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Article

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China Journal of Accounting Research

Provided in Cooperation with:
Sun Yat-sen University

Suggested Citation: Xu, Liping; Wang, Jingwei; Xin, Yu (2010) : Government control, uncertainty, and investment decisions in China's listed companies, China Journal of Accounting Research, ISSN 1755-3091, Elsevier, Amsterdam, Vol. 3, pp. 131-157, https://doi.org/10.1016/S1755-3091(13)60022-2

This Version is available at:
https://hdl.handle.net/10419/187618

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Government Control, Uncertainty, and Investment Decisions in China's Listed Companies*

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Abstract

This paper empirically investigates the relation between uncertainty and investment among China's listed companies, and analyzes the influence of government control on the investment-uncertainty relation. We find that there is a negative relation between total firm uncertainty and investment in China's listed companies. However, this holds only for privately controlled firms. Among privately controlled listed firms, investment is negatively related to firm-specific uncertainty, whereas among government-controlled ones, investment is positively related to market uncertainty. We also find that the risk-taking preference of government-controlled listed companies is greater among those firms with fewer investment opportunities. Finally, among financially distressed firms, the negative relation between investment and uncertainty becomes nonsignificant because of risk shifting, which is more serious among government-controlled listed companies. We conclude that government control leads to state interference and weak corporate governance, which, in turn, distorts investment decision making among listed companies.

JEL classification: G31; G32

Keywords: Government control; Investment; Uncertainty

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* The authors thank the editor, two anonymous referees, Donghua Chen, Xijia Su, Qingquan Xin, and participants at the 9th Chinese Young Economist Forum (Chengdu, 2009) and the 3rd Symposium of the China Journal of Accounting Research (Hangzhou, 2009) for their helpful comments and suggestions. The study was supported by the National Natural Science Foundation of China (Project Nos. 70702031 and 70872115). All errors are the sole responsibility of the authors.

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1. Introduction

Throughout history, governments around the world have been involved in production and commerce. For instance, state ownership of mills and metal working was common in the ancient Near East (Sobel, 1999), while during the Qing Dynasty in China, government monopolized the salt and iron trades. Since the 1980s, starting with the Thatcher government in Britain, there has been a worldwide trend toward privatization, with government seeming to gradually withdraw from involvement in production and commercial activities. However, after the subprime mortgage crisis in the United States in August 2008, many countries launched stimulus programs to prevent economic recession. As a result, the degree of government intervention in the economy increased. In the United States, for example, government nationalized the mortgage giants, the Federal National Mortgage Association (Fannie Mae) and the Federal Home Mortgage Corporation (Freddie Mac), and arranged a rescue package for American International Group, Inc. (AIG), the country's biggest insurance company. In addition, the US government became the largest shareholder of General Motors after its reorganization. In China, a market economy has developed following the promotion of the open door policy and launch of economic reforms in 1978. However, the state-owned sector remains the mainstay of the nation's economy.[1]

The role of government control has been investigated by a great array of studies. Various theories have been put forward to explain the existence of government control (for a survey, see Mao, 2007), while the debate on the relative efficiency of state and private ownership is never ending (Shirley and Walsh, 2000). The privatization wave in the 1980s led to a surge in research into privatization and its economic consequences (Megginson and Netter, 2001), and in recent years, the examination of political connections has become increasingly popular.

China's unique marketization process has been remarkably successful. The efficiency of government control and related governance problems in China are much discussed among academics and policy makers. Many studies have investigated the impact of the type of ownership and ownership structure on firm performance (eg, Sun and Tong, 2003; Wei, Xie, and Zhang, 2005; Chen, Firth, and Xu, 2009), and there is increasing research interest in the influence of government control on firm behavior and corporate governance mechanisms (eg, Li, 2002; Chen, Chen, and Wan, 2005). However, there is no consensus to date on whether or not government involvement in production and commerce promotes firm efficiency. Hence, this paper investigates the influence of government control on the investment decisions of listed companies in the hope of providing more evidence regarding efficiency and government control.

Investment decisions are among the most important decisions of firms. Whether to

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[1] For example, in 2006, the realized profit of all enterprises in China was RMB 1,200 billion, of which two-thirds came from companies controlled by the State-owned Assets Supervision and Administration Commission (SASAC). Data source: www.sasac.gov.cn.

invest, when to invest, and the choice of projects – all of these decisions affect the return on investment, which has a direct effect on the firm's future. Corporate investment behavior has long been of interest among academics and practitioners. Traditionally, the discounted cash flow method, or net present value (NPV) method, has been used to make investment decisions. However, in a dynamic business environment, the NPV method fails to capture the value of project flexibility. Therefore, real options theory has been applied to the investment decision-making process, in which the influence of uncertainty and the value of waiting on an irreversible investment are considered to incorporate more comprehensive information to modify and correct investment decisions. In the real options framework, an investment decision is the trade-off between investing immediately and waiting to obtain more valuable information. The greater is cash flow uncertainty, the more value will be obtained by delaying investment. Therefore, investment and uncertainty are negatively related (eg, McDonald and Siegel, 1985; Dixit and Pindyck, 1994).

Government control affects the corporate governance of listed companies. Governments will also use the listed companies that they control to realize social and macroeconomic goals. Such influence is reflected in the investment decisions of listed companies. The investment decisions of government-controlled firms depend therefore on a set of factors: the risks and returns of projects; information and agency problems; the problem of poor governance among state-owned companies; and the influence of public policy. As a result, the extent to which investment depends on risks and returns is likely to be lower among firms controlled by government compared to privately owned ones. This paper aims to verify the foregoing argument by examining the relation between investment and uncertainty in China's listed companies. Specifically, we expect the negative relation between investment and uncertainty to be weaker in government-controlled listed companies than in privately controlled ones. This paper also examines whether the weak relation between investment and uncertainty arising from government control is efficient or not.

The study finds that a negative relation exists between total firm uncertainty and investment among China's listed companies. Therefore, the investment decision making of these companies is sensitive to uncertainty. However, this negative relation holds only for privately controlled firms. Fixed effects regression analysis with an interaction term reveals that government control weakens the negative relation between investment and uncertainty. We then decompose total firm uncertainty into firm-specific, industry, and market uncertainty using the capital asset pricing model (CAPM) and regress investment on the three variables. Investment is found to be negatively related to firm-specific uncertainty in privately controlled listed companies and positively related to market uncertainty in state-controlled ones. That is, government control weakens the negative relation between investment and firm-specific uncertainty and leads to a positive relation between investment and market uncertainty. The results demonstrate that government control increases the risk-taking preference of firms. The positive relation between investment and market uncertainty in government-controlled firms shows that, in the

case of greater macroeconomic risk, government will let state-owned companies increase the level of their investment to stimulate economic growth. We then divide the sample into two groups, firms with greater and those with fewer growth opportunities, and find a lower level of investment-uncertainty sensitivity only in the latter group. This finding suggests that greater risk preference due to government control is not the result of rational decision making. Finally, we find that among financially distressed companies, because of risk shifting, or asset substitution, the negative relation between investment and uncertainty becomes nonsignificant, and that risk shifting is greater in government- than privately controlled companies. Hence, the inherent flaw of state ownership, poor governance, remains difficult to overcome.

The reforms of China's state-owned enterprises (SOEs) have included increasing decision-making rights, imposing taxes on profits, and establishing the contract and modern enterprise systems. The ultimate goal of SOE reform has been to eliminate government intervention. Undeniably, the reform has been successful overall. However, government intervention in SOEs still exists, and the corporate governance mechanisms of SOEs require improvement.

This paper contributes to both the investment and the risk-taking literature. Regarding the former, most of the current literature on government control and investment behavior emphasizes the impact of financing constraints caused by agency problems in state- and privately controlled enterprises. Many studies have found that state-controlled enterprises tend to over-invest, whereas privately controlled ones are apt to under-invest. Government control can lead listed companies to treat risk differently. In investigating the relation between uncertainty and investment, this paper reveals how the investment behavior of government- and privately controlled listed companies differs because of their different risk preferences.

In recent years, there has been increasing research interest in risk preference and its determinants. For example, Adams, Almeida, and Ferreira (2005) and Cheng (2008) investigated the influence of CEO power and board size on firm performance. John, Litov, and Yeung (2008) and Acharya, Amihud, and Litov (2008) examined the influence of investor protection and creditor protection on corporate risk taking. The current paper finds that government control has a positive effect on corporate risk taking.

The rest of the paper is organized as follows. Section 2 reviews the literature on the investment-uncertainty relation; Section 3 analyzes how government control affects the investment behavior of enterprises; Section 4 presents the results of the empirical tests; Section 5 investigates investment efficiency and agency problems under government control; and Section 6 concludes the paper.

2. Uncertainty and Investment

Research on corporate investment over the last twenty years has focused mainly on three areas: the relation between financial constraints and investment in incomplete

markets, namely, investment-cash flow sensitivity (eg, Fazzari, Hubbard, and Petersen, 1988; Kaplan and Zingales, 1997; Cleary, 1999) and investment-debt sensitivity; overinvestment and underinvestment caused by agency problems; and the relation between uncertainty and investment based on real options theory (eg, McDonald and Siegel, 1985; Leahy and Whited, 1996). Stein (2003) has conducted an excellent review of the first two strands of the literature. Here, we mainly discuss the third.

Real options are nonfinancial options among which investors can choose in the process of investment decision making. The real options approach focuses on irreversible investment and how uncertainty and the value of waiting affect firm investment behavior. It adopts financial options theory to analyze investment behavior, treating investment opportunities as options owned by enterprises, and regarding investment behavior as the process of exercising those options. In addition to the project value based on cash flows, the real options approach takes into account the values of time and of managerial flexibility, and the value resulting from reducing uncertainty. Therefore, it can better predict firm investment behavior compared with other approaches.

The concept of real options was originally proposed by Myers (1977), who stated that the profit created by cash flows in an investment program is the sum of the values of the assets presently owned and future investment opportunities. That is, enterprises can obtain the right to buy or sell a real asset or an investment plan for some price in the future. We can use the way that ordinary options are assessed to evaluate real asset investment. McDonald and Siegel (1985) established a framework based on real options theory, which incorporates uncertainty, irreversibility, and corporate investment. They argued that the traditional neoclassical and Q theories fail to consider the specificity and irreversibility of capital investment and the resulting problem of sunk costs in the real world (McDonald and Siegel, 1985). The theory of irreversible investment holds that uncertainty exists in the capital asset investment decision-making process. That is, the future return on an investment is a random variable. In addition, traditional theories ignore the fact that investment opportunities do not disappear right away if money is not immediately invested. Therefore, the wait and see approach becomes valuable: as the economic environment changes over time, more information about the prospects of the investment project becomes available. A later decision may be the better one, especially when considering the irreversibility of investment. The firm may pay more if it decides to invest immediately and then tries to make changes to or retrieve its investment in the future. Combining uncertainty and irreversibility, investment theory offers a useful approach for the assessment of real-world investment opportunities.

Dixit and Pindyck (1994) showed that when the return on an investment project exceeds an endogenous threshold generated by a model, the investment option will be exercised. This threshold not only is greater than the investment cost but also relies on the uncertainty of returns on investment assets. The greater is the uncertainty, the higher is the threshold; that is, a higher level of uncertainty will result in a lower level of investment. Caballero and Pindyck (1996) studied the effects of industry and idiosyncratic uncertainty on irreversible investment, and tested the proposition that

an increase in uncertainty would increase the investment trigger point, and found a positive relation between uncertainty and the trigger point. Using data from a panel of US manufacturing firms, Leahy and Whited (1996) found that uncertainty had a negative effect on investment, consistent with irreversible investment theory. Minton and Schrand (1999) used cash flow volatility as a proxy for uncertainty, and found that a higher level of cash flow was associated with greater financing costs and lower investment levels. Extending the concept of investment to include human resource investment, Rosenberg (2004) grouped firms into labor-intensive and capital-intensive groups and found a negative relation between uncertainty and both types of irreversible investment. Bulan (2005) decomposed total firm uncertainty into market, industry, and firm-specific uncertainty according to the CAPM and verified not only that investment and uncertainty are negatively related but also that increased industry uncertainty has a pronounced negative effect on firm investment. Eisdorfer (2008) provided empirical evidence that financially distressed firms engage in risk shifting by testing a positive relation between uncertainty and investment; and that the investments of such firms generate less value during times of greater uncertainty.

To summarize, according to financial options theory, the greater is the price of underlying fluctuations, the greater is the value of delaying investment and the weaker is the motivation to exercise the option to invest right now. According to real options theory, given greater expected cash flow volatility, deferring investment is more valuable; that is, firms will wait rather than invest now. Therefore, uncertainty and firm investment are negatively related. Generally speaking, uncertainty can influence firm investment in two ways. On the one hand, the value of waiting motivates firms to defer their investment to obtain more information or wait until conditions become certain. On the other hand, uncertainty can reduce the investment level by influencing the optimal scale of the risky project. Based on the foregoing discussion, we propose the first hypothesis:

H1: *A significantly negative relation exists between uncertainty and investment.*

3. Government Control and Firm Investment Behavior

The reform of the investment system has been an integral part of China's economic reform over the past three decades. In the transition from a centrally planned to a market economy, three main changes have been made to the investment system (Xin, 2007). First, investment entities have greatly diversified, changing from various levels of government to state- and privately owned entities. Second, funding channels have multiplied, changing from solely treasury budgets to a variety of sources, including internal funds, bank loans, treasury allocations, and foreign capital. Finally, the manner of government involvement in corporate investment and financing has changed, from direct (administrative management) to indirect (market regulation).

However, great differences still exist between SOEs and privately owned enterprises.

First, although a series of reforms have been implemented over the transition period, including imposing taxes on profits and implementing contract and shareholding schemes, the government still intervenes in the operation of SOEs, requiring them to perform macroeconomic control and social welfare functions. For example, the financial turmoil caused by the subprime mortgage crisis in the United States swept across the globe, triggering a worldwide economic recession. To prevent economic recession, the Chinese government launched a four trillion yuan investment plan in November 2008 to stimulate social capital investment, strengthen the agricultural sector, modify the pattern of economic growth and development, and promote major infrastructure construction. The plan was, to a large extent, realized through investment by SOEs.

Second, government control cannot prevent the inherent disadvantage of state ownership, that is, the agency problems caused by the absence of the real owners (Alchain, 1965). Managers of SOEs have centralized control rights but no cash flow rights. Hence, they have an incentive to maximize their own interests at the expense of those of the firm. For example, SOE managers tend to pursue political goals (political performance and promotion) rather than state ones (Boycko, Shleifer, and Vishny, 1996; Shleifer and Vishny, 1994). Among the most important indicators in assessing the performance of officials in China are output and fiscal revenue. To maximize output and revenue growth, government officials will expand business. Such expansion is inevitable when government and managers have the same target. For SOE managers, the larger is the SOE, the greater are the resources that they control, the higher is their personal income level, and the higher is the administrative level that they can achieve.[2]

Finally, SOEs lack effective monitoring and incentive mechanisms. Two or more of the positions of chair, general manager, Party secretary, or other key posts may be held by the same person in the SOE or positions may overlap to a high degree. Therefore, the systems of checks and balances regulating the general meeting of stockholders, the board, and the board of supervisors may be compromised. In addition, China's market mechanisms are immature. The product, capital, and managers' markets fail to effectively monitor managers. Compared to their counterparts in private firms, SOE managers have more opportunities to transfer the risk of failure to the government and banks. Also, although the link between the assessment and bonuses of SOE managers with firm performance has been established in recent years, the assessment indicators have yet to be improved and the compensation system has little effect on long-term performance.[3]

In short, government control influences corporate investment decisions both because listed SOEs have to fulfill certain public policy goals and because investment decision

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[2] For example, Wei and Liu (2007) found that SOE managers are obsessed with expanding the scale of business and adopt aggressive investment strategies; however, they are more concerned about private benefits than returns or economies of scale.

[3] For example, Xin, Lin, and Wang (2007) found a tendency toward overinvestment among low income managers in firms controlled by the state assets management bureaus and the SOEs affiliated with local governments.

making is influenced by the agency problems inherent in state ownership.[4] In particular, such control makes listed SOEs less sensitive to uncertainty. Therefore, we propose the second hypothesis:

H2: *Government control weakens the negative relation between uncertainty and investment.*

4. Empirical Tests

4.1. Sample and Descriptive Statistics

Our sample includes all main board pure A-share manufacturing firms listed on the Shanghai and Shenzhen Stock Exchanges from 1999 to 2008.[5] For each firm year, we identify the controlling shareholders of the listed companies using the *Guidelines for Articles of Association of Listed Companies* of the China Securities Regulatory Commission (CSRC) (1997).[6] Then, we divide listed companies into government- and privately controlled based on the type (state or private) of ultimate owner among the controlling shareholders.[7] Investment (I) is defined as changes in capital assets plus amortization in the current year. Following Leahy and Whited (1996), we measure uncertainty using

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[4] Some scholars claim that state-owned banks are also compelled to fulfill government objectives, and to provide support to SOEs. If SOEs have financial problems, then the banks can offset such problems by asking for government subsidies. However, they will be blamed for their failure to collect on loans to non-SOEs. This leads banks to reduce the loan qualification requirements for state-owned enterprises (Cull and Xu, 2003; Brandt and Li, 2003; Allen, Qian, and Qian, 2005; Ge and Qiu, 2007). As government-controlled listed companies can obtain loans more easily than can their privately controlled counterparts, the former can take greater risks. However, Firth, Malatesta, Xin, and Xu (2010) found no evidence of bank credit discrimination among listed companies, so we do not make the assumption of credit discrimination here.

[5] We delete small and medium board-listed companies because their firm size is usually too small, and their risk level and investment mode differ greatly from those of main board companies. We use only manufacturing firms for two reasons: first, the level of capital assets varies greatly between firms in manufacturing and those in other industries; second, the investment of firms in other industries may not be in the form of capital assets. Finally, we drop B-share, H-share, and other foreign share firms. Because each market has its own evaluation level, it is difficult to calculate precisely and consistently the Tobin's Q of those firms.

[6] According to the *Guidelines for Articles of Association of Listed Companies* (CSRC, 1997), the controlling shareholder refers to the shareholder who meets one of the following conditions: (1) this person alone or acting with others can select more than half of the directors; (2) this person alone or acting with others can exercise more than 30% of the voting rights of the company or can control the exercise of more than 30% of the voting rights; (3) this person alone or acting with others can hold 30% of the company shares; (4) this person alone or acting with others can in fact control the company in other ways.

[7] In rare cases (1.5% of the sample), the listed companies have no controlling shareholders. We then determine whether the listed companies are government controlled in accordance with the nature of the ultimate controller of the largest shareholders.

the variance of stock returns.[8] Specifically, total firm uncertainty (UC) is measured as the annualized standard deviation of daily stock returns.[9] The advantage of using the variance of stock returns is that the returns contain the various kinds of uncertainty faced by firms including input and output and macro and micro factors. Many studies demonstrate that investment is related to investment opportunities, the level of internal funds, and the debt level, so we control for these factors in our regression equations. We use the beginning Tobin's Q as the proxy for investment opportunity, calculated as the market value of tradable shares plus the book value of non-tradable shares and total liabilities, divided by the book value of total assets. The level of internal funds is substituted by the operating cash flow (CF). To eliminate the influence of scale, I and CF are both divided by beginning-of-period capital assets (K) and denoted as I/K and CF/K, respectively. The debt level is measured by the beginning debt-to-asset ratio (LEV), namely, the proportion of total liabilities to total assets. Two variables are used to measure government control, Gov and State. Gov is a dummy variable that is coded as one if the ultimate controller of a listed company is the government, a stated-owned assets management bureau, or a state-owned enterprise, and zero otherwise. State is the sum of the proportion of shares owned by the government, the stated-owned assets management bureau, or the state-controlled enterprises in a listed company. We drop firms with missing financial data and those with fewer than 60 trading days in a year to calculate reliable UCs. All continuous variables are winsorized at the first and ninety-ninth percentiles. The final sample has 5,406 firm years, of which 3,909 (72.31%) are government controlled and 1,497 (27.69%) are privately controlled. The ownership data are hand collected from annual reports, and the financial and trading data are retrieved from the China Stock Market and Accounting Research (CSMAR) database.

Total firm uncertainty represents the uncertainties due to market, industry, and firm-specific factors. The traditional view asserts that systematic risk, market uncertainty under the CAPM, influences firm investment by affecting the firm's cost of capital. In contrast, real options theory holds that total firm uncertainty matters for firm investment. Dixit and Pindyck (1994) claimed that capital irreversibility is more pronounced at the industry level. Bulan (2005) decomposed total firm uncertainty into market, industry, and firm-specific components, and found that both industry and firm-specific uncertainty had a negative effect on firm investment.

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8 Some studies use profit volatility, cash flow volatility, or sales revenue volatility as a proxy for uncertainty (eg, Minton and Schrand, 1999). Compared with those proxies, stock price can reflect more comprehensively the macro and micro factors faced by companies, and is forward looking. Hence, stock price can substitute for expected uncertainty. Also, some studies adopt the generalized autoregressive conditional heteroskedasticity (GARCH) model, which requires time series data, to estimate expected uncertainty (eg, Eisdorfer, 2008). However, the history of China's stock market is relatively short; thus, that method is not suitable, either.

9 The annualized standard deviation of daily stock returns is calculated as the standard deviation of daily stock returns in the year multiplied by the square root of 250, which is the number of trading days in a year.

Following Bulan (2005), to decompose total firm uncertainty into market, industry, and firm-specific components, we first estimate the following two-index model for each firm year:

$$r_{i\tau} = \alpha_{i\tau} + \beta_{it} r_{M\tau} + \gamma_{it} r_{I\tau} + \varepsilon_{i\tau} \qquad (1)$$

where τ = 1, 2, ... t_i; t_i is the trading days in year t; $r_{i\tau}$ is the daily returns of firm i's equity; $r_{M\tau}$ is the daily market returns (total market capitalization weighted index of all of the A-shares traded on the Shanghai and Shenzhen Stock Exchanges); and $r_{I\tau}$ is the daily industry returns (total market capitalization weighted index of all of the A-share companies of the corresponding industry). We use the China Securities Regulatory Commission (CSRC) manufacturing sub-categories (C0-C9) to classify industries and construct the industry index. β_{it} and γ_{it} are the market and industry betas, respectively. The annualized standard deviation of residuals from the regression of equation (1) is the estimated firm-specific uncertainty. Market uncertainty is calculated as β_{it} multiplied by the annualized standard deviation of daily returns on the market index. Similarly, industry uncertainty is measured as the product of γ_{it} and the annualized standard deviation of daily returns on the industry index.

Table 1 presents the descriptive statistics of the whole sample and sub-samples based on type of controlling shareholder. The mean and median of total uncertainty (annualized standard deviation of daily stock returns) are 46.11% and 42.60%, respectively. The level of uncertainty is a little lower among government-controlled listed companies (mean and median of 45.33% and 41.92%, respectively), compared with that among privately controlled listed companies (mean and median of 48.15% and 45.37%, respectively). After decomposing total firm uncertainty, firm-specific uncertainty has a mean and median of 34.18% and 32.62%, respectively, and again, the mean and median for government-controlled listed companies are lower. Industry uncertainty, with a mean and median of 29.25% and 26.45%, respectively, is not as great as firm-specific uncertainty, but is similar in government- and privately controlled companies. There is little market uncertainty (mean and median of only -0.91% and -0.76%, respectively) after taking industry and firm-specific uncertainty out of total firm uncertainty. It is amazing that in most firm years, market uncertainty has a negative value. This is because the estimates of β_{it} in equation (1) are usually negative. One possible reason is that the market index reflects the stock performance of all listed companies and is greatly influenced by those large cap stocks.[10] However, such stocks are almost always monopolized by the financial and energy industries, so the market fundamentals reflected in the market index may deviate from those for our sample manufacturing firms.

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[10] For example, at the end of 2009, the top ten stocks (ranked by market capitalization) on the Shanghai Stock Exchange were all financial and energy companies, such as China Petroleum and the Industrial and Commercial Bank of China. Our sample excludes all of those companies, which account for as much as 30% to 40% of the total market capitalization of the Shanghai Stock Exchange.

The mean and median investment ratios are 23.95% and 14.69%, respectively, and those for government-controlled companies are slightly higher. Tobin's Q has a mean of 1.5702 and a median of 1.3622, and is larger in privately controlled companies. The operating cash flow (CF/K), which has a mean of 16.44% and median of 14.23%, differs little between government- and privately controlled firms. The mean and median of debt level (LEV) are 47.76% and 46.54%, respectively, and are much lower in government-controlled listed companies. Finally, the mean and median of state-owned shares (State) are 38.42% and 42.59%, respectively. Naturally, state-owned shares are at a very low level in privately controlled listed companies, with a median of 0. However, in government-controlled listed companies, the mean and median of State are 51.22% and 52.89%, respectively.

Table 1. Descriptive Statistics

	Whole Sample (N = 5,406)		Government Controlled (n = 3,909)		Privately Controlled (n = 1,497)	
	Mean	Median	Mean	Median	Mean	Median
UC	0.4611	0.4260	0.4533	0.4192	0.4815***	0.4537***
UC_F	0.3418	0.3262	0.3334	0.3171	0.3639	0.3544***
UC_I	0.2935	0.2645	0.2926	0.2646	0.2957	0.2641*
UC_M	-0.0091	-0.0076	-0.0090	-0.0075	-0.0094	-0.0077
I/K	0.2395	0.1469	0.2432	0.1515	0.2298	0.1330***
Q	1.5702	1.3622	1.5233	1.3528	1.6926***	1.4038***
CF/K	0.1644	0.1423	0.1663	0.1406	0.1593	0.1464
LEV	0.4776	0.4654	0.4686	0.4597	0.5010***	0.4792**
State	0.3842	0.4259	0.5122	0.5289	0.0502***	0.0000***

*Note: UC is total firm uncertainty, measured as the current year annualized standard deviation of daily stock returns. UC_F is firm-specific uncertainty, UC_I is industry uncertainty, and UC_M is market uncertainty. To calculate UC_F, UC_I, and UC_M, we first regress the following two-index equation for each firm year: $r_{i\tau} = \alpha_{i\tau} + \beta_{it}r_{M\tau} + \gamma_{it}r_{I\tau} + \varepsilon_{i\tau}$, where $\tau = 1, 2, \ldots t_i$; t_i is the trading days in year t; $r_{i\tau}$ is the daily returns of firm i's equity; $r_{M\tau}$ is the daily market returns (total market capitalization weighted index of all of the A-shares traded on the Shanghai and Shenzhen Stock Exchanges); and $r_{I\tau}$ is the daily industry returns (total market capitalization weighted index of all of the A-share companies of the corresponding industry). β_{it} and γ_{it} are the market and industry betas, respectively. The annualized standard deviation of residuals from the regression of the equation is the estimated firm-specific uncertainty. Market uncertainty is calculated as β_{it} multiplied by the annualized standard deviation of daily returns on the market index. Similarly, industry uncertainty is measured as the product of γ_{it} and the annualized standard deviation of daily returns on the industry index. I/K is the investment level, which is measured as the current year changes in capital assets plus amortization, divided by the beginning-of-period capital assets. Q is the beginning Tobin's Q, calculated as the market value of tradable shares plus the book value of non-tradable shares and total liabilities, divided by the book value of total assets. CF/K is the ratio of the current year operating cash flow to beginning capital assets, and LEV is the beginning debt-to-asset ratio. State is the proportion of state-owned shares. ***, **, and * represent statistically significant differences between government- and privately controlled firms at the 1%, 5%, and 10% levels, respectively.*

Next, we test the correlations among the main variables, and the results are reported in Table 2. The upper right triangle shows the Spearman's rho correlation coefficients, and the lower left triangle shows the Pearson correlation coefficients. We can see that total firm uncertainty is highly positively related to firm-specific and

industry uncertainty, but negatively related to market uncertainty. Consistent with our predictions, investment (I/K) is negatively related to total firm uncertainty (UC), firm-specific uncertainty, and industry uncertainty. However, a positive relation is found between investment and market uncertainty, as in Bulan (2005). Bulan (2005) asserted that market uncertainty represents investment opportunities and therefore is positively related to investment. We believe that in China's case, there are two other possible reasons for the positive investment-market uncertainty relation. First, the market index reveals risks in the whole market, which are not necessarily the same across the manufacturing sector as the index is heavily influenced by the performance of giant financial and energy companies. Second, if the market index represents the weathercock of the macro economy, then the positive relation may be the result of government behavior. When the government expects economic risk to increase, it will push state-controlled listed companies to invest more to stimulate economic growth. Finally, the relations between investment and the control variables Q, CF/K, and LEV are positive, positive, and negative, respectively, consistent with the theory and literature.

Table 2. Correlation Results

Spearman / Pearson	*UC*	UC_F	UC_I	UC_M	*I/K*	*Q*	*CF/K*	*LEV*
UC	1.000	0.890***	0.727***	-0.279***	-0.209***	-0.005	-0.076***	0.245***
UC_F	0.862***	1.000	0.389***	-0.194***	-0.231***	-0.045***	-0.084***	0.285***
UC_I	0.800***	0.404***	1.000	-0.320***	-0.079***	-0.008	-0.042***	0.065***
UC_M	-0.258***	-0.188***	-0.262***	1.000	0.181***	0.136***	0.105***	-0.134***
I/K	-0.115***	-0.138***	-0.048***	0.129***	1.000	0.089***	0.232***	-0.176***
Q	0.141***	0.076***	0.132***	0.082***	0.058***	1.000	0.058***	-0.200***
CF/K	-0.041***	-0.045***	-0.027**	0.082***	0.181***	0.061***	1.000	-0.096***
LEV	0.199***	0.278***	0.017	-0.114***	-0.167***	0.081***	-0.049***	1.000

*Note: See the definitions of the variables in the note beneath Table 1. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.*

To directly observe the relation between investment and uncertainty, we first group total firm uncertainty (UC) into 20 quantiles (ventiles), and plot the mean and median values of I/K according to each ventile of CF/K. The results are shown in Figure 1a, where the abscissa represents the medians of each ventile of UC. We can see that as total firm uncertainty increases, investment declines correspondingly. The figure therefore shows a negative relation between uncertainty and investment.

To intuitively observe the different investment-uncertainty sensitivities of government- and privately controlled companies, we then separately plot the median values of I/K for the two types of firms according to each ventile of CF/K.[11] The results

[11] Plotting the chart using the means yields similar results.

are shown in Figure 1b, where the abscissa represents the order of ventiles of UC from low to high. GOV represents the government-controlled sample, and PRI represents the privately controlled sample. Figure 1b shows that the magnitude of the decrease in the level of investment as uncertainty increases is smaller in government-controlled listed companies than in privately controlled ones. That is, the investment decisions made by the former companies are less sensitive to uncertainty than are those made by the latter firms.

Figure 1a. Uncertainty and Investment

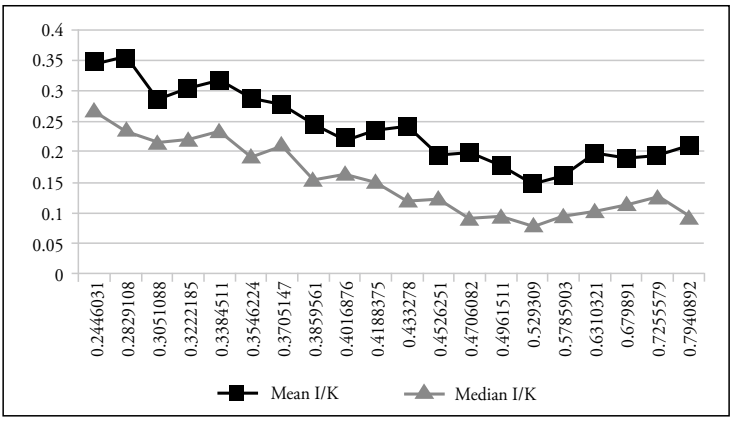
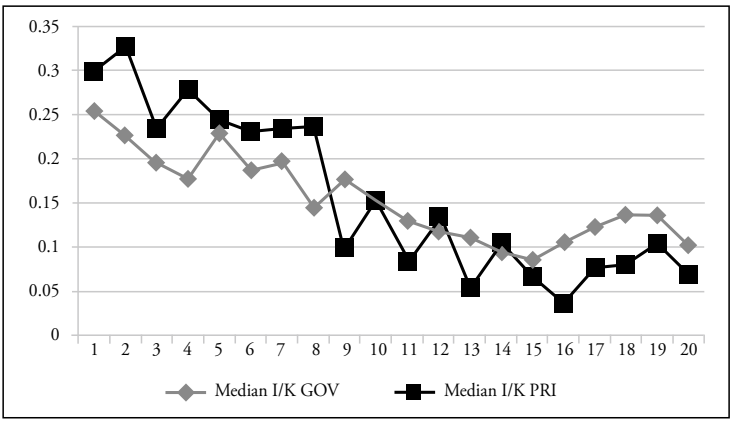


Figure 1b. Government Control, Uncertainty, and Investment



Our sample covers a relatively long period, namely, ten years. Therefore, it is possible to check the time-series patterns of the main variables. We report and plot the means and medians of uncertainty and the investment variables for each year in Table 3, Figure 2a, and Figure 2b. We find that uncertainty and investment levels are relatively stable

before 2004. However, from 2005, the level of uncertainty increases whereas that of investment decreases yearly. This general trend of changing uncertainty and investment levels reveals the increase in the level of economic uncertainty since 2005 due to share-split reform and the worldwide financial crisis caused by the subprime mortgage crisis in the United States. Figures 2a and 2b clearly show that the levels of firm-specific uncertainty and investment always change in opposite directions; therefore, we speculate that the two have a strictly negative relation. Overall, total firm uncertainty, firm-specific uncertainty, and industry uncertainty move in opposite directions from investment, whereas market uncertainty and investment always move in the same direction. The findings are consistent with the results of the correlation coefficient analysis. These trends also indicate the existence of fixed annual effects in the main variables; that is, the observations in the same year may be correlated with each other. Hence, we control for year and firm fixed effects in all of the regression analyses, and use the robust standard errors to calculate the T-values.

Table 3. Time-Series Statistics of Uncertainty and Investment

Year		UC	UC_F	UC_I	UC_M	I/K
1999	Mean	0.4457	0.3379	0.2822	-0.0067	0.2834
(n = 341)	Median	0.4400	0.3294	0.2893	-0.0088	0.1795
2000	Mean	0.4150	0.3552	0.2047	0.0077	0.2922
(n = 400)	Median	0.4122	0.3496	0.2081	0.0054	0.1789
2001	Mean	0.3268	0.2285	0.2250	-0.0029	0.2956
(n = 472)	Median	0.3222	0.2176	0.2356	-0.0019	0.1846
2002	Mean	0.3641	0.2186	0.2837	-0.0047	0.2708
(n = 522)	Median	0.3585	0.2069	0.2889	-0.0034	0.1853
2003	Mean	0.3057	0.2401	0.1785	-0.0019	0.2834
(n = 564)	Median	0.3006	0.2291	0.1812	-0.0028	0.1897
2004	Mean	0.3781	0.2947	0.2295	-0.0038	0.2596
(n = 601)	Median	0.3714	0.2829	0.2290	-0.0044	0.1804
2005	Mean	0.4278	0.3280	0.2693	-0.0196	0.2164
(n = 630)	Median	0.4297	0.3231	0.2738	-0.0219	0.1336
2006	Mean	0.4980	0.4149	0.2613	-0.0129	0.1824
(n = 631)	Median	0.4838	0.4038	0.2665	-0.0152	0.1128
2007	Mean	0.6546	0.5075	0.3920	-0.0149	0.1478
(n = 621)	Median	0.6506	0.4980	0.4053	-0.0156	0.0846
2008	Mean	0.7061	0.4368	0.5407	-0.0210	0.2263
(n = 624)	Median	0.7104	0.4292	0.5648	-0.0216	0.1320

Note: See the definitions of the variables in the note beneath Table 1.

Figure 2a. Time Series Distributions of Uncertainty and Investment (Mean)

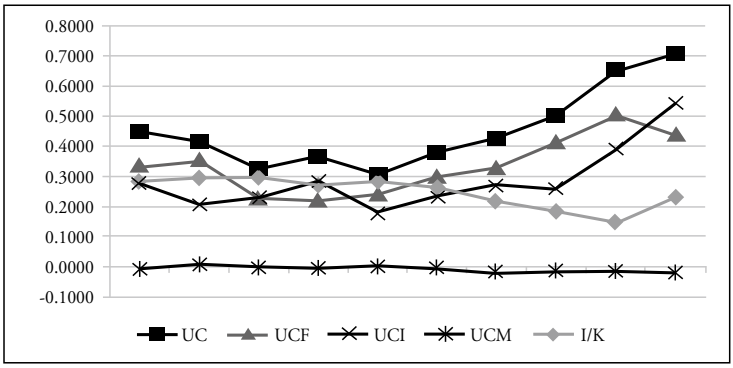
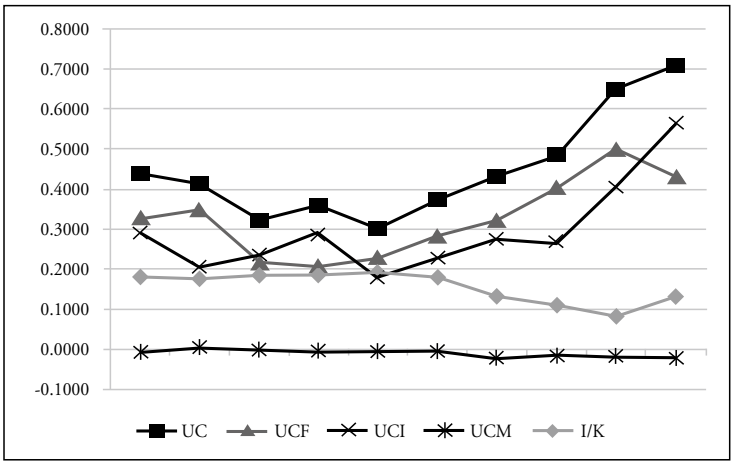


Figure 2b. Time Series Distributions of Uncertainty and Investment (Median)



4.2. Regression Analysis

The abovementioned descriptive statistics, univariate variable analysis, and intuitive graphical analysis do not control for other factors that may affect firm investment decisions. To control for other factors, including investment opportunities, level of internal funds, and debt ratio, and to examine the negative relation between investment and uncertainty (ie, Hypothesis 1), we set investment (I/K) as the dependent variable and total firm uncertainty (UC) as the independent variable and incorporate the control variables Q, CF/K, and LEV into the investment equations, to construct the following fixed effects model:

$$\frac{I_{i,t}}{K_{i,t-1}} = \beta_0 + \beta_1 \mathrm{UC}_{i,t} + \beta_2 \mathrm{Q}_{i,t-1} + \beta_3 \frac{CF_{i,t}}{K_{i,\,t-1}} + \beta_4 \left(\frac{CF_{i,t}}{K_{i,t-1}}\right)^2 + \beta_5 \mathrm{LEV}_{i,t-1} + \nu_i + \eta_j + \varepsilon_{it}\,. \quad (2)$$

We expect β_1 to be significantly negative. In the Q theory of investment, Q represents investment opportunities. The greater are future investment opportunities, the more firms will invest. Hence, we expect β_2 to be positive. Additionally, the literature shows that, because of financial constraints, firm investment is associated with internal funds. Cleary, Povel, and Raith (2007) and Firth, Malatesta, Xin, and Xu (2010) found that the trade-off between liquidation risk and revenue generation leads to a significant positive relation between investment level and the quadratic term of cash flow, that is, a U-shaped investment-cash flow relation. Hence, we include CF and the quadratic term of CF in our model and predict that both β_3 and β_4 will be positive. Finally, because of debt overhang and the agency problem of free cash flow, debt is expected to be negatively related to investment, and β_5 to be negative. Finally, we incorporate firm fixed effects (ν_i) into the regression equation to control for the effects of other unknown factors that cause the investment level to vary across firms, and time fixed effects (η_j) to control for investment changes caused by time factors.

Table 4 reports the regression results. We find that investment and total firm uncertainty are significantly negatively related. Investment level decreases 0.155% with a 1% increase in total firm uncertainty, which supports Hypothesis 1. The regression results of the control variables are highly consistent with our predictions. To examine the influence of government control on the investment-uncertainty relation and test Hypothesis 2, we regress equation (2) for government- and privately controlled listed companies, respectively. The results are also shown in Table 4. We find that government- and privately controlled companies react differently to total firm uncertainty. The negative relation between investment and total firm uncertainty in government-controlled listed companies becomes nonsignificant, whereas in privately controlled listed companies it remains significant. Therefore, Hypothesis 2 is supported.

Table 4. Regression Results for Uncertainty and Investment

Dependent variable: I/K	Whole Sample	Government Controlled	Privately Controlled
UC	-0.155	-0.101	-0.297
	(-1.86*)	(-1.06)	(-1.88*)
Q	0.091	0.074	0.121
	(5.86***)	(3.62***)	(4.36***)
CF/K	0.038	-0.013	0.107
	(1.18)	(-0.30)	(2.25**)
$(CF/K)^2$	0.342	0.389	0.312
	(8.67***)	(7.31***)	(5.07***)
LEV	-0.393	-0.456	-0.326
	(-7.87***)	(-6.22***)	(-4.40***)
Cons	0.356	0.373	0.431
	(7.19***)	(6.23***)	(3.85***)

Year Effects	Yes	Yes	Yes
R^2	0.1453	0.1453	0.1832
No. of Obs.	5,406	3,909	1,497
No. of Firms	663	529	259
F-Statistics	23.50	13.78	12.24

*Note: The dependent variable is the investment level (I/K). The independent variables are UC, Q, CF/K, $(CF/K)^2$, and LEV. UC is total firm uncertainty, measured as the annualized standard deviation of daily stock returns; Q is the beginning Tobin's Q, which is the market value of tradable shares plus the book value of non-tradable shares and total liabilities, divided by the book value of total assets; CF/K is the ratio of the current year operating cash flow to beginning capital assets; and LEV is the beginning debt-to-asset ratio. The regression equation contains firm and year fixed effects, and Cons is the mean of firm fixed effects. R^2 is R^2-within from the fixed effects panel data regression. The T-values calculated using the robust standard errors adjusted for the cluster of firms are reported in brackets. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.*

To test whether the negative relation between investment and total firm uncertainty differs significantly between government- and privately controlled listed companies, we introduce government control and the interaction term of government control and total firm uncertainty into equation (2). We use two proxies for government control, Gov and State. Table 5 displays the regression results. We can see that the coefficients of UC are negative and significant, indicating a negative relation between total firm uncertainty and investment. The coefficients of both Gov and State are negative, which indicates that, controlling for other factors, the investment level of government-controlled companies is somewhat lower than that of privately owned ones. The coefficients of the interaction term of government control and UC are both significantly positive. These results again demonstrate that government control reduces the sensitivity of investment to total firm uncertainty, supporting Hypothesis 2. In sum, government- and privately controlled listed companies treat uncertainty differently, with the former tending to have a greater appetite for risk.

Table 5. Regression Results for Government Control, Uncertainty, and Investment

Dependent variable: I/K	Whole Sample	Dependent variable: I/K	Whole Sample
UC	-0.339	*UC*	-0.354
	(-3.29***)		(-3.47***)
Gov	-0.124	*State*	-0.212
	(-2.62***)		(-2.50**)
*Gov*UC*	0.270	*State*UC*	0.558
	(3.35***)		(3.46***)
Q	0.092	*Q*	0.092
	(5.92***)		(5.91***)
CF/K	0.036	*CF/K*	0.037
	(1.12)		(1.15)

(CF/K)²	0.345	*(CF/K)²*	0.344
	(8.71***)		(8.74***)
LEV	-0.391	*LEV*	-0.392
	(-7.84***)		(-7.85***)
Cons	0.439	*Cons*	0.425
	(6.92***)		(6.75***)
Year Effects	Yes	Year Effects	Yes
R^2	0.1475	R^2	0.1480
No. of Obs.	5,406	No. of Obs.	5,406
No. of Firms	663	No. of Firms	663
F-Statistics	21.38	F-Statistics	21.30

*Note: The dependent variable is the investment level (I/K). The independent variables are UC, Gov (State), Gov*UC (State*UC), Q, CF/K, $(CF/K)^2$, and LEV. UC is total firm uncertainty, measured as the annualized standard deviation of daily stock returns. Gov is a dummy variable that is equal to one if the listed company is controlled by the government, and zero otherwise. State is the proportion of state-owned shares. Q is the beginning Tobin's Q, which is the market value of tradable shares plus the book value of non-tradable shares and total liabilities, divided by the book value of total assets. CF/K is the ratio of the current year operating cash flow to beginning capital assets. LEV is the beginning debt-to-asset ratio. The regression equation contains firm and year fixed effects, and Cons is the mean of firm fixed effects. R^2 is R^2-within from the fixed effects panel data regression. The T-values calculated using the robust standard errors adjusted for the cluster of firms are reported in brackets. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.*

We then investigate the relation between investment and decomposed components of total firm uncertainty. We substitute total firm uncertainty (UC) in equation (2) with firm-specific uncertainty (UC_F), industry uncertainty (UC_I), and market uncertainty (UC_M). The regression results are reported in Table 6. When regressed on the whole sample, investment and firm-specific uncertainty are negatively related, supporting the real options theory. Consistent with the findings of Bulan (2005), investment is positively related to market uncertainty. We again perform separate regressions for government- and privately controlled listed companies. We find that the negative relation between investment and firm-specific uncertainty is mainly driven by the privately controlled listed companies, confirming the second hypothesis. In contrast, the positive relation between investment and market uncertainty is primarily driven by the government-controlled listed companies. This indicates that with increasing market (or macro economy) uncertainty, government-controlled listed companies will increase their level of investment. The results verify that the investment decisions of government-controlled listed companies are to some extent politically oriented. It is well known that the growth of China's economy is investment driven. Whenever the economic environment is volatile or the level of market risk increases, the government offers a stimulus package, such as the aforementioned four trillion yuan investment plan. In addition, SOEs are always the first to carry out the government's plans.

Table 6. Regression Results for Investment and Decomposed Uncertainty

Dependent variable: I/K	Whole Sample	Government Controlled	Privately Controlled
UC_F	-0.142	-0.065	-0.316
	(-1.87*)	(-0.71)	(-2.31**)
UC_I	-0.046	0.037	-0.143
	(-0.46)	(0.32)	(-0.81)
UC_M	0.423	0.886	-0.388
	(2.00**)	(3.56***)	(-1.05)
Q	0.088	0.069	0.125
	(5.67***)	(3.39***)	(4.48***)
CF/K	0.038	-0.011	0.107
	(1.18)	(-0.26)	(2.26**)
$(CF/K)^2$	0.342	0.386	0.314
	(8.67***)	(7.29***)	(5.10***)
LEV	-0.387	-0.445	-0.322
	(-7.69***)	(-6.04***)	(-4.31***)
Cons	0.351	0.349	0.436
	(6.91***)	(5.76***)	(3.90***)
Year Effects	Yes	Yes	Yes
R^2	0.1462	0.1488	0.1846
No. of Obs.	5,406	3,909	1,497
No. of Firms	663	529	259
F-Statistics	20.80	12.93	10.83

*Note: The dependent variable is the investment level (I/K). The independent variables are UC_F, UC_I, UC_M, Q, CF/K, $(CF/K)^2$, and LEV. UC_F is firm-specific uncertainty, UC_I is industry uncertainty, and UC_M is market uncertainty. Q is the beginning Tobin's Q, which is the market value of tradable shares plus the book value of non-tradable shares and total liabilities, divided by the book value of total assets. CF/K is the ratio of the current operating cash flow to beginning capital assets. LEV is the beginning debt-to-asset ratio. The regression equation contains firm and year fixed effects, and Cons is the mean of firm fixed effects. R^2 is R^2-within from the fixed effects panel data regression. The T-values calculated using the robust standard errors adjusted for the cluster of firms are reported in brackets. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.*

To examine whether the influence of government control on the relation between investment and each component of uncertainty is statistically significant, we introduce government control and the interaction terms of government control and the different componentss of uncertainty into our regression equation. The regression results are reported in Table 7. The results, which are consistent with those presented in Table 6, show that after controlling for industry and market uncertainty, investment and firm-specific uncertainty are significantly negatively related. Meanwhile, the interaction terms of government control and firm-specific uncertainty and market uncertainty are both positive, indicating that government control greatly weakens the negative relation between investment and firm-specific uncertainty, and makes the relation between investment and market uncertainty positive.

Table 7. Regression Results for Government Control, Decomposed Uncertainty, and Investment

Dependent variable: I/K	Whole Sample	Dependent variable: I/K	Whole Sample
UC_F	-0.359	UC_F	-0.341
	(-3.30***)		(-3.20***)
UC_I	-0.156	UC_I	-0.172
	(-1.15)		(-1.27)
UC_M	-0.476	UC_M	-0.203
	(-1.23)		(-0.54)
Gov	-0.153	*State*	-0.244
	(-3.13***)		(-2.83***)
$Gov*UC_F$	0.325	$State*UC_F$	0.579
	(2.72***)		(2.46**)
$Gov*UC_I$	0.178	$State*UC_I$	0.371
	(1.51)		(1.58)
$Gov*UC_M$	1.298	$State*UC_M$	1.764
	(2.91***)		(2.02**)
Q	0.091	*Q*	0.090
	(5.86***)		(5.77***)
CF/K	0.037	*CF/K*	0.038
	(1.14)		(1.17)
$(CF/K)^2$	0.344	$(CF/K)^2$	0.343
	(8.74***)		(8.73***)
LEV	-0.384	*LEV*	-0.385
	(-7.64***)		(-7.64***)
Cons	0.448	*Cons*	0.426
	(6.92***)		(6.64***)
Year Effects	Yes	Year Effects	Yes
R^2	0.1506	R^2	0.1501
No. of Obs.	5,406	No. of Obs.	5,406
No. of Firms	663	No. of Firms	663
F-Statistics	18.02	F-Statistics	17.70

Note: The dependent variable is the investment level (I/K). The independent variables are UC_F, UC_I, UC_M, Gov (State), Gov UC_F (State* UC_F), Gov* UCI (State* UC_I), Gov* UC_M (State* UC_M), Q, CF/K, $(CF/K)^2$, and LEV. UC_F is firm-specific uncertainty, UC_I is industry uncertainty, and UC_M is market uncertainty. Gov is a dummy variable that is equal to one if the listed company is controlled by the government, and zero otherwise. State is the proportion of state-owned shares. Q is the beginning Tobin's Q, which is the market value of tradable shares plus the book value of non-tradable shares and total liabilities, divided by the book value of total assets. CF/K is the ratio of the current operating cash flow to beginning capital assets. LEV is the beginning debt-to-asset ratio. The regression equation contains firm and year fixed effects, and Cons is the mean of firm fixed effects. R^2 is R^2-within from the fixed effects panel data regression. The T-values calculated using the robust standard errors adjusted for the cluster of firms are reported in brackets. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.*

To summarize, we discover that among China's listed companies, investment is negatively related to both total firm uncertainty and firm-specific uncertainty. However, this negative relation holds only for privately controlled listed companies. Among government-controlled listed companies, the negative relation between investment and total firm uncertainty or firm-specific uncertainty is nonsignificant, whereas market uncertainty has a positive effect on investment. Therefore, the empirical results support our hypotheses.

4.3. Robustness Checks

We conduct a series of robustness tests to check the reliability of our empirical results. First, because of differences in investment across industries, our sample includes only manufacturing firms. However, when we include all non-financial companies in the sample, the same conclusions are obtained. Second, we use the variability of the weekly returns of stock returns to measure uncertainty, and the results are basically the same. Third, using the variability of the difference between firm and market returns as a proxy for firm-specific uncertainty, we obtain the same conclusions. Fourth, using the equal weight average or tradable market value weighted average returns to calculate industry uncertainty and market uncertainty, we get similar results. Finally, because of the differences in valuation between tradable and non-tradable shares in China's A-share listed companies, we treat the market value of tradable shares as their market price and calculate the market value of non-tradable shares according to the book value of the net assets when we calculate Q. We also use the total market capitalization and 70% of the stock price to calculate the market value of non-tradable shares, and the results are statistically similar.

5. Government Control, Investment Efficiency, and Agency Problems

In Section 4, the empirical analyses consistently show that investment and uncertainty are negatively related, and that government control weakens this relation. However, a question yet to be answered is whether the investment preference due to government control is efficient. In fact, it is difficult to directly measure investment efficiency. Studies typically test investment efficiency indirectly by examining whether investment is supported by opportunities (eg, Lang, Ofek, and Stulz, 1996). If incremental investment can bring marginal returns (ie, investment opportunities are supported), then new investment is efficient; otherwise, it is inefficient, or overinvestment.[12] Therefore, we divide the sample firms into two groups based on

[12] Of course, there are two types of inefficient investment, overinvestment and underinvestment. However, we cannot observe which one dominates. Some studies use the residuals of investment regression to identify overinvestment and underinvestment (eg, Richardson, 2006). However, this approach relies on an assumption that may not be established, namely, that on average, firms invest at the optimal level. Put another way, on average, there is neither overinvestment nor underinvestment. This obviously cannot be verified. Therefore, this paper tries to establish only whether overinvestment exists.

growth opportunities: greater (Qs greater than the median Q; the high-Q group) and fewer (Qs lower than the median Q; the low-Q group). We then investigate whether investment preference due to government control differs between the two kinds of companies. The results are shown in Table 8.

Table 8. Regression Results for Government Control, Uncertainty, and Investment among the High-Q and Low-Q Samples

Dependent variable: I/K	*High Q*	*Low Q*	Dependent variable: I/K	*High Q*	*Low Q*
UC	-0.382	-0.282	*UC*	-0.359	-0.338
	(-2.31**)	(-1.92*)		(-2.15**)	(-2.37**)
Gov	-0.091	-0.202	*State*	-0.154	-0.360
	(-1.24)	(-3.04***)		(-1.07)	(-3.19***)
*Gov*UC*	0.196	0.432	*State*UC*	0.299	0.964
	(1.62)	(4.01***)		(1.20)	(4.49***)
Q	0.067	0.439	*Q*	0.067	0.423
	(3.57***)	(4.54***)		(3.54***)	(4.42***)
CF/K	0.009	0.065	*CF/K*	0.009	0.068
	(0.18)	(1.57)		(0.18)	(1.64)
$(CF/K)^2$	0.339	0.336	$(CF/K)^2$	0.338	0.338
	(6.12***)	(5.00***)		(6.13***)	(5.04***)
LEV	-0.323	-0.776	*LEV*	-0.324	-0.782
	(-5.09***)	(-6.49***)		(-5.11***)	(-6.58***)
Cons	0.453	0.167	*Cons*	0.450	0.169
	(4.55***)	(1.15)		(4.45***)	(1.18)
Year Effects	Yes	Yes	Year Effects	Yes	Yes
R^2	0.1246	0.1694	R^2	0.1241	0.1727
No. of Obs.	2,703	2,703	No. of Obs.	2,703	2,703
No. of Firms	641	619	No. of Firms	641	619
F-Statistics	8.75	12.92	F-Statistics	8.75	13.15

*Note: The dependent variable is the investment level (I/K). The independent variables are UC, Gov (State), Gov*UC (State*UC), Q, CF/K, $(CF/K)^2$, and LEV. UC is total firm uncertainty, measured as the annualized standard deviation of daily stock returns. Gov is a dummy variable that is equal to one if the listed company is controlled by the government, and zero otherwise. State is the proportion of state-owned shares. Q is the beginning Tobin's Q, which is the market value of tradable shares plus the book value of non-tradable shares and total liabilities, divided by the book value of total assets. CF/K is the ratio of the current operating cash flow to beginning capital assets. LEV is the beginning debt-to-asset ratio. The regression equation contains firm and year fixed effects, and Cons is the mean of firm fixed effects. R^2 is R^2-within from the fixed effects panel data regression. The T-values calculated using the robust standard errors adjusted for the cluster of firms are reported in brackets. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.*

As Table 8 shows, in the high-Q group, although the interaction terms of government control and total firm uncertainty (Gov*UC and State*UC) are positive, they are not statistically significant. In contrast, in the low-Q group, the two interaction terms are both significantly positive and the coefficients are even greater than those of total firm uncertainty. Hence, the investment preference due to government control is more common among companies with fewer growth opportunities, indicating that the investment preference of SOE managers is inefficient. The administrative intervention and agency problems associated with government control may be the main reasons for the irrational investment preferences of government-controlled listed companies.

An agency problem arising from imperfect governance is risk shifting, or assets substitution. Eisdorfer (2008) found that because of risk shifting, firms facing financial distress will plan to invest in high-risk projects, to damage the interests of creditors, and that risk taking makes the negative relation between investment and uncertainty nonsignificant, or even makes the relation positive. We predict that this phenomenon also exists in China's listed companies. In addition, because of administrative intervention and poor corporate governance resulting from government control, we expect that SOE managers are more likely to shift risk than are their counterparts in private firms. To investigate the above predictions, we calculate the Altman Z-score (Altman, 1968) at the end of the previous year, and define those companies with a Z-score under 1.80 as financially distressed.[13] We then repeat the tests of model (2) for financially healthy and financially distressed companies. The results are reported in Table 9.

Table 9. Regression Results for Government Control, Uncertainty, and Investment among Financially Healthy and Financially Distressed Companies

Dependent variable: I/K	Financially Healthy Companies	Financially Distressed Companies	Dependent variable: I/K	Financially Healthy Companies	Financially Distressed Companies
UC	-0.336	-0.198	*UC*	-0.371	-0.171
	(-2.22**)	(-1.33)		(-2.42**)	(-1.19)
Gov	-0.051	-0.218	*State*	-0.148	-0.352
	(-0.76)	(-2.77***)		(-1.17)	(-2.34**)
*Gov*UC*	0.191	0.343	*State*UC*	0.446	0.601
	(1.70*)	(2.78***)		(1.93*)	(2.30**)
Q	0.061	0.104	*Q*	0.060	0.106
	(3.00***)	(3.36***)		(2.96***)	(3.44***)

[13] The formula to calculate the Altman Z-score at the end of the previous year is: Z = 1.2 * (Working Capital/Book Value of Total Assets) + 1.4 * (Retained Earnings/Book Value of Total Assets) + 3.3 * (Earnings before Interest and Tax [EBIT]/Book Value of Total Assets) + 0.6 * (Market Capitalization/Total Liabilities) + 0.999 * (Revenues/Book Value of Total Assets).

CF/K	0.004	0.137	*CF/K*	0.005	0.140
	(0.10)	(3.07***)		(0.12)	(3.13***)
(CF/K)²	0.335	0.248	*(CF/K)²*	0.333	0.247
	(6.82***)	(3.73***)		(6.80***)	(3.73***)
LEV	-0.436	-0.313	*LEV*	-0.436	-0.315
	(-3.98***)	(-3.80***)		(-3.96***)	(-3.82***)
Cons	0.464	0.404	*Cons*	0.484	0.373
	(4.78***)	(3.79***)		(4.88***)	(3.52***)
Year Effects	Yes	Yes	Year Effects	Yes	Yes
R^2	0.1070	0.1478	R^2	0.1072	0.1461
No. of Obs.	3,562	1,788	No. of Obs.	3,562	1,788
No. of Firms	639	450	No. of Firms	639	450
F-Statistics	8.70	6.51	F-Statistics	8.83	6.22

*Note: The dependent variable is the investment level (I/K). The independent variables are UC, Gov (State), Gov*UC (State*UC), Q, CF/K, $(CF/K)^2$, and LEV. UC is total firm uncertainty, measured as the annualized standard deviation of daily stock returns. Gov is a dummy variable that is equal to one if the listed company is controlled by the government, and zero otherwise. State is the proportion of state-owned shares. Q is the beginning Tobin's Q, which is the market value of tradable shares plus the book value of non-tradable shares and total liabilities, divided by the book value of total assets. CF/K is the ratio of the current year operating cash flow to beginning capital assets. LEV is the beginning debt-to-asset ratio. The regression equation contains firm and year fixed effects, and Cons is the mean of firm fixed effects. R^2 is R^2-within from the fixed effects panel data regression. The T-values calculated using the robust standard errors adjusted for the cluster of firms are reported in brackets. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.*

In Table 9, the regression results of investment and total firm uncertainty for financially healthy companies are consistent with those reported in Table 5, except that the coefficient of the interaction term of government control and total firm uncertainty has a lower significance level. However, the regression coefficient of total firm uncertainty for financially distressed companies is no longer significant, indicating that firms facing financial distress will not reduce the level of their investment under increasing uncertainty, consistent with risk-shifting theory. For financially distressed companies, the coefficient of the interaction term of government control and total firm uncertainty is significantly positive and much greater than that of total firm uncertainty itself, indicating that the risk-shifting problem is much more serious in government-controlled listed companies.

6. Conclusion

This study empirically investigates the relation between investment and uncertainty. We find that among China's listed companies, as predicted based on real options theory, investment and uncertainty are negatively related. However, the relation between investment and uncertainty differs between government- and privately controlled listed companies. Among the former, investment is not sensitive to total firm uncertainty.

The main reason is that government-controlled listed companies have a stronger risk preference because of administrative intervention, weak corporate governance, and the lack of an effective incentive system. We decompose total firm uncertainty into firm-specific, industry, and market uncertainty according to the CAPM, and regress investment on each of the three variables. We find that government control makes the negative relation between investment and firm-specific uncertainty nonsignificant and the relation between market uncertainty and investment positive. We also find that risk preference due to government control is greater among firms with fewer growth opportunities. Therefore, the risk taking of government-controlled firms is the result of inefficient investment decision making rather than a rational decision. Finally, because of risk shifting, the negative relation between investment and uncertainty no longer holds in financially distressed firms but holds in government-controlled listed companies. Our research shows that China's state economy is still inefficient in some aspects. Reducing administrative intervention and overcoming the inherent agency problems of state ownership are still important tasks in the management of the state economy.

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