Asymmetric information, firm investment and stock prices

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Abstract

Purpose – The purpose of this paper is to explore the relations of investment and stock prices (Tobin-Q), the impact of asymmetric information on the investment sensitivity to stock price, and the impact of asymmetric information on the stock price sensitivity to investment.

Design/methodology/approach – Research was conducted with 313 listed companies and 1,878 firm-year observations from Chinese stock market. Empirical studies were conducted based on two hypotheses by using R^2, information delay and scores of information disclosure as measures of asymmetric information and taking changes in book assets and capital expenditures scaled by book assets as measures of investment.

Findings – The key findings of the paper are: managers are learning from the market when they make investment decisions; the asymmetric information has a significant negative impact on the investment sensitivity to stock price; and the asymmetric information has a significant positive impact on the stock price sensitivity to investment.

Practical implications – The paper has a significant practical implication for regulation policy making in stock market.

Originality/value – The paper fills the research gap in two points. It studies the impact of asymmetric information on the investment sensitivity to stock price, and the impact of asymmetric information on the stock price sensitivity to investment in Chinese stock market for the first time.

Keywords Investments, Information strategy, Stock prices, China

Paper type Research paper

1. Introduction

Tobin-Q theory, advocated by Tobin (1969) and developed by Summers (1981), Hayashi (1982), etc. argues that if the capital market is complete, firm's investment will depend on the ratio of the marginal market value of capital to the marginal cost. When Q is more (less) than 1, the firm should increase (decrease) its investment. As an important branch of investment theory, Tobin-Q has been a fundamental theoretical for the firm's decision.

China Finance Review International
Vol. 1 No. 1, 2011
pp. 6-33

2044-1398
DOI 10.1108/20441391111092246

JEL classification – G10, G12, G14

Dongmin Kong wishes to acknowledge financial support from the National Natural Science Foundation of China (NSFC Grant No. 70803013).

Numerous tests prove that Tobin-Q can explain the investment expenses. For instance, from a microscopic view, Blundell *et al.* (1992) test the relationship between investment expenses of 532 British firms from 1975 to 1986 and Tobin-Q with penal data. Similarly, Fazzari *et al.* (1988) and Hayashi and Inoue (1991) test firms in the USA and Japan, respectively. These studies show that Tobin-Q indeed has a significant positive effect on the firm investment.

Since Q-ratio, advocated by Tobin (1969), is on the concept of marginal, which is difficult to measure in practice, researchers always use average-Q to proxy it. In practice, Tobin-Q is the ratio of a firm's market value to the reproduction cost (Furstenberg, 1977). As for the market value, we usually use the market price of the stock, which implies the hypothesis of market efficiency. Later, Lindenberg and Ross (1981) and Lang and Litzenberger (1989) provide the detail to calculate the average value and Chung and Pruitt (1994) simplify these methods. However, Hayashi (1982) points out that the replacement of average Q to Tobin Q should be on the condition that firms are the complete price takers.

Studies of Morck *et al.* (1990) and Blanchard *et al.* (1993) show significant positive correlation between price and firm investment, but these researchers have got no agreement on what is the reason for the positive correlation. Since the existence of market friction and incompleteness of information transfer, market information is asymmetric. Firms make their optimal strategy from the maximization of firm value and individuals from the maximization of utility. In this sense, one convincing explanation for the correlation between firm investment and stock price is, with the stock price, managers can learn some information about firm performance in future. Namely, the stock prices reflect information of various market participants and these participants may have no information communication with firms, so the stock prices may contain some information unknown to the managers which will help managers to form strategies such as investment decisions.

In fact, in their early studies, Grossman and Stiglitz (1980), Glosten and Milgrom (1985) and Shleifer and Vishny (1997) point out that firm information produced by investors will be used in the transaction actives, so this information can be naturally reflected in the market price and the price fluctuation can deliver the information about the future prospect of firms. Boot and Thakor (1997) argue individual investors in the market may be business experts and be better informed about the change in the industry and customers' preferences. In this case, although individual investors know less information than managers, the market will offer the total information through its function of information centralization, which can reflect some information unknown to the managers. Subrahmanyam and Titman (1999) also believe that information that cannot be obtained in other ways can be got through the market's function of information centralization. Dow and Rahi (2003) point out that individual investors may possess information about company profits which is unknown to the managers. However, this information is limited and has little influence on the decision strategy of firms. Yet, if all the information of individual investors is collected together, it will have a practical influence on the decision strategy of firms. Therefore, one important role of the stock price is to centralize the scattering information which is useful to the firms' decision making. So, not only has the market got the function of information generation and centralization, information produced in the market may be new to managers and useful to their decision making.

Recently, with the non-synchrony and the probability of informed trading (PIN) as the measures of personal information in stock price, Chen *et al.* (2007) study the influence of information in stock price over the sensitivity of investment to price. They find that, there is a remarkable positive correlation between price and investment, and that the personal information in the price has a positive effect on the sensitivity of investment to price. After controlling manager information and other variables, the positive effect is still robust. Their conclusion supports that, to maximize firm value in decision making, managers should try to use more information including information in the stock market, the acquired information and information that has not been reflected in the stock price. So, the more information in the stock price, the more sensitive the firm investment will be to the stock price and the more the firm decision making will depend on the stock price.

Although Chen *et al.* (2007) find that the synchrony of the stock price in the Western countries is informative, in the stock market of China, studies show that companies with lower R^2 are firms whose market's response is not effective enough and companies with lower R^2 can make reverse selection to a greater degree, which is different from Western countries (Kong and Shen, 2008). Therefore, in the Chinese stock market, non-synchrony may conversely hold back managers' learning process. With the increase of the information asymmetry, it will be more difficult for the managers to grasp the real situation of the market investors. So in the situation of high information asymmetry, especially when this information asymmetry reflects noise instead of information, managers will make conservative estimation of market information since information-asymmetry potentially can cause big mistakes or risks. If this situation is real, results will be different from Western countries. Given this argument, with the data from Shenzhen Stock Market, we bring forward the following competitive hypothesis:

H1a. Firms' idiosyncratic information will affect investment strategy. If idiosyncratic information reflects noise to a greater extent, the sensitivity of firm investment to stock prices will decrease with the increasing of information asymmetry.

H1b. Firms' idiosyncratic information will affect investment strategy. If idiosyncratic information is not noise to a greater extent, the sensitivity of firm investment to stock prices will increase with the increasing of information asymmetry.

A subsequent question based on *H1* is that, on the margin of information asymmetry, whether firms' investment strategy influences the investors in the stock market. Instinctively, with the increasing of information asymmetry, it will be more difficult for investors to make a reasonable judgment on firms' investment behaviors. So, the sensitivity of stock price (i.e. investors' responses) to firms' investment will marginally increase with the increasing of information asymmetry. Our *H2* is as follows:

H2. Investors in the stock market will response to the firms' investment and information disclosure, however, with the increasing of the information asymmetry, the sensitivity of the stock price to the investment will upgrade.

There are few studies on this issue in China. The present study focuses on two aspects: one is to study the relations among information disclosure, information asymmetry and firms' investment in the sight of information asymmetry between firms and public. For example, Zhang *et al.* (2007), using the "listed firms information-disclosure quality scores "of Shenzhen Stock Exchange as the proxy variable of information-disclosure quality, find that the information-disclosure quality is positively related to the firms' performance. Similarly, based on "information-disclosure quality scores" of Shenzhen Stock Exchange, Zhang and Lv (2009) also find firms with higher information-disclosure quality are more efficient. Cui and He (2008) find the quality of accounting information will have positive effect on firms' investment behaviors. Yuan *et al.* (2009) find that firms with low quality of accounting information will have a higher degree of over-investment. Xia and Lu (2005) make a good literature review on information disclosure and information asymmetry between firms and investors. Zhang and Wang (2006) make a specific literature review on information disclosure at home and abroad. Also, some studies are viewed from information disclosure or information asymmetry and investment. Wang and Jiang (2004) and Zeng and Lu (2006) find firms with a higher degree of information disclosure have lower financial cost of vicious circle. He and Zhang (2006) also present a literature review on this.

Studies in China mainly focus on the influence of information asymmetry over firm investment: one is about the efficiency of investment; the other is about over-investment. There is no study viewed from whether firm investment will receive information from the capital market. Specifically, no study has been done on the following issue: with the increasing of information asymmetry, how managers will be affected in getting information from stock marker (namely, whether the sensitivity of stock price will be affected by the information content). Furthermore, there is no study on the change of investors' reaction to firm investment on the margin of information asymmetry.

Furthermore, studies focusing on information asymmetry are mainly from the information asymmetry between managers and stockholders (principal-agent relation), and firm investment. Wang and Zhang (1998) provide a model of principal-agent relation and find information asymmetry indeed influences the firm investment. Cui and Deng (2007) establish a theoretical model with theories of information asymmetry, principal agent and corporate governance, and the same conclusion is made that information asymmetry influences the firm investment. These studies are different from ours since they were viewed from theoretical points.

Overall, our tests show that manages will learn from the market when making decisions and there is a remarkable positive correlation between the cost of firm investment and the stock price; the degree of information asymmetry on the stock market has a remarkable diminishing effect on the sensitivity of firm investment to the stock price; and sensitivity of stock to stock price will increase with the increasing of information asymmetry in stock market.

Additionally, on the study of corporate governance, firm value and stock price in the Chinese stock market, researchers have already found that the type of ultimate controller and the degree of ownership concentration usually affect the market value of listed companies, stock price and the decision making of managers and investors. For the robustness, we make group tests based on the type of ultimate controller and the share shareholding ratio of big shareholders, respectively. Besides, considering the private information of managers will affect information more or less, we also control the individual information of managers. We find our conclusion is robust.

2. Sample selection and research design

2.1 Data and sample selection

All data in this paper refer to firms traded on the Shenzhen Stock Exchange between January 1, 2001 and December 31, 2006. We obtain firm financial and stock return data from China Center for Economic Research (CCER) database. The reason why we take this sample is because we can only get listed companies primary information disclosure, which we need in our tests, from Shenzhen Stock Exchange.

For assurance of data validation, we apply the following data requirements in forming our sample to exclude abnormal cases. First, we exclude those companies which are unlisted or special treatment companies within the observation period. Second, we exclude companies listed after December 31, 2000. Finally, we exclude firms in the financial industry since these firms have different balance sheet structures from other industries. These data are based on 1,878 firm-year observations, which represent 313 listed companies.

2.2 Variables

*2.2.1 Asymmetric information measures (*AsyInfo*).*

The first measure is price non-synchronization ($1 - R^2$). According to Roll (1988), R^2 can capture information contained in asset prices. He suggests that price non-synchronization (or firm-specific return variation) is correlated with private information. His argument goes as follows: prices move upon new information, which is capitalized into prices by two ways. The first is through a general revaluation of stock values following the release of public information, such as unemployment statistics earnings. The second is through the trading activity of speculators who gather and possess private information. As Roll (1988) finds that firm-specific stock price movements are generally not associated with identifiable news release, he argues that private information is especially important in the capitalization of firm-specific information. Empirical evidence documented since then provides strong support to the hypothesis that price non-synchronization reflects more private information than noise. For example, Durnev *et al.* (2003) find that stock price non-synchronization is highly correlated with stock prices' ability to predict firms' future earnings, supporting the argument that price non-synchronization reflects more private information than noise. Morck *et al.* (2000) show that firm-specific return variation is high in countries with well-developed financial systems and low in emerging markets. They argue that in countries with well-developed financial markets, traders are more motivated to gather information about individual firms, and thus, prices reflect more firm-specific information. However, Kelly (2005) argues that low R^2 reflects lower transmission efficiency, the worse quality of information environment, as well as a greater degree of asymmetric information[1].

The variation of a stock return can be decomposed into two different components: a market-related variation and a firm-specific variation. The first component measures systematic variation or price synchronicity. The second one captures firm-specific information or price non-synchronization. It can be estimated by $1 - R^2$, where R^2 is the R-square from the following regression:

$$r_{i,t} = \alpha_i + \beta_i R_{m,t} + \varepsilon_{i,t} \quad (1)$$

Here, $r_{i,t}$ is the return of firm i at time t, $R_{m,t}$ is the value-weighted market return at time t.

The second measurement is price delay (Delay). This measure was first proposed by Hou and Moskowitz (2005), which reflects how fast market information can be integrated in stock price. The reason why they construct this index is for measuring the speed with which certain stocks respond to market information. The more asymmetric information, the slower stock prices will respond to new information, as well as a greater degree of price delay. Therefore, the price delay (*Delay*) is a good measure of the degree of asymmetric information. Specifically, it can be estimated as following regression:

$$r_{i,t} = \alpha_i + \beta_i R_{m,t} + \sum_{n=1}^{4} \delta_i^{(-n)} R_{m,t-n} + \varepsilon_{i,t} \tag{2}$$

where, $r_{i,t}$ is the return of firm i at time t, $R_{m,t}$ is the value-weighted market index at time t. According to Hou and Moskowitz (2005), we do not exclude the stock itself. Using the estimated coefficients from regression, we compute measure of price delay for each firm at the end of fiscal year. First, we get R^2 by estimated regression (2). Then, we get $R^2_{\delta_i^{(-n)}=0,\forall\in[1,4]}$ from regression (2) restricting $\delta_i^{(-n)} = 0, \quad \forall n \in [1,4]$, that is equation (1). We calculate price delay as follows:

$$Delay = 1 - \frac{R^2_{\delta_i^{(-n)}=0,\forall\in[1,4]}}{R^2} \tag{3}$$

Because our tests are based on fiscal year data, we compute measure of price delay (*Delay*) as Hou and Moskowitz (2005) for each firm at the end of fiscal year by estimated regression (2) using daily stock return. Kong and Shen (2007, 2008) give further research on China stock market R^2 and *Delay* index, and they found both are related to information environment.

The third measurement is information disclosure score (InfoIndex). We use the "information disclosure quality scores" in the "credit files" of Shenzhen Stock Exchange as proxy variable. The results are based on "listed company information-disclosure assessment methods in Shenzhen Stock Exchange"[2]. It is well known that asymmetric information is strongly correlated with information disclosure. The less transparency information (the worse information environment or the greater degree of more asymmetric information) is, the lower information-disclosure scores will be. Shenzhen Stock Exchange categorizes four levels for information-disclosure quality: excellent, good, pass and fail. For facilitating our tests, we quantify these levels as follows: "excellent" is scored as 3, "good" is scored as 2, "pass" is scored as 1 and "fail" is scored as 0.

2.2.2 Investment measures (I). In general, the capital expenditure refers to all spending of a company's investment activities in order to obtain operating assets. More specifically, it refers to all investment activities expecting for financing (e.g. short-term investment, trust management, etc.), such as purchasing new equipments, acquisitions, joint ventures, R&D and diversification. In a narrow sense, the capital expenditure refers to direct investment in fixed assets, including expenditure in purchasing, building or updating fixed assets, acquiring other long-term assets and intangible assets.

Referring to Chen *et al.* (2007) and the current China situation, we take two different measures to evaluate corporation investment.

The first measurement is total capital expenditure scaled by beginning-of-year assets (*CAPX*). However, it is difficult to obtain accurate capital expenditure data in China. We obtain "cash paid to acquire and construct fixed assets, intangible assets and other long-term assets" item from cash flow statements as a proxy of *CAPX*, because it is highly relevant to the current corporate investment activities.

The second measurement is change in assets scaled by beginning-of-year assets (*CHGASSET*). Because the investment activity is resulting to the change of firm size, we can use *CHGASSET* as a good proxy. Besides, *CHGASSET* also includes firm's acquisition and divestiture activities.

*2.2.3 Tobin's Q ratio (*Q*)*. Tobin's Q Ratio was first proposed by James Tobin, who was awarded a Nobel Prize in 1969. This ratio is calculated by market value to asset replacement cost, which also reflects a two-way dimension of enterprise valuation. Numerator and denominator represent how much a company is worth in the financial market and the replacement cost of a company, respectively. How much a company is worth in the financial market actually depends on two parts, a company's stock market value and debt market value, while the replacement cost means how much money we should pay to buy all the assets of a company.

According to Tobin-*Q* theory, if *Q* is greater than 1, a company's market value is higher than its capital replacement cost or capital expenditure of a new plant. Under this circumstance, a company can purchase more investment products with issuing fewer stocks, and the investment expenditure will be increased. If *Q* is less than 1, it means that a company's market value is lower than the capital replacement cost, which means the company will not purchase new investment products. If a company wants to acquire capital, it would be cheaper to purchase second-hand equipment from other corporations which can decrease its capital expenditure.

When we do the Tobin-*Q* calculation, we take Hayashi's (1982) assumption which means all corporations are price takers. Then we can use average *Q* to represent margin *Q*. Following the simplified method of Chung and Pruitt (1994) and combining the current China stock market situation, we calculate Tobin's *Q* as following:

$$Q = \frac{MarketValue(TradeableShares) + BookValue(NonTradeableShares) + Debt}{TotalAsset}$$

At present, due to institutions in China stock market, there exist both tradable shares and non-tradable shares. Even after the share reform, the non-tradable shares are still under restrictions for three years. To simplify this problem, we make a reference to Xia and Fang (2005), which uses the net asset per share to represent the value of non-tradable shares.

Based on the above measurement, the average of Tobin's Q is 0.829 (Table I). However, the price of tradable shares is significantly higher than the net asset per share, and it is difficult to observe non-tradable shares' market values. As a result, the higher (lower) the proportion of the tradable (non-tradable) shares of a company is, the larger Tobin's Q will be. In other words, the proportion of non-tradable shares is negatively correlated with Tobin's Q, which may affect the reliability of empirical analysis. To avoid this, we also recalculate Tobin's Q as the following formula:

$$Q' = \frac{MarketValue(TradeableShares) + Debt}{NetBookValue(TradeableShares) + Debt}$$

We found that the average of Q' is 1.424, with a SD of 0.577, which is positively correlated with the former Tobin's Q measure and the correlation coefficient is 0.80. In future tests, we also find that the results are consistent with two measures.

Table I. Summary statistics and correlations

Variable	*CAPX*	*CHGASSET*	*Q*	$1-R^2$	*Delay*	*InfoIndex*	$CF(\times 10^7)$	*RET*	*Log(Size)*	*InstiOwn*	*Q'*
Panel A: summary statistics											
Mean	0.065	0.135	0.829	0.550	0.040	1.783	19.400	−0.696	20.534	0.281	1.424
SD	0.062	0.288	0.451	0.169	0.068	0.648	51.900	0.826	0.723	0.450	0.577
Min.	−0.038	−0.558	0.021	0.111	0.000	0.000	3.020	−2.620	18.643	0.000	0.670
Max.	0.446	5.233	4.637	0.997	0.887	3.000	1.110	4.785	23.167	1.000	5.515
25%	0.020	−0.004	0.550	0.436	0.010	1.000	2.240	−1.276	20.052	0.000	1.099
50%	0.046	0.080	0.749	0.554	0.021	2.000	8.870	−0.708	20.529	0.000	1.253
75%	0.091	0.207	0.994	0.666	0.043	2.000	22.000	−0.267	20.995	1.000	1.525
Panel B: correlations											
CHGASSET	0.210										
Q	0.166	−0.051									
$1-R^2$	−0.028	0.062	0.193								
Delay	0.000	0.031	0.300	0.533							
InfoIndex	0.048	0.103	−0.097	−0.008	−0.070						
CF	0.204	0.110	−0.030	0.045	−0.010	0.089					
RET	0.039	0.161	0.132	−0.082	0.002	0.053	0.055				
Log(Size)	0.161	0.113	0.176	−0.129	0.011	0.134	0.292	0.226			
Insti_own	0.181	0.156	0.099	0.097	0.029	0.173	0.235	0.250	0.395		
Q'	−0.025	−0.055	0.797	0.217	0.329	−0.052	−0.103	0.153	0.169	0.107	1.000

In addition, based on prior studies on the relationship between investment and stock price, our basic regressions include the following set of control variables (*ContVars*): $CF_{i,t}$, $Asyinfo_{i,t-1}.CF_{i,t}$, $RET_{i,t+3}$, $Log(Size)_{i,t}$, $Insti\_own_{i,t}$ and year fixed effect dummy variables ($YRDUM_{i,k}$), which are further described as follows.

Cash flow measure (*CF*). Fazzari *et al.* (1988) and Chen *et al.* (2007) suggest that a company's cash flow has a significant impact on investment, and adequate cash flows are the basis of the investment activities. Referring to their methodologies, cash flow (*CF*) is included in both separately and interactional item with $Asyinfo_{i,t-1}$ to examine the direct effect and interact effect. We obtain "net cash flow from operating activities" item from cash flow statement as a measure of corporate cash flow.

Future return measure (*RET*). Loughran and Ritter (1995), Baker and Wurgler (2002) and Baker *et al.* (2003) argue that firms invest more when their stocks are overvalued. Thus, we include firms' future returns (*RET*) to control managers' market timing of investment. Chen *et al.* (2007) also support this view. Specifically, future return (*RET*) is measured as the value-weighted market to adjust three-year cumulative return, starting from the end of investment year. For observations in the last two years of our sampling period (i.e. 2005 and 2006), two-year or one-year future returns are used.

Market capitalization measure (*Log*(*Size*)). A large number of studies have documented that a company's size will have an important effect in corporate finance research. Therefore, we also set market capitalization as a control variable. We define *Log(Size)* as the nature logarithm value of market capitalization at the end of the prior fiscal year.

Institutional ownership measure (*Insti-own*). Many previous studies have shown that institutional investors have a great impact on stock price and corporate government (Chan and Hameed, 2006; Hou and Moskowitz, 2005), etc. Therefore, we contain *Insti-own* as control variable. Since it is still not easy to get the percentage of shares held by institutional investors for each individual stock, we try to build up a dummy variable as a proxy for the *Insti-own*, where the institutional investors only include closed-end funds and open-end funds.

Specifically, once a company appears in the top ten list of a fund's portfolio, we set *Insti-own* as one and zero otherwise. The annual distribution of the fund in our final sample is shown in (Table II).

Managerial private information measure (*ManagerInfo*). Referring to Gomes and Phillips (2004), and Chen *et al.* (2007), we measure *ManagerInfo* based on earnings surprise. First, we measure earnings surprise as the abnormal stock return (AR) around the earnings announcement dates. Specifically, abnormal stock return is the value-weighted market-adjusted return. In the calculation of market return, we exclude daily individual stock return within 30 days after the initial public offerings. For each earnings announcement, we calculate cumulative AR in the three-day period centering on earnings announcement date, which means our event window is $[-1, +1]$.

Year	2001	2002	2003	2004	2005	2006
Close-end fund	48	54	54	54	54	54
Open-end fund	2	13	49	9	129	195

Table II.

For each fiscal year, we use the average of the absolute ARs around the four quarterly earnings announcement dates as a proxy for the earnings surprise. The underlying idea is that if the average absolute AR is high, there is information in earnings unknown to investors that is not impounded in price. Because managers have access to internal accounting data and know the earnings before they are released to public, thus, earnings surprise is a measure for managers' private information.

Ultimate shareholder measure (*U_Control*). For each firm, we use this dummy variable to measure ultimate shareholder's category. Dummy variable *U_Control* equals 1 if a firm's ultimate shareholder is private, and *U_Control* equals 0 if a firm's ultimate shareholder is the government. Also, we exclude firms where the ultimate shareholder is neither private nor the government. This variable is taken from CCER database.

Large shareholders ownership measure (*CR*). In this study, we measure *CR* based on the percentage of shares held by the top 1, top 5 and top 10 shareholders (denoted as *CR1, CR5* and *CR10*, respectively). However, the estimated results are similar so we only report the result based on *CR5*.

2.3 Empirical model

Roll (1988) points out that change of prices is based on the new information, so stock prices reflect some of the new information in the stock market. Since frictions exist, there is information asymmetry. For the optimal decision, both managers and investors hope to get more information to help them make their investment decisions. We try to study the following two issues with the listed companies from Shenzhen Stock Market:

(1) Whether managers will make decisions based on the information in stock prices, and also, whether information asymmetry will affect the sensitivity of stock prices.

(2) Whether investors will react to the firm investments or information disclosure and make selling-buying decisions based on them, which will further decide stock prices.

To answer the above questions, we build the following basic models[3]:

$$I_{i,t} = \alpha + \beta_1 Q_{i,t-1} + \beta_2 (AsyInfo_{i,t-1} \cdot Q_{i,t-1}) + \gamma ContVars + \varepsilon_{i,t} \quad (4)$$

$$Q_{i,t} = \alpha' + \delta_1 I_{i,t-1} + \delta_2 (AsyInfo_{i,t-1} \cdot I_{i,t-1}) + \varphi ContVars + e_{i,t} \quad (5)$$

where, $I_{i,t}$ is the firm i 's investment measure in t. We use two ways to measure firm investments ($I_{i,t}$): first, the ratio of investment cost to the total assets is $CAPX_{i,t}$, which is the item of "cash paid to acquire fixed assets, intangible assets and other long-term assets" in cash flowing sheet over firm's total asset. Second, the percentage of the total asset change ($CHGASSET_{i,t}$) is the total assets change in t over the total asset of $t-1$. We know that the rising of stock prices depends on the fundamental. When a firm increases its investment, on the one hand it can gain practical benefits for the firm, and on the other hand it reflects the good development of the firm, both of which will push the rising of stock prices. Based on this, we predict $\delta_1 > 0$, namely investments have positive influence on stock prices.

$Q_{i,t}$ is firms i's Tobin's Q ratio in t, which in the firm market value over replacement cost of firm's asset, so it can be viewed as a standard stock price. The specific calculation is stated above. According to Tobin's Q theory, when Q is more than 1, the market value is higher than the replacement cost and the cost of equipment for the new factory is lower than the firm's market value, so the firm inclines to increase the investment cost. Otherwise, when Q is less than 1, the market value is lower than the replacement cost, so the firm inclines to decrease the investment cost. So we predict $\beta_1 > 0$, namely, there is positive correlation between investments and stock prices.

$Asyinfo_{i,t}$ is the measure of information symmetry. As before, we design three different measures to weight information symmetry. The first measure is the non-synchrony of stock prices $(1 - R^2)$, in which R^2 is estimated through the market model regressing the stock's daily returns on market returns year-by-year. The second measure is *Delay* and we apply the method of Hou and Moskowitz (2005) to calculate *Delay*. The third is *InfoIndex*, which is based on the financial performance of firms and the quality of information disclosure, so it can reflect the transparency of information disclosure. The less transparent information disclosure is, the more asymmetric information will be.

3. Results of empirical tests

3.1 Descriptive statistics

Our sample includes 1,878 annual data of 313 listed firms of Shenzhen Stock Market from 2001 to 2006. Descriptive statistics of variables used in the models are in Table I. Panel A reports the mean of each variable, standard deviation and percentiles. From Table I, we know that mean of $(1 - R^2)$ is 0.55037 which means, averagely speaking, market return explains the change of return of 45 percent stocks and this tallies closely with the result of Morck *et al.* (2000) that the Chinese market's R^2 is 0.453. Besides, their study points out that the higher R^2 reflects less private information or the worse quality of the information environment.

Panel B of Table I reports the related coefficient of each variable. Variable $(1 - R^2)$ has the highest correlation coefficient, 0.53338, with *Delay*. This is consistent with our finding before, i.e. both the $(1 - R^2)$ and *Delay* measure and positively relate with the degree of information asymmetry. (As stated above, both $(1 - R^2)$ and *Delay* measure the degree of information asymmetry and are positively correlative with it.) Besides, the related coefficient of *CAPX* and *CHGASSET* is only 0.21028, since the two measures may capture different aspects of firm investment cost. As stated above, *CHGASSET* not only reflects the direct investment cost, but also reflects its other investing activities such as merging and peeling off. We can also see that Q and Q′ are highly correlated to each other. Since testing results of Q and Q′ are very similar, we will mainly report the testing result of Q.

3.2 Tests on sensitivity of firm investment to stock price

In this part, we mainly discuss whether managers will gain some information from a stock price when they are making investment decisions, and whether the information in the stock market will affect the sensitivity of firm investment to price. Table III reports the estimated result of equation (4). With the investment measure of *CAPX,* and $(1 - R^2)$, *Delay* and *InfoIndex* used as information-asymmetry measure, columns 1-3 report the estimated results, respectively, in which controlling variables are excluded. With the investment measure of *CAPX*, column 4 reports the regressing result when equation (4) contains three measures of information asymmetry and controlling variables. With the investment measure of *CHGASSET,* and $(1 - R^2)$,

Table III. Tests of sensitivity of firm investment to price

Variables	1		2		3		4		5		6		7		8	
	Independent: PX								Independent: CHGASSET							
Q	0.0395***	5.79	0.0312***	8.16	0.0121**	2.44	0.0312***	3.93	0.0692**	2.08	0.0438**	2.35	−0.0137	−0.57	0.0616*	1.59
(1 −R²) *Q*	−0.0203**	−2.35					−0.0151	−1.40	−0.0522	−1.24					−0.0426	−0.80
Delay *Q*			−0.0477***	−3.09			−0.0264	−1.42			−0.0889	−1.18			0.0141	0.15
InfoIndex *Q*					0.0091***	3.65	0.0066***	2.59					0.0320***	2.63	−0.0019	−0.15
CF							8.02×10^{-11}***	5.78							-3.51×10^{-10}***	-5.17
(1 − R²) *CF*							-5.34×10^{-11}**	−2.19							2.09×10^{-10}*	1.75
Delay *CF*							1.31×10^{-10}	1.05							-3.50×10^{-11}	−0.06
InfoIndex *CF*							-1.36×10^{-11}***	−3.20							1.18×10^{-10}***	5.66
RET							−0.0018	−1.05							0.0449***	5.22
LOG(Size)							0.0005	0.20							0.0138	1.17
Insti_own							0.0181***	4.87							0.0711***	3.92
Adj. R^2	0.0377		0.0402		0.0425		0.1271		0.0024		0.0023		0.0058		0.0841	

Notes: Significance at: *10, **5 and ***1 percent levels; this table is regressed as equation (4); for brevity, we omit the results of constant and year dummies; Adj. R^2 is the adjusted R^2; sample period is from 2001 to 2006 and including 313 firms listed in Shenzhen Stock Market; observations are 1,878

Delay and *InfoIndex* used as information-asymmetry measure, columns 5-7 report the estimated results, respectively, in which controlling variables are excluded. With the investment measure of *CHGASSET,* column 8 reports the regressing result when equation (4) contains three measures of information asymmetry and controlling variables.

The first column shows the positive correlation of $CAPX_{i,t}$ and $Q_{i,t-1}$ The coefficient is 0.03948 and *t*-value is 5.79 with significance at the 1 percent level. This result supports the conclusion of previous scholars that there is positive correlation of investments and price. We focus on the coefficient of $(1-R^2)_{i,t-1}*Q_{i,t-1}$. From column 1, we know the coefficient is -0.02027 and *t*-value is -2.35 with significance at the 1 percent level, which means the non-synchrony of price (NSYNCH) has a diminishing effect on the sensitivity of investment to price. Given the 25 percent percentile of $(1-R^2)$ is 0.55026 and median is 0.74902, we can see the sensitivity of investment to price is $0.04351[=0.03948-(0.74902-0.55026)*(-0.02027)]$ at the 25 percent percentile level. If a firm's $(1-R^2)$ increases from the 25 to 75 percent percentile (0.99357), the sensitivity of the firm investment to price will decrease to 0.03452, reducing 0.00899 (or 20.7 percent).

In Table III, except column 7, all the results of the other columns show that there is significant positive correlation of investment and price. We will further analyze column 7. From columns 1, 2, 5 and 6, we find that the coefficient of $AsyInfo_{i,t-1}*Q_{i,t-1}$ is significantly negative which shows information asymmetry has a significant diminishing effect on the sensitivity of investment to price. However, the coefficients of $InfoIndex_{i,t-1}*Q_{i,t-1}$ in columns 3 and 7 are positive, which is consistent with the previous conclusion. The smaller the *InfoIndex* is, the more asymmetric information will be, and there will be less sensitivity of investment to price. The fourth and eighth columns show that the equation contains the regression result of three measures of information asymmetry and the controlling variable. In the regression of columns 4 and 8, we include all independent variables, which are three asymmetric information variables and all the control variables. The signs and coefficients of $Q_{i,t-1}$ and *AsyInfo*. $Q_{i,t-1}$ are still consistent with other estimations but show a little decrease in significance. It is probably because there are three measures of information asymmetry in the models which will capture the asymmetric information simultaneously that are highly correlative. For example, the correlation coefficient of $(1-R^2)$ and *Delay* is 0.53338 and there exists multicollinearity to some extent. When we introduce them into the same regression, the multicollinearity may decrease the level of significance.

Here, we further analyze the sensitivity of investment to price in column 7. Although the result of column 7 shows the direct effect of price to investment is -0.01371, which is negative, the coefficient of interactions, $InfoIndex_{i,t-1}*Q_{i,t-1}$ is 0.03202 and the mean of *InfoIndex* is 1.78275. So, with the mean of *InfoIndex,* the total effect of price to firm investment is $0.04337[=-0.01371+0.03202*1.78275]$, namely, the effect of price over investment is still positive, which is consistent with other results.

From results of equation (4) reported in Table III, we find that first, there is significantly positive correlation of investment and price; second, information asymmetry has a significant diminishing effect on the sensitivity of investment to price. Overall, results of Table III support our *H1*.

The first conclusion is consistent with many previous studies and it also coincides with Tobin-Q. However, the second conclusion is not the same as conclusions of all the previous studies. Chen *et al.* (2007) use NSYNCH and PIN to measure the private information in stock prices. Their study shows that there is positive correlation between price and investment and the private information in price has a positive effect on the sensitivity of investment to price. They explain that managers will get some information from stock price and use it when making decisions. The explanation of our conclusion in this paper is that the coefficients of $Q_{i,t-1}$ and $AsyInfo*Q_{i,t-1}$ are significant, so we have reasons to believe that managers will get some information when making decisions. We cite R^2 to explain the information-asymmetry's negative effect on firm investment in marginal. We do not consider the relation of R^2 with information or noise at first. A lower R^2 reflects a greater market fluctuation (the idiosyncratic risk of individual stock), and price reflects investors' expectation to firm future, so low R^2 means there is greater risk in the firm's future. Based on this argument, the other measures (i.e. *Delay* or *InfoIndex*) can be also proxy uncertainty or speculation. This will make managers recognize the firm feature, namely, the future risk for the firm, and managers will become more conservative when making investment decisions. In this case, although the rising of stock price will increase firm investment, the information asymmetry will make firm investment more conservative on the marginal.

In this sense, no matter whether measures of information reflect information or noise, the existence of future risk will provide some information for managers. Here, we do not especially emphasize the point that price reflects trading noise instead of private information. We believe, to a certain extent, price may reflect trading noise, however, the private information is not all excluded from the noise. Recent studies indicate that in China (Kong and Shen, 2008), firms with lower R^2 are firms whose information reactions are not efficient enough, and firms with low R^2 are more inefficient, which is opposite to the Western countries.

Besides, although price only reflects the trading noises, we can also believe that there is information asymmetry in the market. If information is complete symmetry, according to Grossman and Stiglitz (1980), each investor's information set is coherent and their prediction to future price is consistent too, under which, investors will have no trading motivation and there will be no trading existing, so R^2 will always be 1. Thus, the variables' effectiveness to measure information asymmetry, at least to a certain extent, is valid, no matter whether price reflects noise trading or private information.

3.3 Testing the sensitivity of price to firm investment

Now, we study whether information contained in stock price will affect the sensitivity of firm investment cost and further decide stock price when investors make investment decisions. Table IV reports the estimated results of equation (5).

Columns 1-3 report results with *CAPX* as investment measure and $(1-R^2)$, *Delay* and *InfoIndex* as information-asymmetry measures and without any control variables. Column 4 is the same but includes all the three information-asymmetry measure and control variables. Result shows that, except column 1, the direct effects of investment to stock price shown in other columns are all positive; however $(1-\mathrm{R}^2)_{i,t-1}*CAPX_{i,t-1}$, coefficient of interactions in column 1, is 4.21131, and the mean of $(1-R^2)$ is 0.55037. So at a mean of $(1-R^2)$, the total effect of investment to price is 1.11096 $[=-1.20682+4.21131*0.55037]$, which is positive. Thus, when *CAPX* is used as an investment measure, investors will make decisions based on the firm investment, which

Table IV.
Tests of sensitivity of price to firm investment

Variables	Independent: Qt (Investment: CAPX)								Independent: Qt (Investment: CHGASSET							
	1		2		3		4		5		6		7		8	
I	-1.2068^{***}	-3.24	0.5903^{***}	3.44	1.9979^{**}	5.30	0.1388^{***}	0.27	-0.6335^{***}	-5.48	-0.3353^{***}	-6.80	0.1556	1.30	-0.1657	-1.08
$(1-R^2)^*I$	4.2114^{***}	6.50					3.5971^{***}	4.31	0.8181^{***}	4.77					0.3049	1.41
$Delay^*I$			18.9191^{***}	6.50			4.5588^{***}	2.76			4.7226^{***}	6.83			4.0121^{***}	4.52
$InfoIndex^*I$					-0.5683^{***}	-3.02	-0.7222^{***}	-3.55					-0.1416^{**}	-2.34	-0.2024^{***}	-3.38
CF							-1.41×10^{-10}	-1.44							$-2.02\times10^{-10**}$	-2.12
$(1-R^2)^*CF$							-1.51×10^{-10}	-0.86							1.54×10^{-10}	0.92
$Delay^*CF$							$1.69\times10^{-19**}$	1.93							1.19×10^{-9}	1.34
$InfoIndex^*CF$							4.51×10^{-11}	1.46							5.89×10^{-12}	0.20
RET							0.0550^{***}	4.49							0.0467^{***}	3.89
LOG(Size)							0.0531^{***}	3.30							0.0722^{***}	4.46
Insti_own							0.0767^{***}	2.96							0.0992^{***}	3.87
Adj. R^2	0.0466		0.0467		0.0265		0.0994		0.0187		0.0332		0.0078		0.0885	

Notes: Significance at: *10, **5 and ***1 percent levels; this table is regressed as equation (5); for brevity, we omit the results of constant and year dummies; Adj. R^2 is the adjusted R^2; sample period is from 2001 to 2006 and including 313 firms listed in Shenzhen Stock Market; observations are 1,878 will further affect the stock price and firm investment will have significant positive effect on stock price.

Columns 5-8 report results with the investment measure of *CHGASSET*. Except column 7, results in other columns show that the direct effect of investment to price is significantly negative. However, $InfoIndex_{i,t-1}*CHGASSET_{i,t-1}$ the coefficient of interactions in column 7, is -0.14157 and the mean of *InfoIndex* is 1.78275. So, with a mean of *InfoIndex*, the total effect of investment to price is $-0.09674[=0.15564+(-0.14157)*1.78275]$. Thus, with the investment measure of *CHGASSET*, firm investment has a significant negative effect on price which is opposite to the result with *CAPX* used as investment measure. It is probably because the two measures reflect different aspects of firm investments. *CAPX* reflects the direct investment cost, however, *CHGASSET* not only reflects the direct investment cost but also reflects the investment activities such as merging and peeling off.

From Table IV, we know that signs of coefficient of $INFO_{i,t-1}*I_{i,t-1}$ under two different investment measures are the same and both of them are positive. Specifically, coefficients of $(1-R^2)_{i,t-1}*I_{i,t-1}$ and $Delay_{i,t-1}*I_{i,t-1}$ are positive, and coefficient of $InfoIndex_{i,t-1}*I_{i,t-1}$ is negative. This indicates that information asymmetry has an increasing effect on the sensitivity of price to investment. A possible explanation may be that, a rational investor maximizing his utility expects to get as much information as possible when making investment decisions. When the market's information environment is bad, and information is terribly asymmetric, investors' behavior will depend more on the information transferred by firm investment, which includes the idiosyncratic information and can guide investors' buying/selling decisions in relation to the firm's stock.

Overall, from the results of equation (5) reported in Table IV, we find that: first, with different investment measures, effects of firm investment on price are different. With the measure of *CAPX*, firm investment has positive effect on price; however, with the measure of *CHGASSET,* firm investment has negative effect on price. Second, information asymmetry has a significant diminishing effect on the sensitivity of price to firm investment.

4. Robust test

To investigate the robustness of the coefficients of $Q_{i,t-1}$, $AsyInfo_{i,t-1}*Q_{i,t-1}$ and $AsyInfo_{i,t-1}*I_{i,t-1}$ we group the annual data with $(1-R^2)$ and *Delay*. Since *InfoIndex* is dummy variable, we will not give group test to *InfoIndex*. Besides, considering there are four values of *InfoIndex*, we divide the sample into four groups and estimate as follows:

$$I_{i,t}=\alpha+\beta_1\cdot Q_{i,t-1}+\gamma\cdot ContVars+\varepsilon_{i,t} \tag{6}$$

$$Q_{i,t}=\alpha'+\delta_1\cdot I_{i,t-1}+\varphi\cdot ContVars+e_{i,t} \tag{7}$$

Here, since the above equations are estimated by groups, there is no item including *AsyInfo* in controlling variables. *ContVars* includes variables of $CF_{i,t}$, $RET_{i,t+3}$, $Log(Size_{i,t})$ and $Insti\_own_{i,t}$. Table V reports the grouping test about the sensitivity of investment to price.

Panel A reports estimated the results of equation (6) grouped with $(1-R^2)$. With the investment measure of *CAPX*, we find that, except group (Q1) with least $(1-R^2)$, coefficients of $Q_{i,t-1}$ in the other three groups decrease progressively.

Table V.
Grouped tests of sensitivity of firm investment to price

Variables	Independent: CAPX Q1	Q2	Q3	Q4	Independent: CHGASSET Q1	Q2	Q3	Q4
Panel A: quintiles formed by $1 - R^2$								
Q	0.0267***	0.0341***	0.0322***	0.0194***	0.0711*	0.0078	0.0289	0.0181
	(3.43)	(4.48)	(4.49)	(3.05)	(1.77)	(0.22)	(0.73)	(0.76)
CF	4.79×10^{-11}***	2.64×10^{-11}***	2.92×10^{-11}***	8.69×10^{-12}**	1.52×10^{-11}	-2.05×10^{-12}	-1.17×10^{-10}***	1.62×10^{-10}***
	(6.03)	(5.33)	(4.35)	(1.90)	(0.37)	(−0.09)	(−3.17)	(9.39)
RET	0.0142***	−0.0073**	−0.0005	−0.0062	0.0897***	0.0493***	0.0264	0.0293**
	(3.01)	(−2.53)	(−0.17)	(−1.59)	(3.68)	(3.72)	(1.50)	(1.99)
LOG(Size)	−0.0126**	−0.0006	0.0020	0.0063	−0.0638**	0.0279	0.0837***	0.0019
	(−2.12)	(0.15)	(0.42)	(1.21)	(−2.06)	(1.46)	(3.20)	(0.10)
Insti_own	0.0089	0.0251***	0.0175**	0.0284***	0.0766**	0.0770**	0.0281	0.0492
	(1.23)	(3.88)	(2.27)	(3.19)	(2.05)	(2.58)	(0.66)	(1.47)
Number of Obs.	468	443	359	295	468	443	359	295
Adj. R^2	0.1115	0.1549	0.1335	0.0964	0.0464	0.0840	0.0580	0.2868
Panel B: quintiles formed by Delay								
Q	0.0307***	0.0242***	0.0368***	0.0215***	0.0338	0.0096	0.1250***	−0.0046
	(3.84)	(3.35)	(4.58)	(3.88)	(1.10)	(0.39)	(3.40)	(−0.13)
CF	1.94×10^{-11}***	2.84×10^{-11}***	2.88×10^{-11}***	1.81×10^{-11}***	-4.10×10^{-11}	-3.96×10^{-11}	4.11×10^{-11}	9.28×10^{-11}***
	(2.60)	(3.76)	(3.46)	(4.87)	(−1.44)	(−1.52)	(1.08)	(3.83)
RET	0.0075*	−0.00003	−0.0050	−0.0022	0.0315*	0.0314***	0.0414***	0.0728***
	(1.69)	(−0.01)	(−1.54)	(−0.69)	(1.86)	(2.74)	(2.80)	(3.42)
LOG(Size)	−0.0065	0.0027	−0.0025	0.0057	0.0050	−0.0146	0.00003	0.0366
	(−1.11)	(0.52)	(−0.50)	(1.39)	(0.22)	(−0.81)	(0.00)	(1.37)
Insti_own	0.0192**	0.0118	0.0219***	0.0223***	0.0675**	0.1591***	0.0218	0.0191
	(2.14)	(1.59)	(3.09)	(3.15)	(1.97)	(6.17)	(0.67)	(0.41)
Number of Obs.	354	381	408	422	354	381	408	422
Adj. R^2	0.0747	0.0919	0.1023	0.1418	0.0237	0.1245	0.0475	0.0821

Notes: Significance at: *10, **5 and ***1 percent levels; for brevity, we omit the results of constant and year dummies; Adj. R^2 is the adjusted R^2

Coefficient of Group (Q4) with maximal $(1 - R^2)$ is 0.01935 which is the smallest. Tested by group, coefficients of Q are all positive with significance of 1 percent. With *CHGASSET* used as investment measure, except for the second group (Q2), coefficients of $Q_{i,t-1}$ in the other three groups decrease progressively. Coefficient of Q in each group is positive, however, except in the second group (Q2), coefficients of $Q_{i,t-1}$ in the other three groups decrease progressively. The coefficient of Q in each group is positive, however, except in the first group (Q1), coefficients of $Q_{i,t-1}$ in the other groups are not significant with significance of 10 percent. The grouping test decreases the significance of coefficients. Panel B reports the estimated results of equation (6) grouped with *Delay* and results show that except in the third group (Q3), coefficients of $Q_{i,t-1}$ in the other groups all decrease progressively. Except the coefficient of $Q_{i,t-1}$ in the last column in Table V is negative, coefficients of $Q_{i,t-1}$ in other group are positive.

Overall, results reported in Table V basically support the conclusion in the previous text that there is positive correlation of price and investment, and the NSYNCH has a diminishing effect on investment to price. However, without further evidence, this diminishing effect is just a rough judgment, by which we try to point out that the results are robust with different groups.

Table VI reports tests on the sensitivity of stock price to firm investment by group. Panel A reports the estimated result of equation (7) grouped with $(1 - R^2)$. With the investment measure of CAPX, we find, except for group 4 (Q4) with maximal $(1 - R^2)$, that coefficients of $I_{i,t-1}$ in the other three groups are increasing progressively and all the coefficients of each group is positive with significance of 5 percent. With the investment measure of *CHGASSET*, except group 2 (Q2), coefficients of $I_{i,t-1}$ in the other three groups are increasing progressively and the coefficient of $I_{i,t-1}$ in each group is negative with significance of 5 percent. Panel B reports the estimated results of equation (7) grouped with *Delay* and we find that there is no significant increasing or decreasing tendency in the coefficient of $I_{i,t-1}$ in each group. With measurement of *CAPX*, coefficient of $I_{i,t-1}$ in each group is significantly positive. With *CHGASSE*, coefficient of $I_{i,t-1}$ in each group is significantly negative. So, results are robust when grouped with $(1 - R^2)$, however, when grouped with *Delay*, the coefficient of $I_{i,t-1}$ in each group does not show an expected increasing tendency. Yet, conclusions that firm investment has a significantly positive effect on stock price with *CAPX* used as investment and firm investment has a significantly negative effect on stock price with *CHGASSET* used as investment are still robust.

Tables VII and VIII report results grouped by ultimate controllers. We find there is no significant difference between state-owned firms and privately-owned firms; coefficients of interaction are robust in signs and significance (expect the significance of *InfoIndex**I*).

The left part of Tables IX and X report results after controlling concentration of ownership of *CR5* and we find that coefficients of interaction are robust in signs and significance. Coefficient of interaction of *CR5* is only significant when *CAPX* is used as an investment measure, which indicates that concentration of ownership does not affect results of this paper (*CR1* and *CR10* get similar results). So, in general, after controlling the ultimate controller and concentration of ownership, results are still robust.

The right part of Table IX reports results on sensitivity of firm investment to price after controlling manager information (*ManagerInfo*) and we find that interaction of *ManagerInfo**Q* is not significant and coefficients of the other three interactions are robust in signs and significance as before. So, manager information *ManagerInfo*'s

Table VI.
Grouped tests of sensitivity of price to firm investment

Variables	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	Independent: Qt (Investment: CAPX)				Independent: Qt (Investment: CHGASSET)			
Panel A: quintiles formed by $1 - R^2$								
I	0.8545***	0.9571***	1.0035***	0.0812**	−0.1833**	−0.1064**	−0.1744***	−0.1640**
	(2.87)	(4.70)	(3.48)	(1.93)	(−2.09)	(−2.03)	(−2.61)	(−2.22)
CF	-4.13×10^{-11}	-3.29×10^{-11}	-9.46×10^{-11}**	-6.33×10^{-11}*	-4.74×10^{-11}	-2.01×10^{-11}	-6.62×10^{-11}	-5.19×10^{-11}
	(−0.63)	(−1.13)	(−2.29)	(−1.82)	(−0.71)	(−0.68)	(−1.61)	(−1.51)
RET	0.0274	0.0188	0.0122	0.0700**	0.0299	0.0184	0.0172	0.0637**
	(0.93)	(1.22)	(0.57)	(2.50)	(1.01)	(1.17)	(0.79)	(2.30)
LOG(Size)	−0.1290***	0.0245	0.0571**	0.1445***	−0.1167**	0.0312	0.0713**	0.1630***
	(−2.79)	(0.97)	(1.98)	(4.38)	(−2.49)	(1.20)	(2.48)	(4.91)
Insti_own	0.1261**	0.0712**	0.0563	−0.0430	0.1276**	0.0933**	0.0669	−0.0227
	(2.52)	(1.91)	(1.22)	(−0.70)	(2.54)	(2.46)	(1.44)	(−0.37)
Number of Obs.	297	401	437	430	297	401	437	430
Adj R^2	0.0506	0.0777	0.0498	0.0629	0.0383	0.0363	0.0383	0.0656
Panel B: quintiles formed by Delay								
I	0.7964***	0.6562**	1.0064***	0.8063*	−0.1740**	−0.1835**	−0.0884**	−0.2459**
	(3.01)	(2.21)	(3.92)	(1.90)	(−2.56)	(−2.09)	(−2.22)	(−2.16)
CF	-6.08×10^{-11}	-3.55×10^{-11}	-2.95×10^{-11}	-8.30×10^{-11}**	-5.03×10^{-11}	-3.52×10^{-11}	-2.96×10^{-12}	-6.92×10^{-11}**
	(−1.45)	(−0.70)	(−0.69)	(−2.46)	(−1.20)	(−0.70)	(−0.07)	(−2.09)
RET	0.0362	0.0414*	0.0378**	0.0248	0.0469*	0.0383*	0.0361**	0.0197
	(1.44)	(1.85)	(2.27)	(0.85)	(1.86)	(1.72)	(2.14)	(0.68)
LOG(Size)	0.0283	0.0147	0.0047	0.1347***	0.0316	0.0269	0.0192	0.1569***
	(0.86)	(0.42)	(0.19)	(3.91)	(0.95)	(0.77)	(0.77)	(4.53)
Insti_own	0.0903*	0.0846*	0.1445***	−0.0531	0.1048**	0.0999**	0.1556***	−0.0365
	(1.77)	(1.68)	(3.94)	(−0.86)	(2.06)	(1.99)	(4.21)	(−0.59)
Number of Obs.	354	381	408	422	354	381	408	422
Adj R^2	0.0456	0.0292	0.1013	0.0444	0.0388	0.0279	0.0782	0.0468

Notes: Significance at: *10, **5 and ***1 percent levels; for brevity, we omit the results of constant and year dummies; Adj. R^2 is the adjusted R^2

Table VII. Tests of sensitivity of firm investment to price (grouped by the ultimate controller)

Variables	1	2	3	4	5	6	7	8
		Independent: CAPX				Independent: CHGASSET		
State-owned firms								
Q	0.0379***	0.0306***	0.0135**	0.0368***	0.0468	0.0294	−0.0306	0.0629
	4.75	6.16	2.17	3.94	1.15	1.16	−0.96	1.30
$(1-R^2)$ *Q	−0.0167*			−0.0280**	−0.0354			−0.0625
	−1.62			−2.09	−0.67			−0.91
Delay *Q		−0.0388		0.0109		−0.0641		0.0589
		−1.38		0.31		−0.45		0.33
InfoIndex *Q			0.0083***	0.0064**			0.0334**	−0.0050
			2.88	2.16			2.27	−0.32
Adj.R^2	0.0332	0.0326	0.0377	0.1280	0.0014	0.0011	0.0036	0.0804
Private-owned firms								
Q	0.0368***	0.0290***	0.0214**	0.0313**	0.1568***	0.0696**	−0.0051	0.0963
	2.78	4.65	2.39	1.97	2.61	2.44	−0.13	1.36
$(1-R^2)$ *Q	−0.0192			−0.0046	−0.1473**			−0.1369
	−1.18			−0.21	−1.99			−1.37
Delay *Q		−0.0373**		−0.0321		−0.1272		−0.0140
		−2.11		−1.34		−1.57		−0.13
InfoIndex *Q			0.0010	−0.0010			0.0436*	0.0405
			0.18	−0.18			1.65	1.56
Adj.R^2	0.0575	0.0682	0.0527	0.1289	0.0206	0.0152	0.0162	0.1297

Notes: Significance at: *10, **5 and ***1 percent levels; this table is regressed as equation (4); for brevity, we omit the results of constant, year dummies, *CF*, $(1-R^2)$ **CF*, *Delay* **CF*, *InfoIndex* **CF*, *RET*, *LOG(Size)* and *Insti_own*; Adj. R^2 is the adjusted R^2; sample period is from 2001 to 2006 and including 313 firms listed in Shenzhen Stock Market; observations are 1,878

Table VIII.
Tests of sensitivity of price to firm investment (grouped by the ultimate controller)

Variables	Independent: Qt (Investment: CAPX) 1	2	3	4	Independent: Qt (Investment: CHGASSET) 5	6	7	8
State-owned firms								
I	−0.7543*	0.3662*	1.4381***	0.4585	−0.5229***	−0.3063***	0.1136	−0.1307
	−1.89	1.88	3.58	0.84	−4.05	−4.91	0.81	−0.69
$(1-R^2)*I$	3.2258***			2.3619**	0.6240***			0.2740
	4.57			2.51	3.4			1.08
Delay * *I*		17.66***		12.653***		4.1623***		3.4332**
		5.70		3.24		4.11		2.42
InfoIndex * *I*			−0.30	−0.6297***			−0.1097	−0.1864***
			−1.51	−2.96			−1.61	−2.76
$Adj.R^2$	0.0361	0.0451	0.0214	0.0984	0.0137	0.0180	0.0064	0.0820
Private-owned firms								
I	−3.0032**	0.6967	4.7750***	−0.7432	−1.4609***	−0.4546***	0.2641	−0.4831
	−2.45	1.15	3.86	−0.38	−4.28	−3.46	0.84	−1.03
$(1\text{-}R^2)*I$	7.8995***			8.0954***	2.3626***			0.8894
	4.15			2.68	3.94			1.01
Delay * *I*		7.2653***		−0.9325		5.4495***		3.4671*
		3.37		−0.27		4.44		1.85
InfoIndex * *I*			−2.1815***	−1.6819**			−0.3131	−0.3113
			−2.9	−2.05			−1.59	−1.59
$Adj.R^2$	0.0800	0.0607	0.0507	0.1067	0.0573	0.0709	0.0119	0.1000

Notes: Significance at: *10, **5 and ***1 percent levels; this table is regressed as equation (5); for brevity, we omit the results of constant, year dummies, *CF*, $(1-R^2)$*CF Delay*CF, InfoIndex*CF, RET, LOG(Size)* and *Insti_own*; Adj. R^2 is the adjusted R^2; sample period is from 2001 to 2006 and including 313 firms listed in Shenzhen Stock Market; observations are 1,878

Table IX. Tests of sensitivity of firm investment to price (grouped by concentration of ownership or manager's information)

Variables	1	2	3	4	5	6	7	8
	Independent: CAPX				Independent: CHGASSET			
Concentration of ownership (CR5)								
Q	0.0074	5.9×10^{-05}	−0.0161**	0.0064	0.0210	−0.0039	−0.0535	0.0388
	0.76	0.01	−1.99	0.63	0.44	−0.1	−1.35	0.77
$(1-R^2)$*Q*	−0.0179**			−0.0132	−0.0486			−0.0409
	−2.08			−1.22	−1.16			−0.77
*Delay***Q*		−0.047***		−0.0282		−0.0873		0.0124
		−3.04		−1.52		−1.16		0.14
*InfoIndex***Q*			0.008***	0.0058**			0.031**	−0.0026
			3.31	2.27			2.52	−0.21
*CR5***Q or ManagerInfo***Q*	0.0558***	0.0568***	0.0542***	0.0447***	0.0839	0.0871	0.0762	0.0412
	4.53	4.63	4.4	3.74	1.39	1.45	1.26	0.70
Adj.R^2	0.0496	0.0526	0.0536	0.1344	0.0030	0.0030	0.0061	0.0838
Manager's information (ManagerInfo)								
Q	0.0398***	0.0322***	0.0136***	0.0319***	0.0657**	0.0356*	−0.0221	0.0556
	5.81	7.87	2.61	4.01	1.97	1.78	−0.87	1.43
$(1-R^2)$*Q*	−0.0194**			−0.0138	−0.0622			−0.0536
	−2.21			−1.26	−1.46			−1.00
*Delay***Q*		−0.0468***		−0.0268		−0.0956		0.0168
		−3.03		−1.44		−1.27		0.18
*InfoIndex***Q*			0.009***	0.007***			0.032***	−0.0018
			3.64	2.59			2.63	−0.15
*CR5***Q or ManagerInfo***Q*	−0.1073	−0.1418	−0.1861	−0.1952	1.2911	1.1268	1.0398	1.5687
	−0.53	−0.71	−0.93	−0.99	1.30	1.15	1.07	1.63
Adj.R^2	0.0373	0.0399	0.0424	0.1271	0.0028	0.0025	0.0059	0.0851

Notes: Significance at: *10, **5 and *** 1 percent levels; this table is regressed as equation (4); for brevity, we omit the results of constant, year dummies, *CF*, $(1-R^2)$**CF*, *Delay***CF*, *InfoIndex***CF*, *RET*, *LOG(Size)* and *Insti_own*; Adj. R^2 is the adjusted R^2; sample period is from 2001 to 2006 and including 313 firms listed in Shenzhen Stock Market; observations are 1,878

Table X.
Tests of sensitivity of price to firm investment (grouped by concentration of ownership or manager's information)

Variables	Independent: CAPX 1	2	3	4	Independent: CHGASSET 5	6	7	8
Concentration of ownership (CR5)								
I	−0.9847	0.9251*	2.3961***	0.2188	−0.5770***	−0.3286**	0.1459	−0.2741
	−1.61	1.89	4.09	0.31	−3.07	−2.05	0.77	−1.34
$(1-R^2)^{*}I$	4.1868***			3.5884***	0.8216***			0.2930
	6.43			4.29	4.79			1.35
*Delay** *I*		8.8787***		4.5600***		4.7222***		4.0456***
		6.47		2.76		6.82		4.55
*InfoIndex***I*			−0.5630**	−0.7219***			−0.1419**	−0.2060***
			−2.99	−3.55			−2.33	−3.43
*CR5***I or ManagerInfo***I*	−0.3488	−0.5546	−0.6790	−0.1268	−0.1040	−0.0119	0.0184	0.2134
	−0.46	−0.73	−0.89	−0.17	−0.38	−0.04	0.07	0.8
Adj.R^2	0.0461	0.0464	0.0264	0.0988	0.0181	0.0326	0.0072	0.0882
Manager's information (ManagerInfo)								
I	−1.0773***	0.6312***	1.9768***	0.1770	−0.5779***	−0.2417***	0.1628	−0.1367
	−2.83	2.73	4.93	0.34	−4.92	−3.1	1.22	−0.89
$(1-R^2)^{*}I$	4.4761***			3.7091***	1.0123***			0.4480*
	6.71			4.34	5.38			1.93
*Delay** *I*		8.9314***		4.4782***		4.9225***		3.8797***
		6.51		2.7		7.00		4.35
*InfoIndex***I*			−0.5702***	−0.7177***			−0.1411**	−0.2008***
			−3.02	−3.53			−2.32	−3.35
*CR5***I or ManagerInfo***I*	−24.957*	−3.8789	2.2955	−9.4626	−14.075**	−8.0748	−0.6306	−9.1612*
	−1.65	−0.26	0.15	−0.63	−2.48	−1.55	−0.12	−1.66
Adj.R^2	0.0477	0.0461	0.0259	0.0990	0.0219	0.0341	0.0072	0.0895

Notes: Significance at: *10, **5 and ***1 percent levels; this table is regressed as equation (5); for brevity, we omit the results of constant, year dummies, *CF* $(1-R^2)$**CF*, *Delay***CF*, *InfoIndex***CF*, *RET*, *LOG(Size)* and *Insti_own*; Adj. R^2 is the adjusted R^2; sample period is from 2001 to 2006 and including 313 firms listed in Shenzhen Stock Market; observations are 1,878 effect on stock price will not influence results in this paper. Besides, the right part of Table X reports results on sensitivity of price to firm investment after controlling manager information (*ManagerInfo*) and results show our conclusion is robust. So, after controlling the private information of managers, conclusions in our paper are still robust.

Finally, we estimate all the results based on the alternative Tobin-Q and find the results are robust. In the test on sensitivity of price to firm investment, we find signs of estimated coefficients are robust and more significant. In the test on sensitivity of firm investment to price, we find signs are still robust, in which the signs and significance do not change when *CHGASSET* is used as measure of firm investment. When *CAPX i*s used as measure of firm investment, there is no change in signs. However, when we take information-disclosure index (*InfoIndex*) from Shenzhen Stock Exchange as the proxy for information transparency, the estimated coefficients are significant, at significance of 0.10 percent. When taking R^2 or *Delay* proxy the information measures as the proxy, signs are the same with results based on Q, only with a little decrease of significance[4].

Overall, our testing results in this paper are robust.

5. Conclusions

According to investment theory, Tobin-Q plays an important role in firm investment, on condition that the market is complete. When the market is incomplete, if, in case there is information asymmetry, will Tobin-Q affect firm investment significantly? How will the degree of information asymmetry affect the sensitivity of investment to stock prices? This is one aspect we try to study in this paper. Besides, we study the decision-making behaviors of stock investors to investigate information-asymmetry's impact on sensitivity of stock prices to investment. Based on the empirical test of the listed company of A shares in Shenzhen Stock Market, we conclude that.

First, through the study on the sensitivity of firm investment cost to stock prices, we find that managers will learn from the market when making a decision on firm investment and there is significant positive correlation between firm investment cost and stock price, which supports Tobin-Q theory. After adding interaction of $AsyInfo_{i,t-1}{*}Q_{i,t-1}$ in the model, results show that information asymmetry has a significant diminishing effect on the sensitivity of firm investment to stock price.

Second, tests on the sensitivity of price to firm investment find that with different measures of firm investment (I), firm investment will have different effects on stock price because they measure different aspects of firm investment. The coefficients of interaction of $AsyInfo_{i,t-1}{*}I_{i,t-1}$ show that, under two different types of measure, information asymmetry has significant increasing effect on the sensitivity of stock price to firm investment.

Last, results with some concerned tests, such as controlling corporate governance (e.g. the shareholding ratio of big shareholders and types of ultimate controllers), subsample group, or the private information of managers, show that results of this paper are robust, at least with listed companies of A shares in Shenzhen Stock Market.

Notes

1. One of our referee points out that "whether the non-synchrony of $(1 - R^2)$ can be used as the measure of information asymmetry needs further discussion. First, according to Morck *et al.* (2000), level of non-synchrony of developed capital market is low, namely, R^2 is minor and $1 - R^2$ is comparative large, however, in the emerging market, R^2 is large and $1 - R^2$ is

comparatively minor. So, does it means that developed capital market has a higher level of information asymmetry if the author uses the large $1 - R^2$ to represent the high level of information symmetry? Second, the author thinks that $1 - R^2$ represents the variation of the idiosyncratic return, thus higher $1 - R^2$ represents more variation of idiosyncratic return, which further indicates that there are more information flows from firms to market and is capitalized by investors. This is one specific phenomenon of fine environment of developed capital market. So, although the study of Kelly (2005) believes that the lower R^2 of the market model is, the lower efficient the information transmission and the higher degree the information asymmetry will be, there is still great arguments on using $(1 - R^2)$, the non − synchrony of price to measure the degree of information asymmetry. I suggest that, when measuring information asymmetry, we should carefully use the non-synchrony index of $(1 - R^2)$."

We agree with referee's opinion. Indeed, there are still a lot of debates and scholars do not reach agreement on the issue whether low R^2 represents more idiosyncratic information or lower efficiency of information transmission. We think studies supporting low R^2 represents more idiosyncratic information are mostly based on the developed capital market in which investors' behaviors are more reasonable and the protection system for investors is more complete. Investors' return is mainly got depending on analyzing the idiosyncratic information of firms. So, we cannot deny that low R^2 may represent firms' characteristics in a country with mature market and legal system. However, Chinese stock market is in its initial step, speculative atmosphere is too strong, and investors are more those of speculation instead of investment. In such cases, low R^2 may reflects more of the bad information environment in the market and the low efficiency of information transmission, thus, stock price is mostly driven by noise traders. As pointed out by the study of Kelly (2005), investors seldom hold and analysts pay little attention to the stock shares of firms with lower R^2 which have smaller scales and higher trading cost, and this indirectly indicates that firms with lower R^2 may not those with more efficient reaction to information. So, we hope readers should be careful about the results based on R^2.

2. The detail (in Chinese) can be obtained at: www.szse.cn/main/disclosure/bulliten/cxda/xxplkp/

3. We also try to introduce the $Q_{i,t}$ and $I_{i,t}$ at two sides of equations (4) and (5). When variables at t be taken both as independent and dependent variables in estimation, the OLS regression results are biased. To avoid this bias, we use simultaneous equations to get results (two-stage regression) and find there is no substantial change in our results and the coefficients of $Q_{i,t}$ and $I_{i,t}$ are not significant. These results show that the effects mainly lie in the lagged variables, i.e. the price's sensitivity on investment or investment's sensitivity on price are lagged effects. Intuitionally, we think the lagged effects mean that the top managers pay attention to lagged prices when they make investment decision, and the investor more care about the lagged investment from the firms' financial report (actually, at period t, it is difficult for investors to know the firms' financial status of period t. Investors mostly get information lagged). These results are available upon request by e-mail.

4. As stated in the previous test, scholars do not reach agreement on the issue that whether low R^2 reflects more idiosyncratic information or low efficiency of information transmission, besides, there is evidence showing that firms with low R^2 may not be those with more efficient information. So, based on the testing results of Q, signs of R^2 and *Delay* are consistent, however, both of their significance decreases. It is probably because R^2 and *Delay* are not very good at being proxy for the information content.

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