations with B-shares and investigate the relation between information asymmetry and diversification discount by including A-shares only from the whole sample. The regression results are shown in columns (5) and (6) of Table 9 and the same conclusion is derived from this separated sub-sample that the multi-segment firms are valued less due to a higher level of information asymmetry. Therefore, the same conclusion is achieved regardless of the stock exchange and the share type.

Finally, considering the political influence on the effect of diversification, I divide the sample into government-controlled firms versus non-government-controlled firms and check the effect of information asymmetry on diversification discount following the above econometric specification. The regression results are shown in columns (7) to (10) of Table 9 and are consistent with previous analysis in Table 7 that the government control is an important factor when testing the effect of diversification on firm value. As to non-government-controlled firms, the coefficient estimate of DIV is significant in column (9) and loses its significance after adding PIN in column (10). The fact suggests that not only diversification has an effect on the value of non-government-controlled firms, but also the discounted firm value is induced by a higher level of information asymmetry. For the government-controlled firms, the effect of diversification is less strong compared with non-government-controlled firms while the information asymmetry level is still significantly negative

related with firm value. In addition, the coefficient estimates of other control variables in Table 9 are similar to those in Table 8.

[TABLE 9 HERE]

3.6 Robustness tests

To test the robustness of my results, I use a three-step approach to evaluate the effect of information asymmetry on the diversification discount. In addition to the dummy variable DIV, the continuous variable HI is included as an alternative measure of diversification

3.6.1 Econometric Specification

In this section, I run three regressions to test that after controlling for information asymmetry whether diversification has any effect on the firm value discount. In the first step, the diversification dummy variable (DIV) is estimated against the information asymmetry variable (PIN) and a set of firm-specific and industry-specific characteristics, using the following Logit model and a sample including 5,377 firm-year observations:

$$DIV_{i,t} = \beta_0 + \beta_1 PIN_{i,t} + \beta_2 SIZE_{i,t} + \beta_3 VOLATILTY_{i,t} + \beta_4 TAGrow_{i,t} + \beta_5 INTANG_{i,t} + \beta_6 LEVERAGE_{i,t} + \beta_7 STATE_{i,t} + \beta_8 SHRCR_{i,t} + \beta_9 AGE_{i,t} + \beta_{10} EXCHANGE_{i,t} + \sum_k \varphi_k \, Industry\ Dummies + \sum_t \phi_t \, Year\ Dummies + \varepsilon_{i,t} \quad eq.(3.6)$$

The predicted diversification variable $\widehat{\mathrm{DIV}}_{i,t}$ and the regression residual $\widehat{Resid}_{i,t}$ are estimated by the Logit regression in eq. (3.6). The models use the mapping method in econometrics to project DIV into the space combined with

PIN and other explanatory variables in the first step. The predicted $\widehat{DIV}_{i,t}$ from eq. (3.6) represents the special part of the original DIV explained by PIN and other variables, while the residual, $\widehat{Resid}_{i,t}$, orthogonal to the space of information asymmetry, reflect the rest of DIV that is not explained by the regression model of eq. (3.6). In the second step, I use $\widehat{DIV}_{i,t}$ and $\widehat{Resid}_{i,t}$, respectively, to explain the firm value discount in the regressions. The regression model with $\widehat{DIV}_{i,t}$ as the explanatory variable is as follows:

$$Q_{i,t} = \gamma_0 + \gamma_1 \widehat{DIV}_{i,t} + \gamma_2 SIZE_{i,t} + \gamma_3 VOLATILITY_{i,t} + \gamma_4 TAGrow_{i,t} + \gamma_5 INTANG_{i,t} + \gamma_6 LEVERAGE_{i,t} + \gamma_7 STATE_{i,t} + \gamma_8 SHRCR_{i,t} + \gamma_9 AGE_{i,t} + \gamma_{10} EXCHANGE_{i,t} + \sum_k \varphi_k \, Industry\ Dummies + \sum_t \phi_t \, Year\ Dummies + \varepsilon_{i,t}$$

eq.(3.7)

The regression model for $\widehat{\text{Resid}}_{i,t}$ as the explanatory variable is as follows:

$$Q_{i,t} = \theta_0 + \theta_1 \widehat{Resid}_{i,t} + \theta_2 SIZE_{i,t} + \theta_3 VOLATILITY_{i,t} + \theta_4 TAGrow_{i,t} + \theta_5 INTANG_{i,t} + \theta_6 LEVERAGE_{i,t} + \theta_7 STATE_{i,t} + \theta_8 SHRCR_{i,t} + \theta_9 AGE_{i,t} + \sum_k \varphi_k \, Industry\ Dummies + \sum_t \phi_t \, Year\ Dummies + \varepsilon_{i,t}$$

eq. (3.8)

where Tobin's Q and all the other variables are the same as specified in section (3.3).

The primary coefficient of interest in eq. (3.6) is the coefficient on PIN, β_1, which captures the relationship between stock price informativeness and the firm's diversification. In eq. (3.7) the primary coefficient of interest is the coefficient on predicted diversification, γ_1, which indicates the influence on firm valuation exerted by the projection of diversification explained by eq. (3.6). If γ_1 is significantly different from 0, the information asymmetry of the diversified firm is responsible for

the discount in firm value. At the same time, an insignificant coefficient on the residual θ_1 in eq.(3.8), indicates that without the effect of PIN, the remaining part of diversification does not influence firm value. So my hypothesis is as follows:

H_0: β_1 **=0,** γ_1=0 or $\theta_1 \neq 0$

H_1: β_1 **≠0,** $\gamma_1 \neq 0$ and θ_1=0

3.6.2 Regression results

Table 10 presents the regression results of eq. (3.6), (3.7) and (3.8). From columns (1) and (4), the variable, PIN, is positively (negatively) related with DIV (HI) indicating that diversified firms have higher information asymmetry compared with single-focus firms. As shown in the table, the coefficient estimates for $\widehat{\mathrm{DIV}}_{\mathrm{i,t}}$ are significantly negative (positive) at the 1% level in column (2) (column (4)), providing strong evidence that the lower firm value stems from the higher information asymmetry level after diversification. The more diversified the firms are, the higher the level of information asymmetry they will suffer and, in turn, the firm will be valued less by investors due to the lower transparency implied by higher PIN. At the same time, the coefficient estimates, $\widehat{Resid}_{i,t}$, are not significant at all no matter whether the diversification is estimated by DIV or HI, as shown in columns (3) and (6). So diversification cannot affect the value of the firms without the effect of information asymmetry. When it comes to other explanatory variables, on average, firms with higher ratio of intangible assets, lower institutional ownership and lower ownership concentration are more diversified. And listed firms in the SHSE are more diversified compared with those in the SZSE as the coefficient estimate of *EXCHANGE* is significantly positive (negative) in the 1% level in column (1) (column (4)). Moreover, firms that are smaller in size, older in corporate history,

higher institutional ownership, higher leverage and lower ownership concentration are associated with higher Tobin's Q according to the evidence provided in columns (2), (3), (5) and (6).

[TABLE 10 HERE]

3.7 Conclusion

This chapter analyzes the relation between corporate diversification and information asymmetry and their effects on firm value, using the data in China from 2003 to 2008.

I estimate PIN as a proxy of information asymmetry for 1,869 firms traded on the two stock exchanges in China. As predicted, the PIN estimates are higher in China than those found in the U.S. and European countries. First, diversified firms exhibit higher levels of asymmetric information than focused firms. This finding is consistent with the transparency theory suggested by Thomas (2002).

Second, compared with single-focus firms, multi-segment firms have lower Tobin's Q after controlling for other firm-specific factors, including firm size, stock price volatility, growth opportunities, ownership structures and others. Therefore, Chinese firms exhibit a diversification discount, as found by Gilson et al. (2001) for U.S. data.

The main question of the study is to find out whether diversification affects firm value directly or indirectly through information asymmetry. Consistent with my hypothesis, information asymmetry, resulting from corporate diversification, leads to the firm value discount. The rationale is that corporate diversification results in a higher level of asymmetric information, and therefore the loss of firm value for diversified firms is attributed to the more severe asymmetric information problems.

After controlling for PIN, the remaining diversification cannot explain the changes in firm value. If asymmetric information problems are well controlled or managed, the cost of diversification will be reduced significantly.

References

Amihud, Yakov, and Baruch Lev. 1981. Risk Reduction as a Managerial Motive for Conglomerate Mergers. *The Bell Journal of Economics* 12, no. 2: 605-617.

Amit, Raphael, and Joshua Livnat. 1988. A Concept of Conglomerate Diversification. *Journal of Management* 14, no. 4: 593 -604.

Aslan, Hadiye, David Easley, Soeren Hvidkjaer, and Maureen O'Hara. 2008. Firm Characteristics and Informed Trading: Implications for Asset Pricing. Working Paper, University of Houston, Cornell University and Copenhagen Business School.

Bardong, Florian, Söhnke M. Bartram, and Pradeep K. Yadav. 2009. Informed Trading, Information Asymmetry, and Pricing of Information Risk: Empirical Evidence from the NYSE. Working Paper, Lancaster University and Oklahoma University.

Berger, Philip G., and Eli Ofek. 1995. Diversification's effect on firm value. *Journal of Financial Economics* 37, no. 1: 39-65.

Berry, Tammy K., John M. Bizjak, Michael L. Lemmon, and Lalitha Naveen. 2006. Organizational complexity and CEO labor markets: Evidence from diversified firms. *Journal of Corporate Finance* 12, no. 4 : 797-817.

Borisova, Ginka, and Pradeep K. Yadav. 2010. How does Privatization affect Information Asymmetry? Evidence from the European Union. Working Paper, Iowa State University and Oklahoma University

Brown, Stephen, and Stephen A. Hillegeist. 2007. How disclosure quality affects the level of information asymmetry. *Review of Accounting Studies* 12, no. 2-3: 443-477.

Chan, K.L, Albert J. Menkveld, and Yang Zhishu. 2008. Information Asymmetry and Asset Prices: Evidence from the China Foreign Share Discount. *The Journal of Finance* 63, no. 1: 159-196.

Clarke, Jonathan E., C. Edward Fee, and Shawn Thomas. 2004. Corporate diversification and asymmetric information: evidence from stock market trading characteristics. *Journal of Corporate Finance* 10, no. 1: 105-129.

Copeland, Laurence, Woon K. Wong, and Yong Zeng. 2009. Information-based trade in the Shanghai stock market. *Global Finance Journal* 20, no. 2: 180-190.

Doukas, John A., and Christos Pantzalis. 2003. Geographic diversification and agency costs of debt of multinational firms. *Journal of Corporate Finance* 9, no. 1: 59-92.

Easley, David, Soeren Hvidkjaer, and Maureen O'Hara. 2002. Is Information Risk a Determinant of Asset Returns? *The Journal of Finance* 57, no. 5: 2185-2221.

Easley, David, Nicholas M. Kiefer, and Maureen O'Hara. 1996. Cream-Skimming or Profit-Sharing? The Curious Role of Purchased Order Flow. *Journal of Finance* 51, no. 3: 811-33.

Easley, David, Nicholas M. Kiefer, and Maureen O'Hara. 1997a. The information content of the trading process. *Journal of Empirical Finance* 4, no. 2-3: 159-186.

Easley, David, Nicholas M., Kiefer, and Maureen O'Hara. 1997b. One day in the life of a very common stock. *Review of Financial Studies* 10, no. 3: 805 -835.

Easley, David, Maureen O'Hara, and Joseph Paperman. 1998. Financial analysts and information-based trade. *Journal of Financial Markets* 1, no. 2: 175-201.

Firth, Michael, Peter M.Y. Fung, and Oliver M. Rui. 2006. Corporate performance and CEO compensation in China. *Journal of Corporate Finance* 12, no. 4: 693-714.

Gilson, Stuart C, Paul M Healy, Christopher F Noe, and Krishna G Palepu. 2001. Analyst Specialization and Conglomerate Stock Breakups. *Journal of Accounting Research* 39, no. 3: 565-582.

Habib, Michel A., D. Bruce Johnson, and Narayan Y. Naik. 1997. Spinoffs and Information. *Journal of Financial Intermediation* 6, no. 2: 153-176.

Hadlock, Charles J, Michael Ryngaert, and Shawn Thomas. 2001. Corporate Structure and Equity Offerings: Are There Benefits to Diversification? *Journal of Business* 74, no. 4: 613-35.

Hong, Daolin and Dehua Xiong. 2006. The Analysis of Diversification and Performance of Listed Companies in China. *Journal of Financial Research*, no. 11: 33-43.

Jensen, Michael C. 1986. Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers. *The American Economic Review* 76, no. 2: 323-329.

Krishnaswami, Sudha, and Venkat Subramaniam. 1999. Information asymmetry, valuation, and the corporate spin-off decision. *Journal of Financial Economics* 53, no. 1: 73-112.

Lamont, Owen. 1997. Cash Flow and Investment: Evidence from Internal Capital Markets. *The Journal of Finance* 52, no. 1: 83-109.

Lang, Larry H P, and Rene M Stulz. 1994. Tobin's q, Corporate Diversification, and Firm Performance. *Journal of Political Economy* 102, no. 6: 1248-80.

Lee, Charles M C, and Mark J Ready. 1991. Inferring Trade Direction from Intraday Data. *Journal of Finance* 46, no. 2: 733-46.

Lewellen, Wilbur G. 1971. A Pure Financial Rationale for the Conglomerate Merger. *Journal of Finance* 26, no. 2: 521-37.

Lin, Chen, and Dongwei Su. 2008. Industrial diversification, partial privatization and firm valuation: Evidence from publicly listed firms in China. *Journal of Corporate Finance* 14, no. 4: 405-417.

Lins, Karl and Henri Servaes. 1999. International Evidence on the Value of Corporate Diversification. *Journal of Finance* 54, no. 6: 2215-2239.

Lins, Karl and Henri Servaes. 2002. Is corporate diversification beneficial in emerging markets? *Financial Management* 31, no. 2: 5.

Liu, Qiao, and Zhou Lu. 2007. Corporate governance and earnings management in the Chinese listed companies: A tunneling perspective. *Journal of Corporate Finance* 13, no. 5: 881-906.

Lu, Ralph C., and Woon K. Wong. 2008. Probability of Information-Based Trading as a Pricing Factor in Taiwan Stock Market. Working Paper, Ming Chuan University and Tamkang University.

Martin, John D., and Akin Sayrak. 2003. Corporate diversification and shareholder value: a survey of recent literature. *Journal of Corporate Finance* 9, no. 1: 37-57.

Myers, Stewart C., and Nicholas S. Majluf. 1984. Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics* 13, no. 2: 187-221.

Nanda, Vikram, and M. P. Narayanan. 1999. Disentangling Value: Financing Needs, Firm Scope, and Divestitures. *Journal of Financial Intermediation* 8, no. 3: 174-204.

Panzar, John C., and Robert D. Willig. 1981. Economies of Scope. *The American Economic Review* 71, no. 2: 268-272.

Rajan, Raghuram, Henri Servaes, and Luigi Zingales. 2000. The Cost of Diversity: The Diversification Discount and Inefficient Investment. *The Journal of Finance* 55, no. 1: 35-80.

Scharfstein, David S. 1998. The Dark Side of Internal Capital Markets II: Evidence from Diversified Conglomerates. Working Paper Series, Harvard Business School.

Scharfstein, David S. and Jeremy C. Stein. 2000. The Dark Side of Internal Capital Markets: Divisional Rent-Seeking and Inefficient Investment. *Journal of Finance* 55, no. 6: 2537-2564.

Shin, Hyun-Han, and René M. Stulz. 2011. Are Internal Capital Markets Efficient?. *Quarterly Journal of Economics* 113, no. 2 : 531-552.

Stowe, John D., and Xuejing Xing. 2006. Can growth opportunities explain the diversification discount? *Journal of Corporate Finance* 12, no. 4: 783-796.

Sun, Qian, and Wilson H. S. Tong. 2003. China share issue privatization: the extent of its success. *Journal of Financial Economics* 70, no. 2: 183-222.

Teece, David J. 1980. Economies of scope and the scope of the enterprise. *Journal of Economic Behavior & Organization* 1, no. 3: 223-247.

Teece, David J. 1982. Towards an economic theory of the multiproduct firm. *Journal of Economic Behavior & Organization* 3, no. 1: 39-63.

Thomas, Shawn E., and C. Edward Fee. 2000. Corporate Diversification, Asymmetric Information, and Firm Value: Evidence from Stock Market Trading Characteristics. Working Paper, University of Pittsburgh and Michigan State University.

Thomas, Shawn. 2002. Firm diversification and asymmetric information: evidence from analysts' forecasts and earnings announcements. *Journal of Financial Economics* 64, no. 3: 373-396.

Venter, Johannes Hendrik, and Dawid CJ De Jongh. 2004. Extending the EKOP Model to Estimate the Probability of Informed Trading. Working Paper, North-west University.

Villalonga, Belén. 2004. Diversification Discount or Premium? New Evidence from the Business Information Tracking Series. *The Journal of Finance* 59, no. 2: 479-506.

Wei, Zuobao, Feixue Xie, and Shaorong Zhang. 2005. Ownership Structure and Firm Value in China's Privatized Firms: 1991-2001. *Journal of Financial and Quantitative Analysis* 40, no. 01: 87-108.

Weston, J. Fred. 1969. The Nature and Significance of Conglomerate Firms. *St. John's Law Review* 44: 66.

Williamson, Oliver E. 1983. *Markets and Hierarchies: Analysis and Antitrust Implications*. Free Press, January 1.

Yan, Yuxing, and Shaojun Zhang. 2010. An Improved Estimation Method and Empirical Properties of the Probability of Informed Trading. Working Paper, University of Pennsylvania and Nanyang Technological University.

Zhang, Yi, W. Liu and Liutang Gong. 2005. An Empirical Study on Diversification and Firm Performance. *Journal of Financial Research*, no. 09: 122-136.

Chapter 4. Information asymmetry and managerial incentives: evidence from China's stock market

4.1 Introduction

This chapter marries a study of market microstructure and an important corporate governance issue. In particular, I examine the relation between the level of information asymmetry and managerial incentives sensitivity.

The conflict of interest between shareholders and the Chief Executive Officer (CEO) is a classic topic in agency theory (Murphy, 1999; Haubrich, 1994). A shareholder's goal is to maximize firm value, which is positively correlated with his own wealth. However, as a risk-averse individual, a CEO usually takes conservative actions that consider his private interests, which may hurt shareholders' interests. If shareholders can obtain complete information about a CEO's behavior and a firm's investment opportunities, they can construct an optimal managerial contract to drive the CEO's actions towards the principal's benefits. However, it is impossible for the corporate board members to directly and completely monitor a CEO's activities. Usually the CEO has much better information than shareholders in identifying what actions are optimal for firm performance. It is costly for shareholders to monitor management directly. However, the principals (i.e., shareholders, board of directors) could acquire extra information from the stock price to increase their knowledge about managerial activities. On the one hand, the need for optimal incentive contracting requires the principals to gather and analyze all useful information including the important information revealed from the stock market. On the other hand, according to Kang and Liu (2008), informative stock prices also send meaningful signals to financial markets about the need for better corporate

governance, which will force the principals to better incentivize managers. In this chapter, I examine the role of information-based trading in affecting executive incentives using data from China.

Holmstrom and Tirole (1993) analytically show that the principal can use inferred information from the stock market to design a more effective compensation contract. Kang and Liu (2008) empirically test the effect of information asymmetry on managerial incentives using U.S. data. They use the probability of information trading (PIN) and analyst earnings forecasts as the proxies of information asymmetry and use stock-option based pay-performance sensitivity (PPS hereafter) to reflect the managerial incentives. Consequently, they find a positive relation between PPS and the proxies of information asymmetry. In contrast, Subrahmanyam (2008) suggests that more stock price informativeness will induce poorer corporate governance in the U.S. market.

Using data from China, I focus on testing the prediction that information asymmetry is positively related with CEO's compensation incentives. The analysis uses high frequency data from firms listed in China's stock market to estimate the level of asymmetric information or stock price informativeness. Information asymmetry is measured by the probability of information trading (PIN), developed by Easley et al. (1996, 1997a, 1997b). A higher PIN implies a greater amount of private information reflected in the stock market. I find that the PIN in China is much higher than in the U.S., indicating more serious asymmetric information problems in China. To measure the magnitude of the incentives provided by the compensation policy, I use a CEO's pay-performance sensitivity (PPS) as a proxy (Jensen and Murphy, 1990). The mean of the pay-performance sensitivity in China is 1.69,

representing a 1.69 RMB increase in CEO compensation per 1000 RMB increase in shareholders' value.

Using both panel data regressions with fixed effects and the median regressions, I find that firms with higher PINs exert more efficient and stronger incentives on the CEO and make them tie their wealth to the benefits of shareholders. In other words, there is a positive relation between PIN and PPS, after controlling for firm-specific characteristics. Thomas (2002) uses the accuracy of consensus forecasts and the dispersion among forecasts as proxies for asymmetric information. To further check the endogeneity problem in corporate governance, I use the error and dispersion of the analysts' forecasts as instrumental variables and find that the relationship between PIN and managerial pay-performance sensitivity is still significantly positive.

China offers a unique economic and financial environment to address this issue. First of all, China's financial markets are less fully developed and are largely segmented from the rest of the world. Lin and Su (2008) suggest China's financial market is characterized by a lack of reliable information and a high degree of information asymmetry. In addition, the Chinese government desires to retain some control over large firms. That is why most listed firms in China have a controlling shareholder, which is the central or regional government. Political influence may affect the development of listed firms in many ways, such as the appointment of the CEO, the executive compensation structure, and its information asymmetry. Accordingly, I examine whether the information from stock trading can affect managerial incentives of firms listed in China.

The results of my findings have useful implications and economic significance as follows: firstly and most importantly, I show the impacts of information-based

trading on executive incentives. As long as the trading process can impound more information into stock prices, the principal is able to incentivize managers with the tool of performance-related pay. However, many people argue that executives might be rewarded regardless of the profit of shareholders, especially in China. The results show that the principal can better structure managerial incentives if they use the information contained in stock prices and ensure that the CEO works consistently towards the goals of the shareholders.

Secondly, my paper adds to the literature on executive compensation from a special angle. Although executive compensation has been studied widely (e.g., Lambert et al., 1991; Hayes, 2004; Dittman and Maug, 2007), the linkage of a CEO's compensation to market microstructure has been barely studied. I fill in this void in the literature by empirically testing the effect of information asymmetry on managerial incentives.

Thirdly, my paper is closely related to the literature on the effect of information asymmetry. Using the probability of informed trading, PIN, as the proxy, Chen et al. (2007) find the degree of information asymmetry is negatively correlated with the sensitivity of investment to stock price. Faure-Grimaud and Gromb (2004) indicate that shareholders will be incentivized to engage in value-increasing activities if more information is incorporated into stock prices. Easley et al. (1998) investigate the informational role of financial analysts and find that there is no significant relation between the analyst coverage and the probability of informed trading.

The rest of this chapter proceeds as follows. In Section 2, I introduce the background literature. In Section 3, I describe the data sample and the variables. Section 4 provides the main results. Section 5 includes a robustness test controlling for the endogeneity problem. Section 6 concludes with a summary of the findings.

4.2 Literature Review

The large academic literature has explored extensively the information asymmetry revealed from the trading actions of investors. On one hand, some research focuses on the determinants of asymmetric information theoretically and empirically (e.g., Easley et al., 1998; Aslan et al., 2008; Bardong et al., 2009). In summary, information asymmetry measures in the U.S. are shown to be significantly and positively related with trading volumes, return on assets and negatively related with firm size, firm age and Tobin's Q. The estimated PINs are also shown to be higher for firms in the industries of Oil and Petroleum Products, Construction, Textiles and Retail in the U.S. market (Aslan et al., 2008). In a search for the factors leading to information asymmetry, studies focus on some particular firm-specific factors. Also for the U.S. market, Brown et al. (2009) find that information asymmetry decreases (increases) immediately following positive (negative) earnings surprises. Borisova and Yadav (2010) apply the measures of information asymmetry to firms in European Union and find that firms in which the government still retains a stake after privatization exhibit a lower level of information asymmetry than do the fully privatized peer firms.

Another stream of the literature examines information risk in asset pricing. Easley et al. (2002) consider the effect of information asymmetry on the required stock returns and find that stocks in the U.S. market with higher PINs consistently generate higher excess returns than those with lower PINs. The price risk of information asymmetry is also tested for the stocks traded in China. Chan et al. (2008) show that the measures of information asymmetry explain a significant portion of the cross-sectional variation in the foreign share discounts. Therefore, foreign investors

demand a higher rate of return as compensation for bearing a higher information risk when investing stocks in China. Extending research on U.S. stocks to the A-shares traded on the SHSE, Copeland et al. (2009) find that the PINs significantly explain the returns even after controlling for the Fama-French (1992) three factors[9].

In this chapter, I use the estimated PIN as my proxy of stock price informativenss to explain the variations in managerial incentives cross-sectionally. The higher PIN is, the more effective the compensation policy can be in inducing managerial incentives. One of the possible explanations is that, in the stock market, an informed party, as described by Kim and Verrechia (1994), represents a group of well-informed investors that possess a heightened ability to analyze publicly available data to convert them into private information, and can take advantage of the non-public information and profit from it. According to Grossman and Stigliz (1980), individuals who expend resources searching for additional information will receive compensation. Thus, they have an incentive to spend resources to collect signals about the firm's fundamental value. The information is incorporated into the stock price through trading. As a result, the increased information flow into the market improves stock price informativeness, which enables firms to design more efficient managerial contracts. Hence, the information content of stock prices can have an important effect on the pay-performance sensitivity of managerial compensation. Kang and Liu (2010) suggest that the information-based stock trading that enhances managerial incentives is driven by the increased uncertainty of an economy.

Until the 1990s, relatively little research had been done in the area of the role of stock market information production in optimal contracting. Holmstrom and Tirole (1993) helped fill the gap by studying the value of the stock market as a

[9] A similar study by Lu and Wong (2008) finds that information risk is priced for the stocks traded in Taiwan stock exchange.

monitor of managerial performance. They argue that stock prices impound performance information which is useful for constructing the CEO's compensation incentives. After receiving or interpreting the non-public financial market signals, the shareholders will put more effort into monitoring. At the same time, the informative stock price can also provide messages to the market about the current corporate governance status, and tell investors whether it needs to be improved or even be reconstructed. Kang and Liu (2008) empirically examine Holmstrom and Tirole's model using 10 years' of U.S. data from 1992 to 2002. They show that the CEO's pay-performance sensitivity is positively and significantly correlated with PIN and other estimates of information asymmetry. They also find that the impact of stock price informativeness on the compensation sensitivity is much larger for the CEO than for non-CEO executives. In contrast, using U.S. data, Subrahmanyam (2008) finds that more informativeness will induce poorer governance. His explanation is that high stock market liquidity may attract too many short-term speculators who have little vested interest in good governance. However, the negative correlation between market liquidity and corporate governance exists only in 1990s, whereas in later years, it is not significant. Jensen and Murphy (1990) point out that when a board of directors has good information, the pay-performance sensitivity may be small. Nevertheless, their statement assumes that the boards observe and monitor CEO's activities directly. Unfortunately, this is not the case in real world. Apart from the impact from market microstructure on corporate governance, Chung et al. (2010) empirically investigate the relation inversely. They examine how corporate policy affects stock market liquidity and PIN is one of their liquidity measures. The results indicate that poor (good) governance gives rise to greater (less) information asymmetry between the insider and the outside owners, and furthermore amplify

(mitigate) the information asymmetries among all market participants. Lipsom (2003) provides a brief overview of the importance of the links between market microstructure research and corporate governance. He suggests two paths for researchers to proceed: one is to use empirical methods in market microstructure that can be used to evaluate theories in corporate finance; the other is to examine the influence of market microstructure outcomes on corporate decisions.

4.3 Data and variables

This section shows the data selection as well as the methodology that I employ to construct measures of information asymmetry, estimates of managerial incentives and the control variables.

4.3.1 Data

The intraday data used to estimate PIN are extracted from the high frequency database of SinoFin, and consist of all time-stamped trades and quotes from January 2002 to December 2008 for A-(local) and B-(foreign) shares traded on the SHSE and SZSE in China. Following Chan et al. (2008), I exclude the days when trading was halted (i.e. when shares reach the price limit of a 10% change with respect to the previous day's close price), and those trading days with less than 100 transactions, and I exclude the first and last fifteen minutes of each trading session during the day. Following Easley et al. (2002), we require a minimum of 60 trading days in one year.

The sample initially includes 1,910 firms that are listed on both the SHSE and the SZSE for both A-shares and B-shares from 2002 to 2009. The Chinese executive compensation data are drawn from the Corporate Governance database of China Stock Market and Accounting Research (CSMAR). The stock return data, accounting information and industrial sector data are from the Wind Financial Database

(WindDB) as well as the CSMAR database. I exclude the observations in 2002 when the data of the corporate ownership concentration are not available. Due to the unavailability of some financial data, the final sample consists of 6,113 firm-year observations from 2003 to 2008.

4.3.2 Measuring Information Asymmetry

Information asymmetry is estimated according to the microstructure model proposed in a series of papers by Easley et al. (1996, 1997a, 1997b), which provides a measure of the probability of information based trading PIN. In their model, marketmakers, through observing market data, update their beliefs of the probability of the trade based on private information and then set the new price. Therefore, over time stock prices converge to the true value of an asset (i.e. the firm) and reflect full information. The model of PIN allows us to make inferences of the unobservable informed trading using the observable trade and quotation data.

According to the setting of the model, a new information event occurs at the beginning of a trading day with a probability of α. If the event occurs, good news happens with a probability of $(1-\delta)$ and bad news happens with a probability of δ. Whether there is new information at the beginning of the trading day and whether the news is good or bad are chosen by nature. Throughout the trading day, trades are assumed to arrive following Poisson processes. Orders from informed traders arrive at a rate of μ (only on information event days). Informed traders buy if the event is good and otherwise sell. Buy orders from uninformed traders arrive at a rate of ε_b, and sell orders from uninformed traders arrive at a rate of ε_s. Easley et al. (1996, 1997a, 1997b) show that the unobservable parameter set, $\theta=(\alpha, \delta, \mu, \varepsilon_b, \varepsilon_s)$, reflecting the information structure of trades, can be estimated via maximum likelihood.

For a single trading day *i*, the likelihood function is:

$$L(\theta|B_i,S_i) = \alpha(1-\delta)e^{-(\mu+\varepsilon_b)}\frac{(\mu+\varepsilon_b)^{B_i}}{B_i!}e^{-\varepsilon_s}\frac{{\varepsilon_s}^{s}}{S_i!}$$

$$+\alpha\delta e^{-\varepsilon_b}\frac{{\varepsilon_b}^{B_i}}{B_i!}e^{-(\mu+\varepsilon_s)}\frac{(\mu+\varepsilon_s)^{S_i}}{S_i!}$$

$$+(1-\alpha)e^{-\varepsilon_b}\frac{{\varepsilon_b}^{B_i}}{B_i!}e^{-\varepsilon_s}\frac{{\varepsilon_s}^{S_i}}{S_i!} \qquad eq.(3.1)$$

where B_i and S_i denote respectively the total number of buyer-initiated and seller-initiated trades for day *i* and $\theta=(\alpha, \delta, \mu, \varepsilon_b, \varepsilon_s)$ is the parameter vector.

Assuming that trading days are independent, Easley et al. (2002) give the likelihood function for a period of *I* trading days as follows:

$$L(\theta|M) = \prod_{i=1}^{I} L(\theta|B_i,S_i) \qquad eq.(3.2)$$

where $M = ((B_1,S_1),...,(B_i,S_i))$ represents the dataset during the I trading days. Maximizing (3.2) by using the dataset M can provide the estimates of the parameters.

The probability that the trade is information-based, PIN, is derived as follows:

$$PIN = \frac{\alpha\mu}{\alpha\mu+\varepsilon_b+\varepsilon_s} \qquad eq.(3.3)$$

where $\alpha\mu$ is the daily arrival of informed trades and $(\alpha\mu+\varepsilon_b+\varepsilon_s)$ is the arrival of both informed and uninformed trades. The PIN variables provide a direct measure of the risk derived from information-based trading and reflect the level of information asymmetry. PIN has been widely applied to the stocks in different countries over different time periods for various research questions in the previous literature[10].

[10] The PIN estimates have been applied to the stocks listed in the NYSE that operates with a specialist system [see Easley, Hvidkjaer and O'Hara (2002), Bardong et al. (2009) and others]. It has also been applied by other researchers to stock markets that are order-driven without marketmakers. For example, Borisova and Yadav (2008) use PIN for stocks in European countries; Copeland et al. (2009) and Chan et al. (2010) use PIN for stocks in mainland China; and Lu and Wong (2008) use PIN for stocks in Taiwan stock market. In an order-driven market, the uninformed trader, similar to a marketmaker in the specialist system, serves as the liquidity provider to the liquidity demander who is an informed trader.

In order to estimate PIN, the daily number of buys (B_i) and sells (S_i) are required. However, the dataset records the intraday trades and quotations without showing whether each trade is initiated by a buy or a sell. Following Easley et al. (2002), I use the standard Lee and Ready (1991) algorithm to classify the trades as buys or sells. The algorithm classifies any trade with a trading price higher (lower) than the immediate midpoint of the bid and ask as a buyer-initiated (seller-initiated) trade. For a trade happening at the midpoint, it is classified as a buy (sell) if its price is higher (lower) than the most recent but different trading price[11]. Following Lee and Ready (1991), I adopt a five-second lag of the recorded quotation time to adjust for the difference between the recording times of the trades and of the quotes.

The maximization of the likelihood function, (3.2), starts from self-selected starting values for the five parameters. Following Yan and Zhang (2010), Venter and Jongh (2004) and Borisova and Yadav (2010), I specify 125 sets of starting values for the five parameters. The maximization is performed based on each set of the acceptable starting values and then the one that achieves convergence and generates the highest value of the likelihood function is used.

Table 2 provides the summary statistics of the annual estimates of PIN and its parameter measures for all shares traded on the SHSE and SZSE during the period from January 2002 to December 2008. Panel A presents the statistics of PIN. Overall, the mean (median) PIN is 0.23 (0.22) and the standard deviation is 0.08. The average estimate of PIN across all firms is 0.215 in 2002 and it remains at a relatively high level in the following four years. In 2007 and 2008, there is a substantial reduction in the average PIN. One possible explanation is that starting from the bull market in 2006, more uninformed investors join the financial market. In that case, the arrival

[11] If the trading price equals the previous trading price, I will revert to additional lags. The maximum number of lags is two in our study.

rates of uninformed investors (both buyers and sellers) substantially increase. This explanation is supported by evidence from the average arrival rates of uninformed buyers (ε_b) and sellers (ε_s), which are respectively 73.91 and 78.65 in 2006, and are almost tripled up to 232.32 and 240.71 in 2007. The arrival rate of informed investors (μ) increases too but at a lower percentage rate from 2006 to 2007. In addition to the stimulus from the bull market, the reform of non-tradable shares [12]could also attract individual investors to join the market and then raise the arrival rate of uninformed investors after 2006. By the end of 2006, 1,301 listed companies on mainland markets have undergone or already completed their non-tradable share reforms, accounting for 97 percent of the total companies that need to be reformed. The aim of the reform is to change the situation of two kinds of stocks and pricings co-existing in the same market and to strengthen the common interests of all shareholders. In other words, it protects the interests of individual investors and makes the financial markets more attractive to them. Therefore, the reform of non-tradable shares is probably responsible for the higher arrival rate of uninformed investors and lower PIN in 2007 and 2008. However, since there is no data precisely capture the process of each firm in its reform of non-shares, we can not empirically evaluate the effect of this reform towards my results. Moreover, the average PIN in the SZSE is significantly higher than the one for the SHSE at the 5% level.

Panel B in Table 2 shows the statistics of the estimated parameters that are used to calculate PIN over the entire sample period. The mean (median) of α, the

[12]Not all the shares in a company incorporated in China that are listed on a stock exchange are freely tradable. The split share structure of the Chinese public securities market refers to the existence of a large amount of non-tradable shares, including state-owned shares and legal person shares of a listed Chinese company. Only about one-third of the shares in a listed Chinese company are freely tradable. The China Securities Regulatory Commission (CSRC) in 2005 published the guidance notes on the split share structure reform of listed companies or the reform of non-tradable shares. The reform is designed to float the non-tradable legal person shares through the open market. Such legal person shares could, under the reform program, be converted to tradable A-shares. The converted A-shares are subject to a lockup period.

probability of an information event in a day, is 0.287 (0.266), and the mean (median) δ is 0.362 (0.227), indicating that most of the information is good news.

[TABLE 2 HERE]

According to Chan et al. (2008), the average level of the PIN estimate is higher for the B-shares than for the A-shares due to the small amount of uninformed trades in the B-shares market. I analyze firms that have both A-shares and B-shares in one sample. In Table 3, the PIN statistics of B-shares versus the corresponding A-shares are presented. The differences in PIN between A-shares and B-shares are not consistently positive or negative over years. In most years, the PIN estimate is higher for B-shares than the A-shares, because the PIN parameters, ε_b and ε_s, are significantly higher for A-shares than for B-shares. The difference in ε_b and ε_s between A-shares and B-shares are significantly and positively different from zero at the 1% level for all years in both exchanges. As pointed out by Chan et al. (2008), the higher information asymmetry in the B-shares market is attributed to the relatively low number of uninformed trades. However, the PIN estimate and its parameters in my study are not directly comparable to those in Chan et al. (2008). They focus on the event when Chinese citizens are allowed to trade B-shares in March 2001 using the monthly PIN from January 2000 to November 2001, while my data start from 2002.

[TABLE 3 HERE]

Lin and Su (2008) claims that China's financial markets are less fully developed and largely segmented from the rest of the world. They are characterized by a lack of reliable information and a high degree of information asymmetry. Comparing my estimates with the estimates of PIN in other regions, the Chinese firms are shown to have a higher level of information asymmetry. In Easley et al.

(2002), the mean, median and maximum of PIN in the U.S. from 1983 to 1998, are respectively 0.191, 0.185 and 0.530. In Taiwan, the PIN statistics from 1997 to 2005, reported by Lu and Wong (2008), have a mean of 0.20 and a median of 0.18. Different from our study, Copeland et al. (2009) estimate the monthly PIN in the SHSE from 2001 to 2006 and find an average of 0.114.

4.3.3 Measuring CEO incentives

Appropriate compensation that ties the CEO's welfare to the shareholders' interests gives the manager incentives to select and implement actions that maximize shareholders' wealth (Jensen and Murphy, 1990). An increase of managerial ownership also contributes to the improvement in firm performance (Core and Larcker, 2002). I employ the pay-performance sensitivity to measure the appropriateness of the reward structures to top managers. According to Jensen and Murphy (1990), I define the pay-performance sensitivity (PPS) as the RMB change in the CEO's wealth associated with a 1000 RMB change in the shareholders' wealth, as follows:

$$PPS_{it} = \left(OWN_{i,t-1} + \frac{\Delta(CEO\ pay_{related} Wealth)_{i,t}}{\Delta(Shareholder\ Wealth)_{i,t}} \right) \times 1000 \qquad eq.(4.1)$$

where $OWN_{i,t-1}$ measures the change of CEO's wealth from the stock ownership and other pay-related wealth including the basic salary and bonus in firm *i* at the end of time *t-1*. The change in shareholder wealth is defined as $r_t V_{t-1}$, where r_t is the rate of return on common stock realized in year *t*, and V_{t-1} is the firm value at the end of the previous year.

The pay-performance sensitivity measures the impact of a change in equity value on the manager's wealth. Higher pay-performance sensitivity can drive a CEO to work harder to achieve higher profits and efficiency and to increase the market

value of the firm for the shareholders' benefit (Firth et al., 2006). Hall and Liebman (1998) and Murphy (1999) show that in the U.S., the pay-performance sensitivity in the compensation structure is mostly driven by the value changes of CEO holdings of stock and stock options[13]. Hence, it is necessary to include the stock ownership of CEO in the firm to capture the effect of stock price on the managerial compensation.

4.3.4 Control Variables

A set of control variables are included to incorporate the characteristics of the firms and the CEOs. According to Firth et al. (2006), ownership structure plays a strong effect on the managerial incentives in China. Most listed firms have a controlling shareholder in China, the central or regional government, or a State Owned Enterprise (Lin and Su, 2008). According to Firth et al. (2006), when the State is the dominant owner or the largest shareholder, CEO pay is less constrained by firm performance in China. To control for the political influence from the government, I include a dummy variable, *GOV*, that is coded 1 if the firm is a *SOE* and coded 0 otherwise. I also include the state ownership (*STATE*) to capture the government effects, which is the percentage of shares held by the state agency. To control for other influences of ownership structure, I include the measure of *ownership concentration (SHRZ)*, which is defined as the ownership of the largest shareholder over that of the second largest shareholder. Firth et al. (2006) states that a distinct characteristic of Chinese firms is that they have one dominant shareholder whose ownership is much higher than the next largest shareholder.

According to the model of Holmstrom and Tirole (1993) and Hartzell and Starks (2003), institutional ownership is strongly related with the pay-performance

[13] Recent research studies on the U.S companies also include stock options to the CEO's pay-related wealth. However, I ignore the stock options in our study because the option data for the CEO's compensation in China are not fully disclosed.

sensitivity of executive compensation since institutional investors are better at monitoring executive behavior. Hence, I include the institutional ownership *(INS)* variable to control for this monitoring effect, which is the total institutional shareholding as a percentage of the total number of shares outstanding. Schaefer (1998) models the relation between firm size and pay-performance sensitivity and provides evidence that pay-performance sensitivity declines with firm size. Accordingly, *firm size (SIZE)* is included, which is measured as the natural logarithm of market value of equity. Demsetz and Lehn (1985) shows that *stock return volatility (VOLATILITY)* can be considered as noise that increases the monitoring cost. I therefore include the annualized stock volatility, which is the standard deviation of daily stock price returns. To measure a firm's performance, I calculate *Tobin's Q (Q)* as the ratio of the market value of equity plus book value of total debts divided by the book value of assets. I also include the *return on assets (ROA)*, which is defined as the net income before extraordinary items and discontinued operation divided by total assets. To capture the variation across industries, I include industry dummy variables to test the industry effects on managerial incentives. According to the two-digit industry code of CSRC (China Securities Regulation Commission), 13 industries are considered. Other control variables are *CEO's tenure*, *CEO's age* and year dummies.

4.3.5 Summary Statistics

Table 11 shows the descriptive statistics of the annual estimates of executive incentives measures and other control variables. The mean and median values of the pay-performance sensitivity (PPS) are RMB1.69 and RMB1.72, respectively. Compared with the average level of PPS, $40.79, in the U.S. market, as shown by

Kang and Liu (2008), the managerial pay-performance sensitivity in China is much lower. As for the compensation package, the executives in international listed firms usually receive four types of economic rewards. The first one is the basic salary, which refers to the fixed remuneration not associated with job performance. The second one is the annual income, including non-cash welfare benefits, allowances, tax benefits and pension. The third one is short-term incentive, primarily refers to the annual bonus which is associated with firm performance. The last one is the long-term incentive payouts, refers to stock options and restricted stock. In China, listed companies have adopted the Annual Salary System in general, consisting of salary and bonus mainly. Since 2006, the executive stock option schemes were carried out gradually for long-term managerial incentive[14]. According to the statistics in Table 11, comparing the two different components of PPS, the basic salary and bonus are obviously more influential, since the average CASH_PPS is 1.22 taking up 72% of the overall pay-performance sensitivity. Meanwhile, the average PPS from CEO's stock ownership is next to zero. The results are consistent with the previous explanation of the Annual Salary System adopted by China's listed firms. In my sample, among the total 6,113 firm-year observations, around 70% (4340) of them belong to State Owned Enterprises and the mean value of the state ownership for the whole sample is 30%. At the same time, the averages of the institutional ownership and the ownership concentration are 15.53 and 19.17. The average age and tenure of

[14]In 2005, the CSRC launched a reform of non-tradable shares, which was accompanied by a series of changes in the Corporate Law and Security Law. It paved the way for granting stock options to executives. Effective from 2006, the new rule allow publicly traded firms that have successfully completed structural reforms to offer stock options or restricted stocks to their higher management, board and supervisory board members, excluding independent board members, CSRC (2005). Hence, there is no use of the stock options in managerial incentives in China before 2006. Firth et al. (2006) also indicates another reason that the listed companies reject the options incentive. It suggests that CEO's turnover in China is so frequent that the executives can not exercise their options in their tenure. Moreover, the return on options is related with macro economy to some extent, such as the economic policy and the trade policy, rather than the manager's efforts, which finally reduce the effect of long-term incentive.

the CEOs in China are respectively 45.78 and 2.83, which are lower than the findings for the CEOs in the U.S., as shown by Kang and Liu (2008), where the average age is 55.07 and the average tenure is 7.67.

[TABLE 11 HERE]

In China, most listed firms have a controlling shareholder that influences its strategies and policies, including the compensation structures. Central or regional government is often the ultimate owner of the controlling stake. In other cases, the controlling shareholder is a *SOE* or a private blockholder. The different types of controlling investor may have different incentive structure for the CEO. According to Firth et al. (2006), when the State is the controlling shareholder, CEO pay does not depend on firm performance. In contrast, when the largest shareholder is SOE or private blockholder, CEO pay is positively related with the accounting performance and stock returns. Therefore, I explore the differences in ownership and assess their implications for compensation policy.

Table 12 partitions the sample into two parts: government controlled versus non-government controlled firms. Consistent with previous analysis, Table 12 shows that the average PPS for government-controlled firms and non-government-controlled firms are 1.68 and 1.69, respectively. The t-statistics for the difference in sample means is significant at the 10% level, indicating that the CEO's pay-performance sensitivity in State Owned Enterprises is lower compared with private firms. The statistics of the other variables in Table 12 also show that government-controlled firms differ substantially from non-government-controlled firms in China. In particular, the state owned firms overall have significantly lower stock price volatility and Tobin's Q; but larger firm size, higher institutional ownership, higher ownership concentration and higher ROA than private firms. Meanwhile, CEOs in

government-controlled firms are older and have greater working tenure. These results indicate that government control is an important factor for the corporate structure, firm value and the tenure of the CEO.

[TABLE 12 HERE]

4.4 Regression Analysis

In this section I present the main results on the relation between the CEO compensation incentives and the probability of informed trading (PIN) for firms listed in China.

4.4.1 Econometric specification and hypotheses

I specify the regression model measuring the relation between information asymmetry and CEO's compensation sensitivity as follows:

$$PPS_{i,t} = \alpha_0 + \alpha_1 PIN_{i,t-1} + \alpha_2 SIZE_{i,t-1} + \alpha_3 VOLATILITY_{i,t-1} + \alpha_4 Q_{i,t-1} + \alpha_5 ROA_{i,t-1} + \alpha_6 STATE_{i,t-1} + \alpha_7 GOV_{i,t-1} + \alpha_8 GOV_{i,t-1} \times PIN_{i,t-1} + \alpha_9 INS_{i,t-1} + \alpha_{10} SHRZ_{i,t-1} + \alpha_{11} AGE_{i,t-1} + \alpha_{12} TENURE_{i,t-1} + \sum_k \varphi_k \, Industry\ Dummies + \sum_t \phi_t \, Year\ Dummies + \varepsilon_{i,t}$$

eq. (4.2)

where PPS refers to the CEO's pay-performance sensitivity defined in eq. (4.1), and PIN stands for the probability of informed trading, measuring the amount of private information available in stock market. The rest are the control variables, as described in section (4.3). The independent variables are lagged one year compared to the dependent variables, in order to test how these variables affect the compensation contracting in the following year. The interaction term, GOV×PIN, measures the effect of the interplay between government control and information asymmetry on

the CEO's pay-performance sensitivity. Under the econometric specification in eq. (4.2), I test the following hypothesis:

H_0: $\alpha_1 = 0$.

H_1: $\alpha_1 > 0$.

The coefficient α_1 captures the influence of information asymmetry on incentives. A higher PIN indicates that more private information is revealed from stock market trading. Shareholders tend to spend more time and resources on monitoring the firm, which in turn, will increase the CEO's pay-performance sensitivity. I therefore expect a positive α_1 which indicates a positive relation between the PIN and the CEO's pay-performance sensitivity.

4.4.2 Regression results

I use panel data regression to evaluate the influence of information asymmetry on managerial incentives. Since my data sample is long enough with 7 years, fixed-effect estimation is carried out to control for the time variation in cross-section units. Table 13 presents the regression results of eq. (4.2).

According to the summary statistics, some of the PPS is unexpectedly negative, indicating that the CEO's wealth declines although the wealth of shareholders increases. To limit the effect of such firms, the regression model defined by eq. (4.2) is also estimated by using the sample including only positive PPS, and the results are shown under the columns with a title of PPS+. In Table 13, columns (1) and (2) are the results for the whole sample while columns (5) and (6) are for those with positive PPS. I also examine the relationship between PIN and PPS separately for the two different components of CEO's compensation package. In columns (3) and (4) of

Table 13, the stock ownership based and the salary and bonus based pay-performance sensitivity are included as the dependent variables respectively.

Table 13 shows how the CEO incentives respond to the probability of informed trading (PIN), after control for general firm-specific characteristics and corporate ownership structure. The estimated coefficients on the PIN measure (α_1) are all significantly positive in most columns, confirming the effect of PIN on a CEO's pay-performance sensitivity. Nevertheless, the increase of adjusted R-square in columns (5) and (6) indicate that PIN is better in explaining the firm's pay-performance sensitivity when the firm's managerial compensation is positively related to shareholders' wealth. However, the managerial incentives from CEO's stock holding itself can not be effected by the market microstructure since the coefficient estimates of PIN is insignificant in column (3) where OWN_PPS is the dependent variable. One possible explanation leads to this inconsistent result is that the stock ownership takes up less than 30% of the total compensation package which is much less influential than the compensation from basic salary and bonus. Accordingly, the salary and bonus based PPS is highly related with information asymmetry as the coefficient estimate of CASH_PPS is significantly positive in column (4). Therefore, CEO's salary and bonus is a considerable part of the executive compensation package in China and it drives the overall pay-performance sensitivity to be related with information asymmetry.

Table 13 also shows that the estimated coefficients of some control variables are statistically significant. The signs and significance levels of the control variables are consistent with those in the literature. For example, Firth et al. (2006) indicate the CEO's pay-performance sensitivity is very low if the State Bureau has a controlling stake. Consistent with this analysis, I also find a significantly negative relation

between the top managers' pay-performance sensitivity and the government control dummy variable (*GOV*). Consistent with the conclusion in Hartzell and Starks (2003) that institutional ownership is beneficial for managerial incentives, I find a significantly positive coefficient on institutional ownership.

[TABLE 13 HERE]

Because the measure of pay-performance sensitivity is highly skewed, I also substitute the above panel data regression with median regression to test the robustness of the results following Kang and Liu (2008). Table 14 presents the median regression results based on eq. (4.2). As Table 13 shows that PIN is better at explaining the sample of positive PPS, I focus on these observations and estimate the regression equation defined by eq. (4.2). Columns (1), (2) and (3) show the regression results by using data from the whole market. In considering the variations across stock exchanges, I partition the sample into firms listed in SHSE and firms listed in SZSE and check the effect of information asymmetry on managerial incentives following the above econometric specification. The regression results in columns (4) and (5) in Table 14 are for the data from the SHSE and the SZSE respectively. Moreover, I exclude the observations from B-shares and investigate the relation between PIN and CEO pay-performance sensitivity by including A-shares only from the whole sample. The regression results are shown in columns (6).

In Table 14, PIN is highly significantly and positively related with PPS in all columns, at the 1% or 5% level. The coefficient estimates of variables as well as the explanatory power of the model remain similar across the different columns. Consistent with the panel data regression, the positive effect of PIN on PPS is shown to be weaker for the government-controlled firms than for the non-government-controlled firms, as the coefficient estimates for the interaction terms, GOV×PIN, are

significantly negative at the 1% level in columns (2), (3), (4) and (6). However, in column (5) with data from SZSE only, I find that the coefficient estimates of the government-control dummy variable, GOV and the interaction term, GOV×PIN are insignificant, indicating little state influence on managerial incentives in SZSE. The result is expectable as most of the powerful SOEs prefer to be listed in SHSE, such as the big four state owned commercial banks, Ping'an insurnace, China Life insurance, Sinopec, China Unicom, etc. Comparably, SZSE has fewer influential SOEs and surfer less political interruption when it comes to corporate governance. In the panel data regression in Table 13, the estimates of pay-performance-sensitivity are highly skewed and drive the coefficients of several explanatory variables to be relatively high. Under median regression in Table 14, the magnitudes of the estimated coefficients are smaller. The results overall remain consistent for the fixed-effect panel data regression in Table 13 and for the median regression in Table 14.

[TABLE 14 HERE]

4.5 Robustness Test: Instrumental Variable (IV) estimation

In this section, I assume the effect of information asymmetry on managerial incentives to be endogenous. I apply an instrumental variable estimation technique to isolate the influence of PIN on pay-performance sensitivity.

According to Thomas (2002), the accuracy of consensus forecasts (ERROR) and the dispersion (DISPERSION) among the forecasts of financial analysts can be considered as proxies for asymmetric information. Firms with larger information asymmetry between managers and outsiders regarding earnings are expected to have higher forecasting errors. The disagreement among financial analysts arises from a lack of available information about a firm.

Based on Gu and Wu (2003), analyst forecast error (*ERROR*) for firm *i* in year *t* is defined as the difference between the actual earnings per share (*EPS*) and the mean forecast deflated by the stock price at the beginning of the year, as follows:

$$ERROR_{i,t} = \frac{actual\ EPS_{i,t} - analyst\ forecast_{i,t}}{Price_{i,t-1}} \times 100 \qquad eq.(4.3)$$

The analysts' forecast dispersion is a measure of disagreement among analysts, which is defined as the standard deviation of analysts' forecasts deflated by the stock price five days before the earnings announcement date (Thomas, 2002), as follows:

$$DISPERSION_{i,t} = \frac{std(analyst\ forecast)_{i,t}}{Price_{i,t}} \times 100 \qquad eq.(4.4)$$

For the IV approach, I include the above two measures, ERROR and DISPERSION, as my instrumental variables for the robust tests examining the endogeneity problem. In the first step, I estimate PIN against a set of firm-specific characteristics using the following model:

$$PIN_{i,t} = \alpha_0 + \alpha_1 ERROR_{i,t} + \alpha_2 DISPERSION_{i,t} + \alpha_3 SIZE_{i,t} + \alpha_4 VOLATILITY_{i,t} + \alpha_5 Q_{i,t} + \alpha_6 ROA_{i,t} + \alpha_7 STATE_{i,t} + \alpha_8 INS + \alpha_9 SHRZ_{i,t} + \alpha_{10} AGE_{i,t} + \alpha_{11} TENURE_{i,t} + \varepsilon_{i,t} \qquad eq.(4.5)$$

In the second step, I use the fitted value estimate $\widehat{PIN}_{i,t}$ from regression (4.5) as an instrument for the original PIN estimate and include it along with a number of exogenous variables in the following regression:

$$PPS_{i,t} = \beta_0 + \beta_1 \widehat{PIN}_{i,t-1} + \beta_2 SIZE_{i,t-1} + \beta_3 VOLATILTY_{i,t-1} + \beta_4 Q_{i,t-1} + \beta_5 ROA_{i,t-1} + \beta_6 STATE_{i,t-1} + \beta_7 INS_{i,t-1} + \beta_8 SHRZ_{i,t-1} + \beta_9 AGE_{i,t-1} + \beta_{10} TENURE_{i,t-1} + \sum_k \varphi_k\ Industry\ Dummies + \sum_t \phi_t\ Year\ Dummies + \varepsilon_{i,t} \qquad eq.(4.6)$$

To test the robustness of my results, I use the two-stage least squares (2SLS) procedure with the hypothesis of:

H_0: $\beta_1 = 0$.

H_1: $\beta_1 > 0$.

Columns (1)-(3) in Table 15 report the regression results of the effect of information asymmetry on managerial incentives using ERROR only as the instrumental variable while columns (4)-(6) report the results using both ERROR and DISPERSION as instrumental variables. As shown in the table, the coefficient estimates for the fitted value of PIN, $\widehat{PIN_{i,t}}$, are all significantly positive under the different regression methods (i.e., IV regression or panel data regression with fixed-effects) or model specification in explaining PPS, providing a strong evidence that information asymmetry is associated with higher managerial incentives. Furthermore, consistent with Thomas (2002), the coefficient estimates of ERROR and DISPERSION are significantly positive at the 5% level in column (4), indicating that firm with higher information asymmetry have higher analysts' forecast errors and variation. In addition, the coefficient estimates of other explanatory variables indicate that smaller firms and lower stock price volatility are consistent with higher managerial incentives, which are conformable with the expectation in the literature (e.g. Schaefer, 1998; Demsetz and Lehn, 1985). However, the effects of government ownership on CEO pay-performance sensitivity are no longer significant here.

[TABLE 15 HERE]

4.6 Conclusion

In this chapter, I investigate the role of the probability of information-based stock trading in affecting managerial incentives in China. Using executive compensation data and stock market data, I empirically test the economic significance of how information asymmetry has an effect on optimal contracting. I

use the probability of informed trading (PIN) as a proxy of stock price informativeness and find a significantly positive relationship between the level of information asymmetry (PIN) and the CEO's pay-performance sensitivity (PPS) for Chinese firms.

When more information asymmetry is revealed from the stock market, market monitoring is enhanced to drive the CEO to work in the interests of the shareholders. Consequently, a CEO's pay becomes more sensitive to the wealth of the principals due to extra monitoring and more efficient compensation structure. My study not only highlights the important role of the information based-trading in strengthening executive compensation but also generates useful managerial implications. In particular, the principals should make an effort to promote information-based trading and incorporate trading characteristics (e.g., stock price informativeness, liquidity) into the contracting process. Apart from the function of market monitoring, institutional ownership could also work as an alternative monitoring mechanism in optimal contracting, which deserves the attentions of principals to incentivize executives.

References

Aslan, Hadiye, David Easley, Soeren Hvidkjaer, and Maureen O'Hara. 2008. Firm Characteristics and Informed Trading: Implications for Asset Pricing. Working Paper, University of Houston, Cornell University and Copenhagen Business School.

Bardong, Florian, Söhnke M. Bartram, and Pradeep K. Yadav. 2009. Informed Trading, Information Asymmetry, and Pricing of Information Risk: Empirical Evidence from the NYSE. Working Paper, Lancaster University and Oklahoma University.

Borisova, Ginka, and Pradeep K. Yadav. 2010. How does Privatization affect Information Asymmetry? Evidence from the European Union. Working Paper, Iowa State University and Oklahoma University

Brian J. Hall, and Jeffrey B. Liebman. 1998. Are CEOs Really Paid Like Bureaucrats? *The Quarterly Journal of Economics* 113, no. 3: 653-691.

Chan, K.L, Albert J. Menkveld, and Yang Zhishu. 2008. Information Asymmetry and Asset Prices: Evidence from the China Foreign Share Discount. *The Journal of Finance* 63, no. 1: 159-196.

Chen, Qi, Itay Goldstein, and Wei Jiang. 2007. Price Informativeness and Investment Sensitivity to Stock Price. *Review of Financial Studies* 20, no. 3: 619-650.

Chung, Kee H., John Elder, and Jang-Chul Kim. 2010. Corporate Governance and Liquidity. *Journal of Financial and Quantitative Analysis* 45, no. 02: 265-291.

Copeland, Laurence, Woon K. Wong, and Yong Zeng. 2009. Information-based trade in the Shanghai stock market. *Global Finance Journal* 20, no. 2: 180-190.

Core, John E., and David F. Larcker. 2002. Performance consequences of mandatory increases in executive stock ownership. *Journal of Financial Economics* 64, no. 3.: 317-340.

Demsetz, Harold, and Kenneth Lehn. 1985. The Structure of Corporate Ownership: Causes and Consequences. *Journal of Political Economy* 93, no. 6: 1155-77.

Dittmann, I., and E. Maug. 2007. Lower Salaries and No Options? On the Optimal Structure of Executive Pay. *The Journal of Finance* 62, no. 1: 303-343.

Easley, David, Soeren Hvidkjaer, and Maureen O'Hara. 2002. Is Information Risk a Determinant of Asset Returns? *The Journal of Finance* 57, no. 5: 2185-2221.

Easley, David, Nicholas M. Kiefer, and Maureen O'Hara. 1996. Cream-Skimming or Profit-Sharing? The Curious Role of Purchased Order Flow. *Journal of Finance* 51, no. 3: 811-33.

Easley, David, Nicholas M. Kiefer, and Maureen O'Hara. 1997a. The information content of the trading process. *Journal of Empirical Finance* 4, no. 2-3: 159-186.

Easley, David, Nicholas M., Kiefer, and Maureen O'Hara. 1997b. One day in the life of a very common stock. *Review of Financial Studies* 10, no. 3: 805 -835.

Easley, David, Maureen O'Hara, and Joseph Paperman. 1998. Financial analysts and information-based trade. *Journal of Financial Markets* 1, no. 2. Journal of Financial Markets: 175-201.

Faure-Grimaud, Antoine, and Denis Gromb. 2004. Public Trading and Private Incentives. *Review of Financial Studies* 17, no. 4: 985 -1014.

Firth, Michael, Peter M.Y. Fung, and Oliver M. Rui. 2006. Corporate performance and CEO compensation in China. *Journal of Corporate Finance* 12, no. 4: 693-714.

Grossman, Sanford J, and Joseph E Stiglitz. 1980. On the Impossibility of Informationally Efficient Markets. *American Economic Review* 70, no. 3: 393-408.

Gu, Zhaoyang, and Joanna Shuang Wu. 2003. Earnings skewness and analyst forecast bias. *Journal of Accounting and Economics* 35, no. 1: 5-29.

Hartzell, Jay C, and Laura T Starks. 2003. Institutional Investors and Executive Compensation. *The Journal of Finance* 58, no. 6: 2351-2374.

Haubrich, Joseph G. 1994. Risk Aversion, Performance Pay, and the Principal-Agent Problem. *Journal of Political Economy* 102, no. 2: 258-76.

Hayes, Rachel M. 2004. Discussion of Underwater Options and the Dynamics of Executive Pay-to-Performance Sensitivities. *Journal of Accounting Research* 42, no. 2: 413-421.

Holmström, Bengt, and Jean Tirole. 1993. Market Liquidity and Performance Monitoring. *The Journal of Political Economy* 101, no. 4: 678-709.

Jensen, Michael C., and Kevin J. Murphy. 1990. Performance Pay and Top-Management Incentives. *The Journal of Political Economy* 98, no. 2: 225-264.

Kang, Qiang, and Qiao Liu. 2008. Stock trading, information production, and executive incentives. *Journal of Corporate Finance* 14, no. 4: 484-498.

Kang, Qiang, and Qiao Liu. 2010. Information-Based Stock Trading, Executive Incentives, and the Principal-Agent Problem. *Management Science* 56, no. 4: 682-698.

Kim, Oliver, and Robert E. Verrecchia. 1994. Market liquidity and volume around earnings announcements. *Journal of Accounting and Economics* 17, no. 1-2: 41-67.

Lambert, Richard A., David F. Larcker, and Robert E. Verrecchia. 1991. Portfolio Considerations in Valuing Executive Compensation. *Journal of Accounting Research* 29, no. 1: 129-149.

Lee, Charles M C, and Mark J Ready. 1991. Inferring Trade Direction from Intraday Data. *Journal of Finance* 46, no. 2: 733-46.

Lin, Chen, and Dongwei Su. 2008. Industrial diversification, partial privatization and firm valuation: Evidence from publicly listed firms in China. *Journal of Corporate Finance* 14, no. 4: 405-417.

Lipson, Marc L. 2003. Market microstructure and corporate finance. *Journal of Corporate Finance* 9, no. 4: 377-384.

Lu, Ralph C., and Woon K. Wong. 2008. Probability of Information-Based Trading as a Pricing Factor in Taiwan Stock Market. Working Paper, Ming Chuan University and Tamkang University.

Murphy, Kevin J. 1999. Executive compensation. O. C. Ashenfelter, D. Card, eds. *Handbook of Labor Economics*, Vol. 3B. Elsevier Science, Amsterdam, 2485-2563.

Schaefer, Scott. 1998. The Dependence of Pay-Performance Sensitivity on the Size of the Firm. *The Review of Economics and Statistics* 80, no. 3: 436-443.

Subrahmanyam, A.. 2008. Corporate Governance and Financial Markets. Working Paper, UCLA.

Thomas, Shawn. 2002. Firm diversification and asymmetric information: evidence from analysts' forecasts and earnings announcements. *Journal of Financial Economics* 64, no. 3: 373-396.

Venter, Johannes Hendrik, and Dawid CJ De Jongh. 2004. Extending the EKOP Model to Estimate the Probability of Informed Trading. Working Paper, North-west University.

Yan, Yuxing, and Shaojun Zhang. 2010. An Improved Estimation Method and Empirical Properties of the Probability of Informed Trading. Working Paper, University of Pennsylvania and Nanyang Technological University.

Chapter 5. Conclusion

My study estimates the probability of informed trading (PIN) measure in China and uses it as a proxy of information asymmetry to analyze its economic role on firm diversification discount and managerial incentives.

There are several findings about the PIN in China's financial markets. First of all, compared with the U.S. data, the PIN estimate is higher in China, indicating a more serious information asymmetry problem in this financial market. Secondly, the information asymmetry levels in the two separated stock exchanges are significantly different. The average PIN in the SZSE is higher than the one in the SHSE, indicating the more severe information problems in the SZSE. Thirdly, the PIN estimate is higher for the B-shares than for A-shares in some years, which indicates that there is more uninformed trading in the A-shares market.

I perform two independent research studies using the PIN estimates in China. Firstly, the role of information asymmetry on corporate diversification is examined. Although most empirical studies conclude that diversification is a value-destroying activity, there is less empirical evidence discussing why this discount exists. The quantitative results in this study suggest that diversified firms have more severe information problems and that increased information asymmetry is responsible for the loss of the firm value. The strategy of corporate diversification itself is not value-destroying. The loss of value is caused by the lack of transparency.

Secondly, I examine the relation between executive incentives and stock price informativeness. The empirical findings imply that information asymmetry helps strengthen managerial incentives as a significantly positive relation between PIN and executive pay-performance sensitivity is found. After using analyst forecast error and

dispersion as instrumental variables to control for the endogeneity problem, the results remain unchanged. These conclusions suggest that the information incorporated into stock prices helps connect executive compensation to firm performance and mitigate the principal-agency problem to some extent.

With the estimate of PIN and its corresponding parameters, there are several issues could be investigated in the future. While previous research tests the risk of information asymmetry in the U.S. and other countries (Easley et al., 2005; Lu and Wong, 2008), the intricate explanatory power of PIN on the asset returns in China is left unexplored. Copeland et al. (2009) have tested only the information risk in the SHSE. Since the information environment is important for the investment visibility and profit of outsider investors, I could also examine the effect of information asymmetry on earnings surprise. Finally, it is worthwhile to investigate the impacts of state and foreign ownership on information asymmetry using the evidence from emerging markets, such as China.

References

Copeland, Laurence, Woon K. Wong, and Yong Zeng. 2009. Information-based trade in the Shanghai stock market. *Global Finance Journal* 20, no. 2: 180-190.

Easley, David, and Maureen O'hara. 2004. Information and the Cost of Capital. *The Journal of Finance* 59, no. 4 (August 1): 1553-1583.

Lu, Ralph C., and Woon K. Wong. 2008. Probability of Information-Based Trading as a Pricing Factor in Taiwan Stock Market. Working Paper, Ming Chuan University and Tamkang University.

Table 1 Yearly market overview in China's stock market

	2002	2003	2004	2005	2006	2007	2008
Panel A: Shanghai Stock Exchange (SHSE)							
No. of Trading Days	237	241	243	242	241	242	246
No. of Listed Companies	715	780	837	833	842	860	864
Market Capitalization *(100 Million RMB Yuan)*	25363.72	29804.92	26014.34	23096.13	71612.38	269838.87	97251.91
A-shares	24921.42	29400.65	25714.07	22856.07	71117.95	268497.27	96875.31
B-shares	442.3	404.27	300.27	240.06	494.43	1314.6	376.59
Composite Index	1357.65	1497.04	1266.5	1161.06	2675.47	5261.56	1820.81
Panel B: Shenzhen Stock Exchange							
No. of Trading Days	237	241	243	242	241	242	246
No. of Listed Companies	508	505	536	544	579	670	740
Market Capitalization *(100 Million RMB Yuan)*	12965.41	12652.79	11041.23	9334.15	17791.52	57302.02	24114.53
A-shares	12605.14	12119.83	10181.84	8472.93	14980.71	45443.63	17421.56
B-shares	360.27	532.96	445.95	379.67	795.51	1211.55	423.29
Composite Index	512.38	449.42	470.55	333.28	550.59	1551.19	1576.5

Source: complied from the webpage of Shanghai Stock Exchange and Shenzhen Stock Exchang

Weblink: http://www.sse.com.cn/sseportal/en/home/home & http://www.szse.cn/main/en

Table 2 Summary statistics for PIN measure

Variables	mean	s.d.	median	25%	75%	Nobs
Panel A: Summary Statistics of PIN						
2002	0.215	0.068	0.214	0.177	0.251	1,247
2003	0.316	0.093	0.319	0.261	0.375	1,296
2004	0.234	0.067	0.248	0.192	0.283	1,444
2005	0.243	0.046	0.247	0.22	0.272	1,429
2006	0.227	0.05	0.231	0.201	0.261	1,489
2007	0.18	0.05	0.179	0.148	0.211	1,584
2008	0.176	0.057	0.170	0.136	0.218	1,663
SHSE	0.223	0.081	0.219	0.169	0.266	5,869
SZSE	0.227	0.068	0.230	0.181	0.270	4,283
Total	0.225	0.076	0.224	0.174	0.268	10,152
Panel B: Summary Statistics of PIN parameters						
α	0.287	0.137	0.266	0.182	0.372	10,152
δ	0.362	0.348	0.227	0.06	0.661	10,152
μ	130.611	88.341	109.726	62.653	187.891	10,152
ε_b	93.806	129.28	39.034	14.872	118.114	10,152
ε_s	99.482	129.612	46.375	17.489	127.598	10,152

The table shows the summary statistics of the annual PIN estimates and the parameters for 1,869 firms listed in SHSE and SZSE during the period from 2002 to 2008 with 10,152 firm-year observations. Panel A presents the summary statistics of PIN estimates by year and then by stock exchanges; Panel B shows the parameters that are used to calculate PIN.

Table 3 Comparison of PIN: B-shares versus the corresponding A-shares

Panel A: SHSE								
		A-share		B-share		Diff PIN		
Year	# of firms	mean	s.d.	Mean	s.d.	mean	s.d.	t-stat
2002	19	0.2037	0.0353	0.2134	0.2199	-0.0097	0.2188	-0.1940
2003	22	0.3296	0.1027	0.3456	0.0708	-0.0160	0.0035	-21.1670
2004	34	0.2408	0.0688	0.2231	0.0518	0.0178	0.0896	1.1577
2005	27	0.2699	0.0472	0.2174	0.0625	0.0524	0.0728	3.7406
2006	44	0.2471	0.0499	0.2543	0.0518	-0.0072	0.0755	-0.6293
2007	44	0.1918	0.0464	0.2134	0.0888	-0.0197	0.0867	-1.4940
2008	44	0.1999	0.0512	0.2267	0.0464	-0.0490	0.0694	-4.6871
Total	44	0.2296	0.0731	0.2379	0.0936	-0.0083	0.1067	-1.1887
Panel A: SZSE								
		A-share		B-share		Diff PIN		
Year	# of firms	mean	s.d.	mean	s.d.	mean	s.d.	t-stat
2002	35	0.2283	0.0502	0.2283	0.0496	0.0000	0.0725	0.0023
2003	34	0.3039	0.0401	0.3177	0.0696	-0.0138	0.0975	-0.8268
2004	37	0.2670	0.0352	0.2400	0.0354	0.0270	0.0569	2.8842
2005	30	0.2550	0.0441	0.2221	0.0537	0.0329	0.0833	2.1635
2006	39	0.2221	0.0546	0.2546	0.0365	-0.0325	0.0692	-2.9379
2007	40	0.1724	0.0468	0.2149	0.0700	-0.0425	0.0805	-3.3407
2008	34	0.1614	0.0479	0.2265	0.0547	-0.0651	0.0644	-5.8949
Total	42	0.2285	0.0688	0.2432	0.0625	-0.0147	0.0816	-2.8465

The table shows the mean and standard deviation (s.d.) of the annual PIN estimates for the firms traded as both A-shares and B-shares during the period from 2002 to 2008. Panel A shows the statistics for SHZE and Panel B for SZSE. The annual difference between the PIN of A-shares and that of its corresponding B-shares is summarized under the columns of "Diff PIN" (Diff PIN = PIN_A – PIN_B).

Table 4 Summary statistics: diversification measures, firm and CEO specific characteristics

Variables	Definition	mean	s.d.	median	25%	75%
DIV	Dummy variables for diversification	0.55	0.50	1.00	0.00	1.00
HI	Herfindahl Index for diversification	0.73	0.24	0.77	0.51	0.97
Q	Tobin's Q	1.35	0.51	1.15	1.00	1.49
ROA	Return on assets	0.05	0.06	0.05	0.03	0.08
SIZE	The logarithm of total assets	21.45	1.08	21.36	20.75	22.06
VOLATILITY	Annualized volatility of daily stock return	0.48	0.17	0.45	0.36	0.61
TAGrow	The percentage annual change in total assets	0.15	0.50	0.08	-0.01	0.21
INTANG	The ratio of intangible assets to total assets	0.04	0.06	0.02	0.01	0.05
LEVERAGE	The ratio of book value of debt to total assets	0.51	0.17	0.52	0.38	0.64
STATE	The percentage of shares held by State Agencies	30.54	24.37	31.73	2.00	51.46
GOV	A dummy variable that takes 1 if it is a state owned firm	0.70	0.46	1.00	0.00	1.00
INS	The percentage of shares held by Institutions	14.28	17.29	6.48	0.87	21.66
SHRCR	The percentage of shares held by the largest shareholder	38.62	16.31	36.27	25.7	51.11
AGE	The number of years after going public	8.03	3.50	8.00	6.00	11.00
EXCHANGE	A dummy variable that takes 1 if firm listed in SHSE	0.54	0.50	1.00	0.00	1.00

The table presents the summary statistics of the annual estimates of diversification, firm values, and other firm-level and industry-level control variables over the period from January 2003 and December 2008.

Table 5 Correlation matrix

	PIN	DIV	HI	Q	ROA	SIZE	VOLATILITY	TAGrow	ITANG	LEVERAGE	STATE	GOV	INS	SHRCR
DIV	0.02*													
HI	0.01	-0.68***												
Q	-0.01	-0.01	0.00											
ROA	0.00	-0.01	0.00	0.61***										
SIZE	-0.17***	-0.03***	0.07***	-0.13***	-0.10***									
VOLATILITY	-0.26***	-0.04***	0.00	0.00	-0.01	-0.08***								
TAGrow	-0.05***	-0.07***	0.02	-0.01	-0.02**	0.13***	0.20***							
INTANG	-0.03***	0.05***	-0.06***	-0.01	-0.01	-0.15***	0.02***	-0.08***						
LEVERAGE	0.00	-0.02	-0.01	0.30***	0.08***	-0.15***	-0.01	-0.03***	-0.01					
STATE	0.08***	-0.06***	0.08***	-0.02*	-0.01	0.24***	-0.09***	0.00	-0.07***	-0.02				
GOV	-0.01	-0.07***	0.03**	0.00	-0.01	0.22***	-0.06***	0.04***	-0.07***	0.00	0.67***			
INS	-0.17***	-0.11***	0.04***	-0.01	-0.01	0.36***	0.08***	0.13***	-0.03***	-0.03**	-0.04***	0.04***		
SHRCR	0.08***	-0.12***	0.14***	-0.02*	-0.01	0.25***	-0.01	0.07***	-0.09***	-0.02**	0.55***	0.33***	0.05***	
AGE	-0.18***	0.11***	-0.08***	0.01	0.00	0.05***	0.13***	-0.06***	0.09***	0.05***	-0.15***	-0.05***	0.00	-0.20***

This table presents the correlations among all candidate variables for diversification and firm value. These variables include the measure of information asymmetry (PIN), Tobin's Q (Q), return on assets (ROA), firm size (SIZE), stock return volatility (VOLATILITY), the change in total assets (TAGrow), the percentage of intangible assets (INTANG), leverage, state ownership (STATE), government-controlled dummy variable (GOV), institutional ownership (INS), ownership concentration (SHRCR) and the number of years of firms after went public (AGE). All the variables are annual measures during the period from January 2003 to December 2008. And the *, ** and ** stand for the significance at the 10%, 5% and 1% level, respectively.

Table 6 Comparison of diversified and non-diversified firms

Variable	Diversified firms		Non-diversified firms		
	mean	s.d.	mean	s.d.	mean difference
PIN	0.23	0.08	0.22	0.07	0.01**[1.81]
Q	1.34	0.51	1.36	0.50	-0.02*[1.38]
ROA	0.04	0.05	0.05	0.06	-0.01***[-5.24]
SIZE	21.38	1.02	21.54	1.15	-0.16***[-5.50]
VOLATILITY	0.50	0.44	0.54	0.46	-0.04***[-4.00]
TAGrow	0.14	0.50	0.17	0.49	-0.03**[-2.22]
INTANG	0.05	0.06	0.04	0.06	0.01***[4.41]
LEVERAGE	0.55	0.59	0.54	0.53	0.02[1.02]
STATE	0.28	0.24	0.34	0.25	-0.06***[- 8.42]
GOV	0.66	0.47	0.73	0.44	-0.07***[-5.61]
INS	13.18	17.07	16.73	20.35	-3.55***[-6.95]
SHRCR	36.53	15.98	41.21	16.33	-4.68***[-10.57]
AGE	8.28	3.52	7.72	3.44	0.56***[5.89]
Nobs	2979		2398		

***, ** and * denote respectively, significance level of 1%, 5% and 10% for a two-tailed two sample t-test. And the numbers in the brackets are the t-statistics.

Table 7 Comparison of government-controlled versus non-government-controlled and diversified versus non-diversified firms

		Diversified firms	Non-diversified firms	Row Test
PIN	Government-Controlled	0.22(0.07)	0.22(0. 07)	0.00[0.60]
	Non-government	0.22(0.07)	0.23(0.07)	-0.00[-0.63]
	Col Test	0.00[0.05]	-0.00[-1.08]	
Q	Government-Controlled	1.28(0.47)	1.27(0.45)	0.01[0.70]
	Non-government	1.42(0.57)	1.47(0.60)	-0.05**[- 1.65]
	Col Test	-0.14***[- 6.71]	-0.20***[-8.37]	
ROA	Government-Controlled	0.04(0.09)	0.05(0.13)	-0.01***[-3.49]
	Non-government	0.00(0. 68)	0.03(0.23)	-0.03[-1.04]
	Col Test	-0.04[-1.64]	0.02***[3.34]	
SIZE	Government-Controlled	21.54(1.03)	21.73(1.14)	-0.20***[-5.62]
	Non-government	21.07(0.92)	21.01(1.00)	0.06*[1.30]
	Col Test	0.47***[12.03]	0.73***[14.28]	
VOLATILITY	Government-Controlled	0.48(0.18)	0.47(0.16)	0.02***[3.17]
	Non-government	0.50(0.19)	0.51(0.17)	-0.01[-1.03]
	Col Test	-0.01*[-1.93]	-0.04***[-5.46]	
TAGrow	Government-Controlled	0.15(0.57)	0.17(0.39)	-0.02[-1.22]
	Non-government	0.11(0.32)	0.15(0.69)	-0.05**[-1.86]
	Col Test	0.05***[2.39]	0.02[0.87]	
INTANG	Government-Controlled	0.05(0.07)	0.04(0.06)	0.01***[4.86]
	Non-government	0.05(0.06)	0.05(0.07)	0.00[0.19]
	Col Test	0.00[0.01]	-0.01***[-3.28]	
LEVERAGE	Government-Controlled	0.52(0.23)	0.51(0.31)	0.00[0.35]
	Non-government	0.63(0.96)	0.61(0.89)	0.02[0.45]
	Col Test	-0.11***[-4.86]	-0.11***[-4.86]	
STATE	Government-Controlled	0.39(0.20)	0.44(0.44)	-0.04***[-6.59]
	Non-government	0.06(0.12)	0.06(0.12)	-0.00[-0.24]
	Col Test	0.34***[49.61]	0.38***[45.64]	
INS	Government-Controlled	13.63(17.36)	17.56(20.74)	-3.94***[-6.31]
	Non-government	12.31(16.45)	14.43(19.08)	-2.13***[-2.40]
	Col Test	1.32**[2.00]	3.13***[3.33]	
SHRCR	Government-Controlled	39.94(16.31)	44.45(15.88)	-4.51***[-8.54]
	Non-government	29.83(12.93)	32.30(14.11)	-2.47***[-3.64]
	Col Test	10.11***[17.10]	12.15***[17.04]	
AGE	Government-Controlled	8.25(3.54)	7.60(3.40)	0.65***[5.67]
	Non-government	8.35(3.49)	8.04(3.52)	0.31**[1.73]
	Col Test	-0.10[-0.72]	-0.44***[-2.75]	

Figures in cells are the sample means and figures in the cells with parentheses are standard deviations. The null hypotheses that the differences in sample means across ownership type and across diversification type are zero are tested using a two-tailed two sample t-test. The differences in sample means across diversification type are reported in the row test, differences in sample means across ownership type are reported in the column test and the figures in brackets are t-statistics. *** , ** and * denote significance levels of 1%, 5% and 10%.

Table 8 Panel data regression of the effect of PIN and diversification on firm value

	Q						Q_{t+1}	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DIV	-0.02***	-0.01	0.04				-0.05***	-0.03
	[-2.60]	[-1.13]	[1.24]				[-3.45]	[-0.73]
HI				0.04**	0.02	-0.09		
				[2.13]	[0.91]	[-1.46]		
PIN		-0.53***	-0.22**		-0.52***	-0.80***		-0.53***
		[-6.54]	[-2.04]		[-6.55]	[-3.88]		[-3.50]
DIV*PIN			-0.27**					-0.00
			[-2.17]					[-0.01]
HI*PIN						0.59**		
						[2.25]		
SIZE	-0.17***	-0.19***	-0.17***	-0.17***	-0.19***	-0.17***	-0.23***	-0.26***
	[-33.33]	[-38.82]	[-33.44]	[-33.32]	[-38.83]	[-33.46]	[-32.84]	[-36.46]
VOLATILITY	0.06	0.07*	0.03	0.06	0.07*	0.03	-0.04	-0.02
	[1.32]	[1.69]	[0.77]	[1.28]	[1.67]	[0.76]	[-0.61]	[-0.31]
TAGrow	-0.04***	-0.05***	-0.04***	-0.04***	-0.05***	-0.04***	-0.07***	-0.08***
	[-4.42]	[-5.52]	[-4.13]	[-4.40]	[-5.52]	[-4.10]	[-4.94]	[-5.81]
INTANG	-0.07	-0.05	-0.07	-0.06	-0.05	-0.07	-0.07	-0.05
	[-0.89]	[-0.7]	p-0.93]	[-0.85]	[-0.68]	[-0.89]	[-0.64]	[-0.46]
LEVERAGE	0.05***	0.05***	0.05***	0.05***	0.05***	0.05***	0.03***	0.03***
	[6.35]	[6.44]	[6.36]	[6.36]	[6.45]	[6.38]	[2.76]	[2.69]
STATE	0.03	-0.06**	0.03	0.03	-0.06*	0.03	0.08	0.11***
	[0.97]	[-1.97]	[0.87]	[0.94]	[-1.96]	[0.82]	[1.80]	[2.62]
GOV	-0.07***	-0.07***	-0.07***	-0.07***	-0.07***	-0.07***	-0.12***	-0.13***
	[-4.82]	[-5.28]	[-4.82]	[-4.75]	[-5.25]	[-4.47]	[-6.17]	[-6.54]
INS	0.02***	0.01***	0.02***	0.02***	0.01***	0.02***	0.03***	0.01***
	[23.66]	[34.22]	[23.90]	[23.69]	[34.27]	[8.27]	[17.75]	[25.90]
SHRCR	-0.00	-0.01**	-0.00	-0.00*	-0.00**	-0.00	-0.00***	-0.00***
	[-1.81]	[-2.36]	[-1.64]	[-1.79]	[-2.35]	[-1.57]	[-2.74]	[-3.21]
AGE	0.01***	0.01***	0.01***	0.01***	0.01**	0.01***	0.02***	0.02***
	[8.43]	[9.82]	[8.26]	[8.43]	[9.82]	[8.27]	[7.71]	[8.71]
CONSTANT	4.60***	5.37***	4.80***	4.56***	5.35***	4.88***	6.04***	6.87***
	[41.86]	[45.53]	[39.00]	[41.46]	[45.28]	[38.25]	[38.92]	[39.98]
INDUSTRY	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YEAR	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.565	0.6063	0.5668	0.5648	0.6063	0.5667	0.5503	0.5571
Obs	5377	5377	5377	5377	5377	5377	5377	5377

This table contains cross-sectional regression results following eq. (3.5.1) and eq. (3.5.2) with 5377 firm-year observations. The dependent variable is Tobin's Q (Q) in columns (1) to columns (6) and one-year lagged Tobin's Q (Lag (Q)) in columns (7) to column (8). DIV is the dummy variable for diversification, HI is the sales-based Herfindahl index and PIN is the estimate of information asymmetry. The interaction terms, DIV×PIN (HI×PIN), measure the effects of the interplay between diversification and information asymmetry on the firm value. SIZE is the logarithm of total assets, VOLATILITY is the annualized volatility of daily stock returns, TAGrow is the percentage change in total assets, INTANG is the percentage of intangible assets, LEVERAGE is the ratio of book value of debt to total assets, STATE is the percentage of shares held by the state agency, GOV is the dummy variable that takes 1 if state owned firms, SHRCR is the ownership concentration measure, INS is the percentage of shares held by institutions, AGE is the number of years after going public. Figures in brackets are t-statistics. ***, **, and * denote significance levels of 1%, 5% and 10%, respectively.

Table 9 Regression of the effect of PIN on diversification discount: subsamples

Independent Variables	SHSE		SZSE		A-shares		Govnment-Cotrolled		Non-Govnment-Cotrolled	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
DIV	-0.02*	-0.00	-0.04***	-0.02	-0.03***	-0.01	-0.02	-0.02	-0.03*	-0.03
	[-1.82]	[-0.11]	[-2.61]	[-1.37]	[-2.70]	[-1.15]	[-1.60]	[-1.48]	[-1.73]	[-1.00]
PIN		-0.45***		-0.63***		-0.52***		-0.46***		-0.49**
		[-4.47]		[-4.62]		[-6.34]		[-4.86]		[-2.48]
SIZE	-0.13***	-0.18***	-0.18***	-0.22***	-0.17***	-0.20***	-0.14***	-0.15***	-0.22***	-0.23***
	[-19.52]	[-28.24]	[-21.72]	[-25.92]	[-33.94]	[-39.11]	[-25.43]	[-25.93]	[-19.99]	[-16.16]
VOLATILITY	0.04	0.12**	-0.01	-0.02	0.04	0.04	0.07	0.04	0.12*	0.51***
	[0.68]	[2.39]	[-0.10]	[-0.27]	[1.56]	[1.46]	[1.31]	[0.76]	[1.68]	[6.46]
TAGrow	-0.03**	-0.05***	-0.05**	-0.05***	-0.05***	-0.06***	-0.04***	-0.03***	-0.04**	0.04
	[-2.42]	[-4.54]	[-2.53]	[-2.78]	[-3.54]	[-4.52]	[-3.26]	[-3.01]	[-2.07]	[1.45]
INTANG	-0.31***	-0.23**	0.06	0.00	-0.08	-0.07	-0.06	-0.07	-0.03	0.04
	[-2.75]	[-2.00]	[0.50]	[0.28]	[-1.03]	[-0.96]	[-0.73]	[-0.80]	[-0.18]	[0.21]
LEVERAGE	0.05***	0.05	0.06***	0.06***	0.01***	0.05***	-0.04**	-0.04**	0.06***	0.05***
	[4.80]	[0.01]	[3.50]	[3.67]	[6.70]	[6.75]	[-2.12]	[-1.97]	[5.43]	[3.55]
STATE	-0.05	0.04	0.02	0.07	0.03	0.05	-0.04	-0.04	-0.09	-0.26**
	[-1.00]	[0.87]	[0.46]	[1.47]	[1.02]	[1.71]	[-0.99]	[-1.05]	[-1.17]	[-2.43]
GOV	-0.05***	-0.06***	-0.06***	-0.01***	-0.07***	-0.06***				
	[-2.65]	[-3.32]	[-2.95]	[-3.58]	[-4.60]	[-4.70]				
INS	0.02***	0.01***	0.02***	0.00***	0.02***	0.01***	0.02***	0.02***	0.03***	0.03***
	[18.00]	[26.18]	[15.20]	[21.91]	[24.54]	[33.28]	[19.65]	[19.92]	[12.51]	[14.12]
SHRCR	-0.00	-0.01*	-0.00	-0.00*	-0.00*	-0.00**	0.00	0.00	-0.00***	-0.00***
	[-0.68]	[-1.80]	[-0.98]	[-1.65]	[-1.68]	[-2.17]	[0.41]	[0.56]	[-3.84]	[-4.11]
AGE	0.01***	0.01***	0.02***	0.02***	0.01***	0.01***	0.01***	0.01***	0.01***	0.02***
	[3.97]	[6.79]	[6.12]	[5.76]	[8.45]	[9.65]	[6.78]	[6.70]	[4.05]	[4.69]
CONSTANT	3.95***	5.11***	4.80***	5.82***	4.70***	5.45***	4.06***	4.35***	5.71***	5.91***
	[27.51]	[34.16]	[25.67]	[28.83]	[42.95]	[46.41]	[32.73]	[31.69]	[23.90]	[17.80]
INDUSTRY	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YEAR	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.5196	0.6064	0.5710	0.6116	0.5689	0.6079	0.5342	0.537	0.6116	0.6177
Obs	3139	3139	2238	2238	5126	5126	3736	3736	1641	1641

This table contains cross-sectional regression results following eq. (3.5.1) and eq. (3.5.2). The dependent variable is Tobin's Q (Q). DIV is the dummy variable for diversification and PIN is the estimate of information asymmetry. Columns (1) and (2) include the firms listed on the SHSE only while columns (3) and (4) include the firms listed on the SZSE only. Columns (5) and (6) include only A-shares. Columns (7) and (8) include government-controlled listed firms only while columns (9) and (10) include non-government controlled listed firms only. SIZE is the logarithm of total assets, VOLATILITY is the annualized volatility of daily stock returns, TAGrow is the percentage change in total assets, INTANG is the percentage of intangible assets, LEVERAGE is the ratio of book value of debt to total assets, STATE is the percentage of shares held by the state agency, GOV is the dummy variable that takes 1 if the firm is a state owned firm, SHRCR is the ownership concentration measure, INS is the percentage of shares held by institutions, AGE is the number of years after going public. Figures in brackets are t-statistics. ***, **, and * denote significance levels of 1%, 5% and 10%, respectively.

Table 10 Robustness test of the effect of PIN on diversification discount

Independent Variables	DIV			HI		
	(1)	(2)	(3)	(4)	(5)	(6)
	First-stage	Second-stage	Residual	First-stage	Second-stage	Residual
PDIV		-2.60***				
		[-8.39]				
PHI					6.35***	
					[9.58]	
Residual			-0.00			0.01
			[-0.85]			[0.49]
PIN	0.94**			-0.10**		
	[2.02]			[-2.00]		
SIZE	-0.06*	-0.17***	-0.19***	0.00	-0.20***	-0.19***
	[-1.89]	[-24.42]	[-30.24]	[0.39]	[-31.23]	[-30.41]
VOLATILITY	0.10	0.33***	0.33***	-0.00	0.25***	0.33***
	[0.64]	[12.37]	[12.38]	[-0.05]	[9.03]	[12.39]
TAGrow	-0.02	0.03*	0.03*	0.00	0.02	0.03*
	[-0.23]	[1.68]	[1.94]	[0.27]	[1.38]	[1.95]
INTANG	1.03**	0.46***	-0.07	-0.18***	1.07***	-0.07
	[2.08]	[4.01]	[-0.78]	[-3.60]	[7.06]	[-0.78]
LEVERAGE	-0.03	0.03***	0.04***	0.00	0.04***	0.04***
	[-0.51]	[2.88]	[4.28]	[0.00]	[4.33]	[4.28]
STATE	-0.15	-0.12***	-0.03	0.01	-0.07**	-0.03
	[-0.99]	[-3.80]	[-1.12]	[0.53]	[-2.47]	[-1.13]
INS	-0.01***	0.01***	0.01**	0.77**	0.01***	0.01***
	[-6.84]	[4.92]	[33.82]	[2.45]	[23.88]	[33.75]
SHRCR	-0.01***	-0.01***	-0.00***	0.00***	-0.01***	-0.00***
	[-5.09]	[-9.44]	[-4.23]	[5.39]	[-10.50]	[-4.32]
AGE	0.06***	0.05***	0.02***	-0.01***	0.07***	0.02***
	[7.16]	[11.73]	[10.43]	[-8.46]	[12.47]	[10.43]
EXCHANGE	0.52***	0.30***	-0.00	-0.05***	0.31***	-0.00
	[8.79]	[7.96]	[-0.06]	[-7.74]	[8.98]	[-0.06]
CONSTANT	-0.18	6.56***	5.04***	-4.89**	0.36***	5.04***
	[-0.25]	[29.04]	[37.17]	[-2.17]	[3.34]	[37.15]
INDUSTRY	Yes	Yes	Yes	Yes	Yes	Yes
YEAR	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.1028	0.3262	0.3176	0.1032	0.3288	0.3175
Obs	5377	5377	5377	5377	5377	5377

Column (1) ((4)) presents first-stage logit regression estimates with DIV (HI) as the dependent variable. Column (2) ((5)) presents the second stage regression estimates with the Tobin's Q (Q) as dependent variables, and the predicted DIV (HI) as the major independent variable. Column (3) ((6)) is the regression estimations with Tobin's Q (Q) as the dependent variables, and the predicted residuals in first-stage regression as the main independent variable. The sample consists of listed firm in China stock markets from 2003 to 2008 with 5377 firm-year observations. Regressions include industry dummies and year dummies. Figures in brackets are t-statistics. ***, **, and * denote significance levels of 1%, 5% and 10%, respectively.

Table 11 Summary statistics: executive incentives measure and firm / CEO characteristics

Variables	Definition	mean	s.d.	median	25%	75%
PPS	Pay-performance sensitivity	1.69	0.45	1.72	1.24	2.14
OWN_PPS	Change in CEO's wealth based on the stock ownership only per RMB1000 change in the shareholder's wealth	0.47	2.17	0.00	0.00	0.03
CASH_PPS	Change in CEO's wealth based on the basic salary and bonus only per RMB1000 change in the shareholder's wealth	1.22	0.47	1.23	0.75	1.70
SIZE	The logarithm of market value	14.54	1.09	14.38	13.82	15.05
VOLATILITY	Annualized volatility of daily stock returns	0.51	0.16	0.44	0.35	0.60
Q	Tobin's Q	1.34	0.48	1.17	1.02	1.48
ROA	Return on assets	0.04	0.06	0.05	0.02	0.08
STATE	The percentage of shares held by State Agencies	30.46	25.16	31.57	0.00	52.51
GOV	Dummy variable that coded 1 if it is a state owned firm	0.71	0.46	1.00	0.00	1.00
INS	The percentage of shares held by Institutions	15.53	19.21	7.17	1.05	23.30
SHRZ	Ownership concentration	19.17	31.25	4.85	1.79	19.32
AGE	The age of CEO	45.78	6.70	45.00	41.00	50.00
TENURE	The numbers of years as CEO	2.83	0.72	3.00	3.00	3.00

The table shows the definition and the summary statistics of the annual estimates of various variables. The sample period is from January 2004 to December 2009 for the pay-performance sensitivity (PPS) and is from January 2003 to December 2008 for the other variables.

Table 12 Comparison of government-controlled versus non-government-controlled firms

Variable	Government-controlled		Non-government-controlled		Mean difference
	Mean	s.d.	Mean	s.d.	
PIN	0.23	0.08	0.23	0.07	-0.00[-0.76]
PPS	1.68	0.45	1.69	0.45	-0.01*[-1.39]
SIZE	14.67	1.05	14.26	0.90	0.41***[16.90]
VOLATILITY	0.45	0.16	0.48	0.28	-0.03***[-5.86]
Q	1.28	0.43	1.44	0.55	-0.16***[-13.82]
ROA	0.05	0.06	0.04	0.07	0.01***[5.83]
STATE	0.42	0.21	0.06	0.12	0.36***[80.26]
INS	15.52	19.52	13.64	17.82	1.88***[3.67]
SHRZ	39.62	190.63	11.31	32.98	28.31***[6.92]
AGE	46.44	6.43	44.09	6.94	2.34***[14.50]
TENURE	2.83	0.69	2.78	0.71	0.05***[3.04]
Nobs	4340		1773		

The table shows the mean and standard deviation (s.d.) of the variables when firms are separated into two groups, government-controlled firms and non-government-controlled firms. The variables are defined in Table 11. ***, ** and * denote respectively, significance level of 1%, 5% and 10% for a two-tailed two sample t-test. And the numbers in the brackets are the t-statistics.

Table 13 Panel data regression of CEO pay-performance sensitivity (PPS)

Independent Variables	PPS		OWN_PPS	CASH_PPS	PPS+	
	(1)	(2)	(3)	(4)	(5)	(6)
PIN	1388.79***	1409.84***	-22.24	1278.56**	2301.33***	2337.91***
	[3.07]	[2.99]	[-0.30]	[2.30]	[3.83]	[3.69]
SIZE		-7.55	7.69	11.75		-79.76
		[-0.13]	[0.79]	[0.16]		[-0.98]
VOLATILITY		-72.23	-15.03	-36.02		53.35
		[-0.37]	[-0.72]	[-0.23]		[0.2]
Q		2.10	0.14	3.06		-60.796**
		[0.27]	[0.11]	[0.32]		[-2.48]
ROA		-24.41	-0.56	-30.23		-21.10
		[-0.44]	[-0.06]	[-0.44]		[-0.36]
STATE	-87.78	-97.19	-17.81	-1.44	-43.02	-39.25
	[-0.67]	[-0.71]	[-0.79]	[-0.80]	[-0.25]	[-0.21]
GOV	-259.72*	-266.64*	-11.69	112.15	-607.08***	-619.06***
	[-1.70]	[-1.67]	[-0.50]	[0.64]	[-2.96]	[-2.82]
GOV_PIN	-1451.69***	-1505.03***	64.91	-920.90	-2508.55***	-2579.01
	[-2.96]	[-2.94]	[0.79]	[-1.50]	[-3.76]	[-3.66]
INS	-2.80**	-2.81*	-0.22	-1.44	-2.96*	-2.12
	[-2.01]	[-1.88]	[-0.91]	[-0.80]	[-1.71]	[-1.13]
SHRZ	0.01	-0.89	0.00	0.00	-0.01	-0.01
	[0.14]	[-0.21]	[0.03]	[0.03]	-0.08	[-0.06]
AGE		-8.47	0.58	-1.53		5.06
		[-0.32]	[0.83]	[-0.30]		[0.85]
TENURE		-9.84	-0.53	-9.54		-39.41
		[-0.30]	[-0.12]	[-0.30]		[-1.1]
CONSTANT	-210.46	48.11	-173.06	-286.80	852.37	2484.39
	[-0.21]	[0.03]	[-0.64]	[-0.14]	[0.87]	[1.23]
INDUSTRY	Yes	Yes	Yes	Yes	Yes	Yes
YEAR	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.0220	0.0225	0.0018	0.0138	0.1077	0.1117
Obs	6113	6113	6113	6113	3605	3605

This table contains fixed-effect estimates of the panel regression of PIN on PPS. The dependent variable is the pay-performance sensitivity (PPS), defined as eq. (4.1). PPS+ is a subsample of the original PPS which includes positive observations only. OWN_PPS is the managerial stock ownership component of the original PPS while CASH_PPS is the basic salary and bonus component of the original PPS. PIN is the estimate of information asymmetry defined in section (4.3.2). SIZE is the logarithm of total market value of equity, VOLATILITY is the annualized volatility of daily stock returns, Tobin's Q is the ratio of the market value of equity plus book value of total debts divided by the book value of assets, STATE is the percentage of shares held by the state agency, GOV is the dummy variable that takes 1 if state owned firms, INS is the percentage of shares held by institutions, SHRZ is the ownership of the largest shareholder over that of the second largest shareholder, AGE is the age of CEO and TENURE is the number of years as CEO worked in the firm. Figures in brackets are t-statistics. ***, **, and * denote significance levels of 1%, 5% and 10%, respectively.

Table 14 Median regression of CEO pay-performance sensitivity

Independent Variables	whole market			SHSE	SZSE	A-shares
	(1)	(2)	(3)	(4)	(5)	(6)
PIN	32.61***	78.81***	79.60***	79.88***	79.31**	58.97***
	[2.59]	[3.76]	[4.22]	[4.16]	[2.30]	[2.95]
SIZE	-5.69***	-4.14***	-4.43***	-4.82***	-6.41***	-4.31***
	[-8.33]	[-5.01]	[-5.73]	[-5.87]	[-3.60]	[-5.22]
VOLATILITY	-5.55	-4.06	-5.42	5.72	-8.87*	4.69
	[-0.81]	[-0.61]	[-0.81]	[0.93]	[-1.69]	[0.73]
Q	-0.03	0.01	0.00	-0.08	-0.81	0.02
	[-1.02]	[0.10]	[-0.01]	[-0.44]	[-0.90]	[0.13]
ROA	-0.01	-0.11	-0.09	-0.27	5.97	-0.11
	[-0.29]	[-0.13]	[-0.11]	[-0.61]	[0.79]	[-0.12]
STATE		-10.29**	-11.27***	-0.03	-18.32**	-9.91**
		[-2.39]	[-2.86]	[-0.63]	[-2.16]	[-2.32]
GOV		-17.01***	-18.30***	-17.57***	-1.09	-14.97***
		[-3.04]	[-3.61]	[-3.36]	[-0.10]	[-2.76]
GOV_PIN		-70.25***	-71.36***	-90.15***	37.89	-59.69***
		[-3.03]	[-3.40]	[-4.14]	[0.81]	[-2.64]
INS		-0.05	-0.05	-0.03	-0.04	-0.04
		[-1.09]	[-1.13]	[-0.63]	[-0.46]	[-0.84]
SHRZ		0.00	0.01	0.00	0.00	0.00
		[0.54]	[0.64]	[1.20]	[0.13]	[0.16]
AGE			-0.07	-0.09	-0.15	-0.07
			[-0.85]	[-0.79]	[-0.65]	[-0.57]
TENURE			0.14	0.96	-1.86	-0.44
			[0.14]	[0.90]	[-0.89]	[-0.42]
CONSTANT	150.01***	110.53***	121.28***	130.39***	154.32***	122.94***
	[8.88]	[5.55]	[6.46]	[6.59]	[3.78]	[6.15]
INDUSTRY	Yes	Yes	Yes	Yes	Yes	Yes
YEAR	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.0200	0.0274	0.0271	0.0309	0.0202	0.0246
Obs	3605	3605	3605	2198	1407	3070

This table contains median regression results following eq. (4.2). The sample contains only the observations with positive pay-performance sensitivity, PPS. PPS is the pay-performance sensitivity, defined in eq. (4.1). PIN is the estimate of information asymmetry defined in section (4.3.2). SIZE is the logarithm of total market value of equity, VOLATILITY is the annualized volatility of daily stock returns, Tobin's Q is the ratio of the market value of equity plus book value of total debts divided by the book value of assets, STATE is the percentage of shares held by the state agency, GOV is the dummy variable that takes 1 if state owned firms, INS is the percentage of shares held by institutions, SHRZ is the ownership of the largest shareholder over that of the second largest shareholder, AGE is the age of CEO and TENURE is the number of years as CEO worked in the firm. Figures in brackets are t-statistics. ***, **, and * denote significance levels of 1%, 5% and 10%, respectively.

Table 15 CEO compensation and probability of informed trading: endogeneity test

Independent Variables	1st stage	2SLS 2nd stage		1st stage	2SLS 2nd stage	
		IV reg	firm fixed effects		IV reg	firm fixed effects
	(1)	(2)	(3)	(4)	(5)	(6)
PIN		31825***	39294***		11095*	18462**
		[2.91]	[2.88]		[1.75]	[2.05]
ERROR	0.16*			0.20**		
	[1.70]			[2.15]		
DISPERSION				0.05**		
				[2.28]		
SIZE	-0.02***	-643.97***	-846.69***	-0.02***	-217.69*	-406.38**
	[-23.43]	[-2.86]	[-2.88]	[-23.52]	[-1.66]	[-2.03]
VOLATILITY	-0.16***	-5143.73***	-6284.66***	-0.16***	-1811.14*	-2978.22**
	[-25.71]	[-2.91]	[-2.87]	[-25.81]	[-1.76]	[-2.03]
Q	-0.01***	-369.33***	-471.47***	-0.01***	-137.40*	-240.37**
	[-9.81]	[-2.95]	[-3.02]	[-9.38]	[-1.83]	[-2.25]
ROA	0.00	174.51	96.63	-0.01	224.82	245.68
	[0.19]	[0.71]	[0.24]	[-0.94]	[0.91]	[0.61]
STATE	-0.01**	183.3	33.26	-0.01**	24.21	-133.36
	[-1.96]	[1.64]	[0.10]	[-2.00]	[0.27]	[-0.77]
INS	0.00***	11.02**	13.19**	0.00***	2.98	5.15
	[8.45]	[2.54]	[2.40]	[8.54]	[1.40]	[1.35]
SHRZ	-0.00*	-0.81*	-1.17*	-0.00*	-0.17	-0.51
	[-1.75]	[-1.75]	[-1.90]	[-1.75]	[-0.45]	[-0.98]
AGE	-0.00***	-13.18***	-12.87	-0.00***	-4.69	-4.28
	[-2.98]	[-2.59]	[-1.63]	[-2.91]	[-1.33]	[-0.64]
TENURE	0.00	87.54***	29.02	0.00	21.29**	-8.32
	[0.12]	[3.11]	[0.76]	[1.54]	[2.19]	[-0.25]
CONSTANT	0.76***	23773.42***	30624.00***	0.77	8053.91*	14513.72**
	[38.45]	[2.86]	[2.89]	[38.54]	[1.68]	[2.04]
INDUSTRY	No	Yes	Yes	No	Yes	Yes
YEAR	No	Yes	Yes	No	Yes	Yes
R2	0.3091	0.0092	0.0142	0.3100	0.0075	0.0121
Obs	3079	3079	3079	3079	3079	3079

The two-stage least squares (2SLS) panel regression uses financial analysts' forecast error and dispersion along with other firm-specific variables as instruments for PIN. Columns (1) and (4) present first-stage regression estimates with PIN as dependent variable. Column (2), (3), (4) and (5) present second stage regression estimates with the pay-performance sensitivity (PPS) as dependent variable. The sample consists of listed firm in China stock markets from 2003 to 2009. Regressions include industry dummies and year dummies. Figures in brackets are heteroskedasticity- consistent t-statistics. ***, **, and * denote significance levels of 1%, 5% and 10%, respectively.