A balancing act: managing financial constraints and agency costs to minimize investment inefficiency in the Chinese market

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Abstract

Using a large panel of Chinese listed firms over the period 1999-2010, we document strong sensitivities of abnormal investment to free cash flow. Specifically, we observe that firms with free cash flow below (above) their optimal level tend to under- (over-) invest due to financial constraints (agency costs). We also highlight significant heterogeneity in the sensitivities depending on firms' ownership structure, financial conditions, and on whether or not they engage in exporting or M&As. Finally, we find that the 2005 exogenous split share reform reduced the agency costs faced by state controlled firms, particularly those controlled by local governments.

***Keywords*:** Investment inefficiency; Under-investment; Over-investment, Free cash flow; Financial constraints; Agency costs

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1. Introduction

Problems of information asymmetry between management and financial markets, and agency conflicts between management and shareholders, as well as between controlling shareholder and minority investors have been found to significantly influence firms' investment decisions (Myers & Majluf 1984; Jensen 1986; Fazzari *et al.* 1988; Abhyankar *et al.* 2005; Jiang *et al.* 2010). These problems are particularly severe in emerging markets. Given the capital market imperfections characterizing it and its poor corporate governance mechanisms (Allen et al., 2005), the Chinese setting provides an ideal laboratory to study firms' investment decisions in the presence of financial constraints and agency problems.

China has been seen as a counterexample to most of the literature, which suggests a positive relationship between financial development and economic growth (Levine 2005). Its under-developed financial system is in fact seriously out of step with its thriving growth (Allen *et al.* 2005).[1] Internal finance, trade credit, and other informal funds might speak louder in explaining the Chinese growth miracle than bank or equity finance. In other words, the role of China's external markets in financing and allocating resources has been limited. This is due, first of all, to the fact that dominant state-owned banks are not efficient since they have plenty of nonperforming loans (NPLs). More importantly, they need to support massive unprofitable state-owned enterprises (SOEs). It is consequently difficult for private firms in China to access external funding (Allen *et al.* 2005; Héricourt & Poncet 2009; Guariglia *et al.* 2011). Credit markets in China have therefore not been playing a very efficient role in allocating resources and relieving financial constraints, which are a significant issue for several Chinese firms.

Second, although it has grown in recent years, the Chinese stock market is still relatively small compared with the banking sector. Due to poor regulation and the fact that a substantial number of listed firms are dominated by the state, and a large portion of the shares cannot be traded freely, the stock market is not very efficient and stock prices do not reflect fundamental values (Allen *et al.* 2005; Wang *et al.* 2009).

China's incredibly fast growth relies heavily on investment. Over the period 1999-2009, China experienced an investment boom (the average annual growth rate for total fixed investment was 22.5%), which was responsible for around 50% of GDP growth.[2] Roaring

[1] China has experienced a rapid growth rate, which reached 14.4% per year over the 1999-2009 period in terms of GDP (gross domestic product). Data source: National Bureau of Statistics (NBS), Statistical Yearbook of China, various issues, Beijing, China Statistical Press.

[2] Data source: National Bureau of Statistics (NBS), Statistical Yearbook of China, various issues, Beijing, China Statistical Press.

growth and over-investment might cause over-heating and over-capacity, and generate inefficiency, which could impair the sustainable development and future wellbeing in China. Given the faint legal system as well as poor corporate governance mechanisms in terms of the weakness of creditor rights and legal protection for shareholders including minority and outside shareholders, the lack of legal professionals and effective law enforcement, and the frequent government intervention, agency problems in China's listed sector are rather severe (Allen *et al.* 2005; Chen *et al.* 2010).

Our work makes several contributions to the literature. First, we distinguish for the first time whether investment inefficiency is induced by financial constraints, agency problems, or a combination of both.[3]

Second, unlike most of the prior research, which examines sensitivities of investment to cash flow (Fazzari *et al.* 1988; Kaplan & Zingales 1997; Cleary 1999; Cummins *et al.* 2006), our work focuses on the sensitivity of "abnormal" investment to "free" cash flow. By deducting required (maintenance) and expected investments from capital expenditure and removing mandated components from cash flow, this approach may eliminate future investment opportunities picked up by cash flow. In particular, in the absence of financing constraint and agency costs, under- and over- investment should not display a systematic response to free cash flow. We believe that using the sensitivities of abnormal investment to free cash flow can provide powerful and unambiguous evidence to test firms' financial constraints and agency costs[4]. Our empirical evidence contributes therefore to the interpretation of (under- and over-) investment to free cash flow sensitivities in the unique Chinese context, shedding light on whether high investment-free cash flow sensitivities can be seen as a signal of financial constraints or agency problems.

Third, our analysis provides evidence as to whether the levels of financial constraints and agency costs faced by firms (respectively measured through the sensitivities of under- and over-investment to free cash flow) can be differentiated on the basis of firms' characteristics, such as ownership, financial conditions, exporting, and Mergers and Acquisitions (M&As) activities. Finally, for the first time in the Chinese context, we propose a number of policies which could solve the problem of investment inefficiency in China.

Our study is conducted using a panel of data from the listed sector in China over the period 1999-2010. We analyze the sensitivity of (under- and over-) investment to free cash

[3] In this study, we define over-investment (under-investment) as investment expenditure beyond (below) its optimal level.
[4] Hereafter, we will refer to both under- and over-investment as abnormal investment.

flow across groups of firms sorted according to different characteristics. In doing so, we adopt the framework proposed by Richardson (2006) to construct firm-level (under- and over-) investment and free cash flow measures. Our empirical results show that a combination of both financing constraints and agency problems can be used to explain investment inefficiency in the unique Chinese context. In particular, our findings are consistent with the financial constraints (FC) hypothesis (Fazzari *et al.* 1988): higher sensitivities of under-investment to free cash flow can be found for the firms with free cash flow below their optimal levels. Our results are also in line with the free cash flow (FCF) hypothesis (Jensen 1986): higher sensitivities of over-investment to free cash flow can be spotted in firms with free cash flow above their optimal levels. These results are robust to the use of alternative measures of abnormal investment (under- or over- investment) and free cash flow, of different estimation methodologies, and of various criteria to define financial constraints and agency costs.

We also find that abnormal investment-free cash flow sensitivities vary across different types of Chinese firms. First, non-SOEs face higher financial constraints than their state controlled counterparts, and have to rely more on their internal finance for their investment. Second, given the weak supervision and management that characterizes them, SOEs affiliated with local governments (SOELGs) face higher agency costs and are more likely to invest beyond their optimal levels than SOEs affiliated with the central government (SOECGs) and non-state controlled firms[5]. Last, exporting contributes to relieving Chinese listed companies' financial constraints.

Finally, we find that the exogenous split share structure reform, which took place in China in 2005, affected local-government-controlled enterprises more than other firms, by reducing their degrees of agency problems. Decreasing sensitivities of over-investment to free cash flow are in fact evident after 2005 for SOELGs.

The remainder of this paper is laid out as follows. Section 2 develops testable hypotheses regarding firms' investment behavior and its relationship with financial constraints and agency problems. Section 3 illustrates our baseline specification and estimation methodology. Section 4 describes the main features of the data and presents summary statistics. Section 5 discusses and examines the main empirical results and further tests, while Section 6 concludes.

[5] In the sub-sample of our dataset (2003-2010) which contains detailed information on firm ownership, we observe that 15.83% of all observations represent SOEs controlled by the state (SOECGs); 50.54%, SOEs affiliated with local governments (SOELGs); and 33.63% , non-SOEs.

2. Development of hypotheses

In a perfect and complete capital market, investment decisions are not affected by the way firms finance themselves (Modigliani & Miller 1958), suggesting that in order to maximize their value, firms will implement investment projects until the marginal revenue of investment equals the marginal costs.

However, in the real world, firms' investments tend to be constrained by the availability of internal finance, due to the existence of asymmetric information (between corporate insiders and outside creditors), agency problems (between managers and shareholders and between controlling shareholder and minority investors), transaction costs (market liquidity), moral hazard (risk taking over investment), and so on. Namely, firms' investments cannot always be in unison with the net present value (NPV) principle. Substantial empirical evidence has documented a significantly positive correlation between cash flow and investment expenditure (Fazzari *et al.* 1988; Hubbard 1998; Stein 2003; Bond & Van Reenen 2007). The reason for the existence of this positive relation remains controversial.

First, there exists considerable evidence to suggest that the positive correlation between investment and cash flow stems from asymmetric information (Myers & Majluf 1984; Fazzari *et al.* 1988; Carpenter & Guariglia 2008; Butler & Cornaggia 2011). This explanation is consistent with the financial constraints (FC) hypothesis where the imperfections in capital markets lead to a cost premium when external finance such as bank loans, debt and equity are used. The cost or availability of external funds force firms to use internal finance, like retained earnings, in preference to external finance. In these circumstances, firms with financial constraints may have to forego good investment projects to avoid the excessively high cost premiums. Thus, when firms face financial constraints, the more internal funds they have, the more they can invest, while negative cash flow shocks may lead to under-investment. A high sensitivity of investment to cash flow can be therefore seen as evidence of financial constraints.

Second, the positive correlation between investment and cash flow may reflect agency costs (Jensen 1986; Stulz 1990; Pawlina & Renneboog 2005). This explanation is in line with the free cash flow (FCF) hypothesis, according to which managers might not have the same objective as shareholders. Managers may in fact focus more on the growth of their firm rather than on maximizing shareholders' wealth, to build empires, since their compensation and wealth are generally positively associated with their firm's growth and expanding the firm

would increase the resources in their hands and enhance their power. Moreover, the interests of controlling shareholder may not be aligned with those of other investors due to weak legal system as well as poor minority shareholder protection. Given the high restriction of share trading and the prevalence of dominant shareholders in China, the risk of controlling shareholder to expropriate resources from minority investors (tunneling) is rather severe. As a result, controlling shareholders may make self-interested and entrenched decisions and prefer to spend the firm's free cash flow on unprofitable projects rather than paying dividends to shareholders, resulting in over-investment. In summary, when firms face agency problems, the more free cash flow they have, the more they prefer to invest. The positive relationship between investment and free cash flow can be hence interpreted as evidence of the presence of agency costs.

Taken together, financial constraints and agency problems can prevent firms from making optimal investment decisions. Both financial constraints and agency problems may therefore increase the sensitivity of investment expenditure to cash flow and induce investment inefficiency. To discriminate between these two scenarios within the Chinese context, we will test the following two hypotheses.

H1: Under-investing firms with negative FCF exhibit significantly positive investment-free cash flow sensitivities resulting mainly from financial constraints.
H2: Over-investing firms with positive FCF exhibit significantly positive investment-free cash flow sensitivities resulting mainly from agency costs.

Both hypotheses are focused on the sensitivity of investment to free cash flow, which is defined as the cash flow beyond what is required to maintain assets and finance expected new investments (Richardson 2006). *H1* assumes that firms with negative free cash flow, who are already under-investing are more likely to face financing constraints, while *H2* posits that over-investing firms with positive free cash flow are more likely to face agency costs. In the section that follows, we will outline the methodology that we adopt to test these two hypotheses.

3. Baseline specification and estimation methodology

3.1. Baseline models

3.1.1. A framework to measure investment inefficiency and free cash flow (Richardson 2006)

We measure both under- and over-investment (investment inefficiency) and free cash flow using Richardson's (2006) accounting-based framework. We then test whether the relationship between investment inefficiency and *FCF* is caused by financial constraints and/or agency costs.

[Insert Fig. 1]

Fig.1 outlines our methodology. Total investment ($I\_total_{i,t}$) is defined as capital expenditure less receipts from the sale of property, plant, and equipment. $I\_total_{i,t}$ can be decomposed into two main parts: new investment expenditure ($I\_new_{i,t}$), and required investment expenditure to maintain assets in place ($I\_main._{i,t}$), which is given by the sum of amortization and depreciation.[6]

New investment expenditure ($I\_new_{i,t}$) can be further split into two components: expected investment expenditure in new positive NPV projects ($I^e\_new_{i,t}$) and unexpected investment or abnormal investment (under- or over- investment, $I^u\_new_{i,t}$).

We then define firms' optimal level of cash flow as the sum of maintenance investment ($I\_main._{i,t}$) and expected investment expenditure ($I^e\_new_{i,t}$). Free cash flow (*FCF*) is computed by subtracting the optimal level of cash flow ($I\_main._{i,t} + I^e\_new_{i,t}$) from net cash flow from operating activities (*CFO*). Accordingly, *FCF* can be either positive or negative, depending on whether net cash flow from operating activities (*CFO*) exceeds the optimal level of cash flow.

3.1.2. Dynamic expectation models of investment expenditure

Following Richardson (2006), a dynamic investment expectation model is used to predict the expected investment expenditure in new positive NPV projects ($I^e\_new_{i,t}$), which can be

[6] Using the sum of amortization and depreciation to proxy for maintenance investment may not be appropriate for all firms. For example, if a firm invests in R&D, its maintenance investment cannot be estimated by amortization and depreciation. In order to overcome these limitations, we include prior investment expenditure and time dummies in our dynamic investment expectation model (Eq.1). These should contribute to capturing omitted maintenance investment.

interpreted as the optimal level of investment expenditure[7]. Specifically, denoting with *I_new* the firm's new investment expenditure; with *Q* (Tobin's *Q*), its market-to-book ratio;[8] with *Cash*, its ratio of cash and cash equivalents to total assets; with *Size*, the natural logarithm of its total assets; with *Age*, the number of years elapsed since its listing; with *ROA*, its return on assets[9]; and with *Leverage*, the ratio of its short-term and long-term debts to total assets, we estimate the following Equation[10]:

$$I\_new_{i,t} = a_0 + a_1 I\_new_{i,t-1} + a_2 Cash_{i,t-1} + a_3 Q_{i,t-1} + a_4 Size_{i,t-1} + a_5 Age_{i,t} + a_6 ROA_{i,t-1} + a_7 Leverage_{i,t-1} + \sum Year + \sum Industry + \sum Year*Industry + \upsilon_i + \varepsilon_{i,t} \quad (1)$$

where the subscript *i* indexes firms; and *t*, years (*t*=1999-2010). We use a dynamic model to allow for a partial adjustment mechanism and to control for unobserved factors not included among other regressors. We lag all our independent variables (except *Age*) to alleviate the simultaneity issue (Polk & Sapienza 2009; Duchin *et al.* 2010).[11]

Eq. (1) also incorporates time dummies ($\sum Year$), which account for the possible effects of business cycles as well as the impact of change in interest rates. Industry dummies ($\sum Industries$) are included to capture the industry fixed effects associated with firms' investments.[12] In addition to aggregate time dummies, we incorporate time dummies interacted with industry dummies ($\sum Year*\sum Industries$) to control for industry-specific business cycle effects.[13]

The error term in Eq. (1) consists of two components: v_i, a firm-specific component, embracing any time-invariant firm characteristics which tend to influence firms' investment,

[7] All investment expenditure variables are scaled by total assets.

[8] The shares of listed firms in China can be either tradable or non-tradable. Following the literature (Chen *et al.* 2010; Huang *et al.* 2011), we calculate Tobin's *Q* as the sum of the market value of tradable stocks, the book value of non-tradable stocks, and the book value of debt divided by the book value of total assets.

[9] As firms in an inefficient market might not make investment decisions based on market valuation (Wang *et al.* 2009), we use the return on assets (*ROA*) instead of stock returns in our dynamic investment model.

[10] See Appendix 2 for complete definitions of all variables.

[11] Using this approach, prior investment decisions and firm characteristics are unlikely to be correlated with unobserved firm-specific changes in investment opportunities. Thus, our result about the sensitivity of abnormal investment to free cash flow are unlikely to be caused by free cash flow picking up investment opportunities, not appropriately captured by standard measures.

[12] According to the industry classification taken from the China Securities Regulatory Commission (CSRC), firms in China's listed sector are assigned to one of the following twelve industrial sectors: Farming, forestry, animal husbandry & fishing; Mining; Manufacturing; Utilities; Construction; Transportation & warehouse; Information technology; Wholesale & retailing; Real estate; Social services; Communications & cultural; Conglomerates. Following previous literature, we exclude the Finance & insurance sector from our study.

[13] Because of collinearity, industry dummies ($\sum Industries$) cannot be included in the equations for the fixed effects estimator.

as well as any time-invariant component of the measurement error which may affect any variable in our regression; and $\varepsilon_{i,t}$, which represents an idiosyncratic component.

The fitted values of Eq. (1) can be interpreted as a proxy for optimal investment. The difference between real investment and optimal investment ($I^u\_new_{i,t}$) is then computed and interpreted as unexpected investment. $I^u\_new_{i,t}$ can be either positive or negative, corresponding to over-investment or under-investment, respectively.

3.1.3. Relationship between under- or over-investment and free cash flow

To analyze the sensitivities of under- or over-investment to free cash flow, we initially estimate the following regression:

$$I^u\_new_{i,t} = a_0 + a_1 Dum_{FCF>0} + a_2 FCF_{i,t} * Dum_{FCF>0} + a_3 FCF_{i,t} * (1 - Dum_{FCF>0}) + \sum Year + \sum Industry + \upsilon_i + \varepsilon_{i,t} \quad (2)$$

We partition firm-years into those characterized by over-investment or under-investment on the basis of their $I^u\_new_{i,t}$. More specifically, over-investing firms are those who have positive abnormal investment ($I^u\_new_{i,t}$). On the contrary, under-investing firms are characterized by negative abnormal investment ($I^u\_new_{i,t}$). As in Richardson (2006), we assume abnormal investment is a function of free cash flow (*FCF*), but, moving the literature forward, we investigate whether the sensitivity of $I^u\_new_{i,t}$ to *FCF* differs for firms facing positive and negative *FCF*. To this end, we interact *FCF* with the dummy $Dum_{FCF>0}$, which is equal to 1 if the firm has positive free cash flow, and 0 otherwise, as well as with (1-$Dum_{FCF>0}$).[14] We expect a_3 to be positive and precisely determined for under-investing firms, which are likely to suffer from financing constraints, while a_2 should also be positive and significant for over-investing firms, likely to suffer from agency cost problems. We also include $Dum_{FCF>0}$ in the regression, to account for the direct effect that it might have on firm investment. Finally, we control for year, industry and firm fixed effects.[15]

[14] Since we partition firm-years into under-/over- investing observations, and positive/negative free cash flow observations, our sample can be broken down into 4 sub-groups (2× 2): Group1 (under-investing observations with negative *FCF*); Group 2 (under-investing observations with positive *FCF*); Group3 (over-investing observations with positive *FCF*); and Group 4 (over-investing observations with negative *FCF*) (See Fig.2).

[15] For the regressions of the sub-groups of under- and over-investment firm-years, including time dummies interacted with industry dummies may cause multicollinearity due to the singleton dummy problem with the robust variance-covariance matrix.

3.1.4. Are under- or over-investment-free cash flow sensitivities due to financial constraints or agency costs?

To test for the financial constraints (FC) hypothesis of under-investment and the agency costs hypothesis of over-investment, we further estimate the following regression:

$$I^u\_new_{i,t} = a_0 + a_1 Dum + a_2 FCF_{i,t} * Dum + a_3 FCF_{i,t} * (1 - Dum) + \sum Year + \sum Industry + \upsilon_i + \varepsilon_{i,t} \quad (3)$$

where *Dum* represents dummies proxying for the degree of financial constraints or agency costs faced by firms. Specifically, we separate firms into different groups on the basis of their *a priori* likelihood of facing financial constraints or agency problems, with the aim of investigating the extent to which different groups of firms have different investment behavior and sensitivities of under- and over-investment to free cash flow.

3.1.5. A possible concern about the estimation of growth opportunities

The interpretation of a positive sensitivity of investment to cash flow is controversial, as it may have something to do with omitted expected future profitability. Namely, a positive sensitivity may appear if investment opportunities are not appropriately accounted for. This could happen if cash flow is endogenous to the variations in unobservable demand shocks (Poterba 1988; Alti 2003; Bergstresser 2006; Cummins *et al.* 2006; Carpenter & Guariglia 2008; Brown *et al.* 2009; Duchin *et al.* 2010). Typically, Tobin's *Q* (firms' market to book value) is used to account for investment opportunities in investment models. However, a number of researchers suggest that stock markets in China are not efficient, or at least not as efficient as those in developed countries like the US or the UK. Hence, China's stock prices might contain limited information about expected future profitability. In addition, Tobin's *Q*, which is based on stock prices, might be measured with error, and for this reason, may not be a good determinant of investment opportunities or future performance in an inefficient market (Allen *et al.* 2005; Wang *et al.* 2009). In order to further account for unobservable investment opportunities or more general demand factors, we follow Ding *et al.* (2010) and Konings *et al.* (2003), by using the firm's sales growth, instead of *Q*, as a proxy for the firm's growth opportunities. We also first-difference our equations to control for observed or unobserved time-invariant investment opportunities across firms. Finally, we introduce time dummies interacted with industry dummies ($\sum Year * \sum Industries$). This approach considers all time-varying demand shocks or technology changes at the industry level, and thus is able to control for cyclical variations (Brown *et al.* 2009; Duchin *et al.* 2010; Guariglia *et al.* 2011).

3.2. Estimation methodology

3.2.1. Dynamic panel models

As it is dynamic, we estimate Eq. (1) using the system Generalized Method of Moments (system GMM) approach developed by Arellano & Bover (1995) and Blundell & Bond (1998). This estimator enables us to control for omitted variables bias, the possible endogeneity of the regressors, as well as firm-specific and time-invariant heterogeneity[16]. The GMM estimator is designed for dynamic panel analysis with few time periods and many individuals (small T and large N). The system GMM builds up a system of two equations (the first-differenced equations and the level equations). Adding the original equation in levels to the system has been shown to dramatically improve the precision and the efficiency of the estimator compared with the simple first-difference GMM estimator.[17] First-differencing is aimed at controlling for unobserved heterogeneity. Lagged values of the independent variables are used as instruments to control for the potential endogeneity of the regressors (Bond *et al.* 2001; Baum 2006; Roodman 2006).

In order to evaluate the validity of instruments and the correct specification of the model, the two most commonly statistical diagnostics are used in our GMM estimations. First, the Hansen *J* tests for over-identifying restrictions under the null hypothesis of instrument validity. The test statistic asymptotically follows a *Chi*-square distribution with the value of degrees of freedom equal to the number of over-identifying restrictions (instruments less the number of parameters). A rejection of the null hypothesis implies that the instruments are correlated with the error term or are being incorrectly included in the regression. The second diagnostics is based on testing for the serial correlation of the differenced residuals, and also provides a further test for the validity of the specification of the model and the legitimacy of instruments. The *m(n)* test asymptotically follows a standard normal distribution under the null hypothesis of no n^{th}-order serial correlation of the differenced residuals. If the *m(n)* test

[16] Some statistical problems may arise when a model includes a lagged dependent variable. First, the presence of a lagged dependent variable leads to serial correlation of the error term. Second, the lagged dependent variable is as stochastic as the dependent variable. This violates the classical assumptions of the linear regression model that both independent variables and error term should be independent. Thus, the estimation of a dynamic model using a conventional approach like the pooled OLS estimator will lead to biased and inconsistent estimates (Maeshiro 1996; 1999).

[17] According to Blundell and Bond (1998) and Blundell et al. (2001), when regressors are persistent over time and the number of time periods is relatively small, the first-difference GMM estimator has been found to have a large finite sample bias and poor performance in simulation experiments. However, the system GMM greatly reduces the finite sample bias and is more asymptotically efficient as it is not dependent on relatively harsh restrictions on the initial condition.

rejects the null hypothesis, the instrument needs to be set to lags n+1 and higher.[18] Since the models in this study generally reject the null hypothesis of no second-order autocorrelation, levels of endogenous variables dated t-3 and further are used as instruments in the first-differenced equations, and first-differences of the endogenous variables dated t-2 are used as additional instruments in the level equations (Baum 2006; Roodman 2006).[19]

For robustness, we also estimate Eq. (1) using the pooled OLS (OLS) and the fixed effects (Fe) estimators. It is worth noting that in a dynamic panel model, the pooled (OLS) estimator does not appropriately account for the unobserved firm characteristics and the possible endogeneity of the regressors. Moreover, the fixed effects (Fe) estimator might suffer from endogeneity problems in a dynamic panel setting. Under the circumstance, the coefficient on the lagged dependent variable obtained from the pooled OLS estimator will be upwards biased, and the one obtained from the fixed effects (Fe) estimator will be downwards biased. Estimating our dynamic models via different approaches enables us to check the validity of our estimates: the true estimated coefficient on the lagged dependent variable should lie between the estimates obtained from the pooled OLS and the fixed effects (Fe) estimators (Bond *et al.* 2001).

3.2.2. Static panel models

For the static panel regression models in Eq. (2) and Eq. (3), we use the fixed effects (Fe) estimator to control for time-invariant firm-specific heterogeneity.[20] In some cases, we also provide pooled OLS estimates for comparison.[21]

[18] It is worth noting that using too many lags of endogenous variables as instruments is likely to generate a possible loss of efficiency (Baum 2006).

[19] Neither the Hansen *J* test nor the *m(n)* test can distinguish poor specification of the model from instrument invalidity.

[20] The key variables in Eq. (2) and Eq. (3) (unexpected investment and free cash flow) are constructed using the residuals from the estimation of Eq. (1). For this reason, they can be considered as exogenous, which justifies the use of a fixed-effects estimator.

[21] All estimates using the pooled OLS estimator in our study are generated as cluster-robust. In a panel data setting, it is important to control for cluster heterogeneity. In this study, we allow for arbitrary heteroscedasticity and intra-cluster correlation at the firm-level. With a large number of clusters (1,168) and relative small cluster size (maximum 12), the asymptotic framework is well developed, and the cluster-robust standard error estimator converges to the true value. Even if there is no serial correlation in the error process, the inference is still robust as long as the number of clusters is large (Wooldridge 2003).

4. Main features of the data and descriptive statistics

4.1. The dataset

The data used in this paper are drawn from the China Stock Market Trading Database (CSMAR) and China Economic Research Service Centre (CCER). Our data covers Chinese companies that issue A-share stocks on either the Shanghai Stock Exchange (SHSE) or the Shenzhen Stock Exchange (SZSE), during the period 1999-2010.[22,23] We exclude financial institutions since the operating, investing and financing activities of these firms are distinct from others. Furthermore, observations in the one percent tails for the main regression variables are excluded in order to minimize the potential influence of outliers. Finally, we drop all firms with less than three years of consecutive observations. All variables are deflated using the gross domestic product (GDP) deflator (National Bureau of Statistics of China).

The information on acquisitions for our listed Chinese companies is derived from the Thomson Financial SDC Mergers and Acquisitions Database. Both successful and unsuccessful deals announced between January 1, 1999 and December 31, 2011 are included.

As far as data cleaning is concerned, our final panel consists of 1,263 listed firms, which corresponds to 9,508 firm-year observations. The number of firm-year observations of each firm varies from three to twelve, with number of observations varying from a minimum of 415 in 1999 to a maximum of 1,081 in 2008.[24]

4.2. Sample separation criteria

4.2.1. Financial constraints

To investigate the role of financial constraints on firms' investment behavior, we use two methods to measure the constraints: the Kaplan and Zingales (*KZ*) index (Lamont *et al.* 2001)

[22] All firms listed on either the SHSE or SZSE market issue tradable shares (which are called A-shares) to domestic investors. Alongside A shares, some of these firms also issue B-shares, which were initially only available to overseas investors including those from Hong Kong, Macao and Taiwan. After February 2001, B-shares have been made available to both overseas investors and domestic investors, as long as investors can provide investment accounts in the proper currency. B-shares listed on the SHSE market trade in US dollars and those on the SZSE market are settled in Hong Kong dollars. Besides, many Chinese companies float their shares (simultaneously) on the Hong Kong Exchange (H-shares) and on the New York Stock Exchange (N-shares).

[23] The cash flow statement in the databases is not available until 1998.

[24] See Tables 1 and 2 for details about the structure of our sample. Around 15 percent of firms have the full 12-year observations. Our panel is unbalanced, allowing for both entry and exit. This can be seen as evidence of dynamism and may reduce potential selection and survivor bias.

and the Whited and Wu (*WW*) index (Whited & Wu 2006). We also measure the level of asymmetric information faced by firms in capital markets with firms' size (total real assets and the number of employees), age, and dividend payout (ratio and indicator), which are widely used to determine the severity of financial constraints, These traditional criteria based on different theoretical assumptions, can be seen as proxies for the *a priori* likelihood of being financially constrained.

Given its relative prominence in the literature, the Kaplan and Zingales (*KZ*) index of constraints constructed by Lamont *et al.* (2001) is used to proxy for firm-specific levels of financial constraints in our study. Kaplan & Zingales (1997) classify their sample of firms into five groups on the basis of their degree of financial constraints via qualitative information contained in the firms' annual reports, as well as quantitative information regarding management's statements on liquidity. Motivated by Kaplan & Zingales (1997), Lamont *et al.* (2001) perform an ordered Logit model of the categories of constraints on five financial ratios using the original KZ sample: cash flow (CF_t, net income + depreciation); dividends (DIV_t); cash and cash equivalents ($Cash_t$) deflated by beginning of year capital (K_{t-1}); Tobin's *Q* (Q_t, market value of equity +market value of net debt)/(total assets-net intangible assets)); and debt ($Debt_t$, the sum of the short-term and long-term debt) to total capital (TK_t, sum of debt and equity). We use the significantly estimated coefficients that they obtain to construct the Kaplan and Zingales (*KZ*) index of financial constraints in the following way:

$$\begin{aligned} KZ = & -1.002 * CF_t / K_{t-1} + 0.283 * Q_t + 3.139 * Debt_t / TK_t \\ & -39.368 * \left(DIV_t / K_{t-1} \right) - 1.315 * Cash_t / K_{t-1} \end{aligned} \tag{4}$$

A firm with a higher value of the *KZ* index can be intended to be more financially constrained.

An alternative index of constraints (the *WW* index), constructed by Whited and Wu (2006), is also used to measure for financial constraints in our study. Their index is constructed using the generalized method of moments (GMM) estimation of a structural investment model from COMPUSTAT quarterly data. Specifically, based on the Euler equation incorporating the shadow cost of scarce external finance, the *WW* index is a linear function of six observable firm characteristics: cash flow [CF_t/BA_{t-1}, (net income + depreciation)/beginning-of-year book assets]; a dividend indicator ($DIVPOS_t$, indicating positive dividends); long-term debt ($TLTD_t/CA_{t-1}$, long-term debt to total current assets); Tobin's *Q* (Q_t); size ($LNBA_t$, natural log of the book value of assets); firm real sales growth (SGR_t); and industry sales growth (ISG_t). We compute the *WW* index is computed as follows,

using the estimated coefficients from their specification:

$$WW = -0.091 * CF_t, / BA_{t-1} - 0.062 * DIVPOS_t + 0.021 * TLTD_t / CA_{t-1} \\ -0.044 * LNTA_t - 0.035 * SG_t + 0.102 * ISG_t \quad (5)$$

Once again, a higher value of the *WW* index is representative of a higher level of financial constraints.

We then investigate whether the degree of financial constraints faced by firms matters for the free cash flow sensitivity of under- and over-investment. To this end, as in Almeida et al. (2004), we classify firms as facing relatively low, medium and high financial constraints in a given year if their *KZ* or *WW* indices in that year fall respectively in the bottom three, the middle four, and the top three deciles of the distribution of the indexes of all firms operating in the same industry they belong to.[25] In this way, we allow firms in our sample to transmit among financial constraint categories each year. As a robustness check, we also use a 50% threshold.

4.2.2. Agency costs

To proxy for agency costs, following the literature (Ang *et al.* 2000; Singh & Davidson, 2003; Henry 2010), we first use the ratio of operating expenses to total assets (*AC1*). This ratio measures the efficiency with which the firm's management controls operating costs, which include direct pay to the managers as well as perquisite consumption. This criterion focuses on the principal-agent problems, namely the conflicts between firm managers and shareholders. *AC1* can be seen as a measure of the extent to which firms are susceptible to agency problems. Generally, relatively higher ratios are associated with higher managerial discretion as well as agency misalignment.

Our second measure of agency costs emphasizes the conflict between controlling shareholder and minority investors, which is referred to as "tunneling". It has been argued that tunneling is highly widespread in emerging markets like China since most listed companies tend to have a concentrated ownership structure. In addition, corporate governance mechanisms and the legal system in China offer few options to protect minority shareholders from controlling shareholders (Liu & Lu 2007; Jiang *et al.* 2010). Following

[25] It is worth mentioning that we do not mean that firms ranked in the top three deciles of the distribution of the *KZ* and *WW* indices are absolutely financially constrained, while firms in the bottom three deciles are absolutely financially unconstrained. Instead, we argue that those firms in the top three deciles are likely to face more severe financing constraints than those in the bottom three deciles.

Jiang et al. (2010), we the ratio of other receivables to total assets (*AC2*) to measure how likely controlling shareholders are of expropriating minority investors[26]. A higher value of *AC2* implies therefore a higher level of agency costs. Average other receivables in our sample constitute about 5% of total assets, and the maximum value of the ratio is around 60%, suggesting a high level of agency costs.

In order to investigate the extent to which agency costs matter for the sensitivities of under- or over- investment to free cash flow, we partition firms each year on the basis of the two agency costs ratios (*AC1* and *AC2*). Specifically, we classify a firm as facing relatively low, medium or high agency costs in a given year if its ratios in that year fall respectively in the bottom three, the medium four, or the top three deciles of the corresponding ratios of all firms operating in the same industry it belongs to. As an additional check, we also use a 50% threshold.

4.2.3. Financial constraints measured by conventional variables

To further check robustness for the financial constraints (FC) hypothesis, we also focus on the *a priori* likelihood of being financially constrained based on firms' size (total real assets and number of employees) and dividend payout (ratio and indicator), which are commonly used in the literature to partition firms into financially constrained and unconstrained. In particular, small firms might not have a sufficiently long track record, leading to increased asymmetric information. In addition, small firms are typically characterized by high idiosyncratic risk and high bankruptcy costs, which might exclude theme firms from credit markets, or make their access to external finance more costly (Gertler & Gilchrist 1994; Beck *et al.* 2005; Clementi & Hopenhayn 2006; Guariglia 2008).

We measure firms' size by their total real assets and number of employees. Specifically, we define as small in a given year a firm ($Small_{i,t}$ =1) whose total real assets or number of employees fall in the bottom three deciles of the distribution of the assets and number of employees of all firms operating in the same industry as that firms in that given year. Similarly, we define as medium-sized firm-years ($Medium_{i,t}$ =1) those observations falling in the middle four deciles of the distribution, and as large firm-years ($Large_{i,t}$ =1), those with total real assets or number of employees in the top three deciles of the distribution.

Prior literature shows that low-dividend payout is also likely to reflect tighter

[26] According to Jiang et al. (2010), "during 1996-2006, tens of thousands of billions in RMB were siphoned [through inter-corporate loans] from hundreds of Chinese listed firms by controlling shareholders" (p.2). The authors explain that these inter-corporate loans are typically reported as "other receivables".

financial constraints (Fazzari *et al.* 1988; Kaplan & Zingales 1997; Cleary 1999; Almeida *et al.* 2004; Almeida & Campello 2007). When firms are more susceptible to capital market imperfections, they are likely to cut or reduce dividend payout. Since low-dividend firms cannot generate enough internal funds or obtain enough external funds for their desired investments, they have to retain all low-cost internal finance, at the expense of paying dividends. In this study, we rank firms based on their dividend payout ratio, which is measured as the ratio of cash dividends to net income. Low-dividend firm-years ($Low\_Div_{i,t}$ =1) are those, whose payout ratio in a given year falls in the bottom three deciles of the distribution of the corresponding ratio of all firms operating in the same industry they belong to in that year. Similarly, medium-dividend firm-years ($Medium\_Div_{i,t}$ =1) are those whose dividends fall in the middle four deciles of the distribution, and high-dividend firm-years ($High\_Div_{i,t}$ =1), those in the top three deciles of the distribution. In addition, we also proxy whether a firm has a propensity of being liquidity constrained in a given year according to its dividend payout status with a dummy variable ($Div\_yes_{i,t}$), which equals 1 if the firm has made any cash dividend payment in the year, and 0, otherwise. In all cases, we interact free cash flow with these dummies and examine the coefficients on the interaction terms in our abnormal investment regressions.

4.2.4. Agency costs measured by ownership

To further check the robustness of the agency costs hypothesis, following the literature, and especially Ang *et al.* (2000) and Jiang *et al.* (2010), we construct a series of ownership structure variables to proxy for the agency costs faced by firms. Our first measure is motivated by international evidence that agency costs may arise when the managerial interests are not in line with those of the firm's shareholders. Managerial ownership ($Shareholding\_CEO_{i,t}$) tends to relieve principal-agent problems between (outside) shareholders and managers. Thus, agency costs (arising from the conflict of interest between managers and shareholders) should be lower at firms managed by a shareholder[27]. In order to test whether this is the case, we construct a dummy variable $Insider_{i,t}$ ($Outsider_{i,t}$), which is equal to one if a firm is managed by a shareholder (outsider), and 0 otherwise. Specifically, if

[27] This can be explained considering that inside managers may have interests more closely aligned interests with the firm's shareholders. Jensen and Meckling (1976) propose a hypothesis of convergence of interest between shareholders and managers and improvement of corporate performance as the managerial ownership increases. Kren and Kerr (1997), Ang *et al.* (2000), Singh and Davidson (2003), and McKnight and Weir (2009) also prvide support for the argument that managerial ownership reduces agency costs.

the top executives including CEOs are holding any of their own shares, they will be considered as insiders. We then interact free cash flow with the $Insider_{i,t}$ and $Outsider_{i,t}$ dummies and examine the differences in the coefficients associated with the two interaction terms in our abnormal investment regressions.

The second measure focuses on the percentage of shares controlled by the largest shareholder ($Blockholder_{i,t}$). It has been argued that concentrated ownership is positively associated with firm's agency costs. As mentioned before, agency costs, arising from the conflict of interest between controlling shareholder and minority investors, may arise when controlling shareholder extract private benefits from minority shareholders (which is referred to as "tunneling"). The ability of the primary owner to expropriate minority investors is expected to increase with his/her ownership. When the interests of controlling shareholders are not aligned with those of other investors, there is in fact good reason to believe that the former may use their power to influence the firm's investment decisions to promote their interests at the expense of minority shareholders. Therefore, a high concentration of ownership at the firm level may indicates a strong incentive to tunnel and a high level of agency costs (Liu & Lu, 2007). However, primary owners in China, often have rather large power to control the company's operation even by only holding a relatively low stake of shares, through pyramid structures and cross-holding among firms. When the primary owner's controlling right is greater than his/her ownership right, he/she tends to derive more benefits from tunneling activities. Thus, a lower incentive to tunnel, and lower agency costs are expected when the highest percentage of shares is held by the primary owner, with lower separation of voting rights and cash-flow rights (Jiang *et al.* 2010). Additionally, investors with a large ownership stake generally have a strong interest in the firm's profit maximization and has a higher incentive to oversee or monitor the manger. Hence, agency costs intended as the conflict between firm managers and shareholders, tend to decline with the ownership stake of controlling shareholders (Jensen & Meckling 1976; Ang *et al.* 2000). The ownership stake of the controlling shareholder has therefore an ambiguous effect on the overall agency costs faced by the firm.

Our next measure of agency costs is constructed to capture the intensity of competition between controlling shareholder. A distinct characteristic of Chinese listed firms is that the largest shareholder has dominant control over the firm, while the rest of largest owners have relatively small ownership. The risk that the controlling shareholder might expropriate minority investors or tunnel is likely to decrease when large shareholders other than the largest one are able to oversee or put pressure on the largest shareholder. This form

of coalition or challenge can help overcome the agency problems arising from tunneling. Additionally, large shareholders also have incentives to monitor the management, which reduces the principal-agent problems. In other words, these large shareholders might be able to fight for corporate control if the management is under-performing. Following (Liu & Lu 2007), we construct a Herfindahl-type index $Share2\_10_{i,t}$ *(Concentration*$_{i,t}$*)*, which is the sum of squares of shareholding percentage of the second to the tenth largest shareholders. This index measures corporate control by the concentration of shares in the hands of top 10 shareholders excluding the largest shareholder.[28]

For the last two measures of firms' ownership structure, we construct the dummies $Low\_share_{i,t}$, $Medium\_share_{i,t}$, and $High\_share_{i,t}$, which are in turn equal to 1 if $Blockholder_{i,t}$ or $Share2\_10_{i,t}$ of firm *i* in year *t* lies respectively in the bottom three deciles, the middle four deciles, and the top three deciles of the distribution of the corresponding ratios of all firms operating in the same industry as firm *i* in year *t*, and 0 otherwise. We then interact these dummies with free cash flow and examine the coefficients of the interaction terms in our abnormal investment regressions.

4.2.5. Special events and the sensitivity of under- and over-investment to free cash flow

Given the unique Chinese context, we also use a Chinese-specific indicator called "Special Treatment (ST)"[29], to study the impact of de-listing risks on the degrees of financial constraints and agency problems faced by firms. Since 1998, China's Stock exchanges implemented a "ST" (special statement) regulation in order to improve the corporate governance of listed firms, by increasing market transparency and warning and protecting investors, especially the small and medium-sized ones. When a firm has two consecutive annual losses, it is labeled as a "ST" firm and needs an internal audit report. Moreover, during the "ST" period, its stocks are constrained to a 5% daily up and down limit. According to Jian & Wong (2010), a firm who faces high agency problems, and is particularly involved in tunneling activities is very likely to acquire "ST" status in the future. Thus, "ST" status can be regarded as a measure of agency costs. Moreover, given that "ST" firms are under pressure of being de-listed from the stock exchanges, "ST" status can also be linked to being

[28] We find similar results using alternative indexes, such as, for instance, the sum of the shareholding percentage of the top 10 shareholders excluding the largest shareholder. Our results were also robust to using the ratio of the sum of the shareholding percentages from the second largest to the tenth largest shareholders to the shareholding percentage of the largest shareholder. The latter index measures the likelihood of the largest shareholder being challenged by other large shareholders. These results are not reported in this paper for brevity.

[29] See Appendix 2 for more details.

financially constrained. We generate a dummy variable ST_i, which is equal to one ($ST_i=1$) if a firm has been issued a special treatment or a de-listing risk warning, and 0 otherwise. $Pre\_ST_{i,t}$ ($Post\_ST_{i,t}$) is a dummy variable for the pre- (post-) period of "ST", which equals one in the year before (after) a firm is labeled as a "ST", and zero otherwise. We then interact free cash flow with these dummies and examine the behavior of the coefficients associated with the interaction terms in our abnormal investment regressions.

Next, we note that, following the spirit of Jensen (1986), Harford (1999), and Malmendier & Tate (2008), conducting mergers can be seen as a signal for the existence of agency costs, as it may follow from managerial entrenchment or overconfidence. The intuition is straightforward: acquisitions are used by empire-building or overconfident CEOs or controlling shareholders to spend abundant internal resources for their own benefit. We define $Bidder_{i,t}$ as a dummy variable that takes the value of 1 if a firm becomes a bidder in the next fiscal year, and 0 otherwise. Similarly, $Bidder\_con_{i,t}$ is a dummy variable for frequent bidding firms, which takes the value of 1 if firms have more than one bidding in two consecutive years, and 0 otherwise. Once again, we interact free cash flow with these dummies and examine the coefficients on the interaction terms in our abnormal investment regressions.

4.2.6. Other dimensions of firm heterogeneity and the sensitivity of under- and over-investment to free cash flow

The literature finds substantial evidence of wide imbalances across various ownership categories and regions in China (Allen *et al.* 2005). For example, firms from the state sector obtain the majority of domestic bank credit, while it is difficult for non-state firms to access external funding (Allen *et al.* 2005). However, firms from the non-state sectors and coastal regions have been expanding much faster than those from other sectors and areas and contribute most to China's growth (Allen *et al.* 2007). Therefore, the variance in ownership structures and location plays a crucial role in determining the extent to which Chinese listed firms face financial constraints and agency problems (Ding *et al.* 2010; Poncet *et al.* 2010; Guariglia *et al.* 2011; Huang *et al.* 2011).

In order to evaluate the sensitivities of under- and over-investment to free cash flow for different types of Chinese firms, we initially distinguish the firms into two ownership categories according to their ultimate controlling shareholder: the SOE sector and the non-SOE sector. The former group includes all companies held by state-controlled entities, which

constitute the majority of listed firms.[30] The non-state sector has non-state entities as controlling shareholder. Among these, there are six types of ownership groups: domestic private, foreign, collective, employees' union, non-profit organizations or institutes, and others.[31]

Second, as in Guariglia et al (2011), we divide our sample into two sub-groups: firms operating inside and outside the coastal regions.[32] The rationale for this classification is that China not only has a very large territory, but its regional economy is also less than fully integrated. Geographical divergence in China may have significant implications on regional resource allocations and economic development.[33] Thus, it is expected that regional variation does matter for firms' investment behavior as well as financial conditions and agency costs.

Third, we split the firm-years into sub-samples based on whether or not they participate in export markets. As discussed in Campa & Shaver (2002) and Greenaway *et al.*(2007), global engagement such as exporting generally improves firms' financial conditions.

4.3 Initial summary statistics

As mentioned in section 3.1.3., in order to study the relationship between abnormal (under- or over-) investment and free cash flow, we partition firm years into 4 sub-groups (2×2): Group1 (under-investing firms with negative *FCF*), Group 2 (under-investing firms with positive *FCF*), Group 3 (over-investing firms with positive *FCF*), and Group 4 (over-investing firms with negative *FCF*). Means and medians for the entire sample and four sub-samples based on their abnormal investments and free cash flow are presented in Table 3.

It can be seen that the average total investment and new investment expenditure in our sample are respectively 5.3% and 2.7%. This suggests that new investment represents a large portion of total investment (around 50%). Moreover, the average free cash flow for all firm-years observations is -0.002. This small value might suggest that listed firms in China are

[30] SOEs constitute the majority of our sample firms (72.2%). This is why we only consider two ownership categories in our study, grouping all non-stated firms into one sector.

[31] Within the non-SOE sector, domestic private companies constitute 84% of the sample firms.

[32] Firms outside the coastal regions include the ones operating in central or western areas. See Appendix 1 for more details.

[33] During the transition period from a planned to an open market economy, the coastal regions benefited from the open-door policy and the coastal development strategy, which notably increased inter-regional imbalances. In order to reduce the imbalances, after the late 1990s, regional development policies such as "the western development strategy", "the northeast revival strategy", and "the rise of central China strategy" have been implemented by the Chinese government in order to speed up the development of central and western regions and reduce regional imbalance. Through such regional coordination, a substantial amount of state funds has been invested in these areas especially in infrastructure, energy, and natural resources projects (Chen 2008).

short of free cash flow, which could be due to financial constraints.

[Insert Table 3]

Interestingly, the total new investment for Group 2 (under-investing firms with positive *FCF*) is negative. This happens because the depreciation plus amortization of firms in this group exceeds their total investment. Depreciation and amortization can be considered as non-cash expenses: if firms are profitable, they might accelerate depreciation and amortization in order to reduce reported profits.

Coming to unexpected investment and free cash flow, we find firms in Group 1 (under-investing firms with negative *FCF*) have the highest negative unexpected investments and free cash flow, which is in line with our Hypothesis 1, according to which, due to financial constraints, firms with negative *FCF* tend to under-invest. As for firms in Group 3 (over-investing firms with positive *FCF*), they have the highest positive unexpected investment and free cash flow, which is in line with our Hypothesis 2, according to which firms with positive *FCF* tend to over-invest, due to agency costs.

As for other financial and operating variables, the statistics show that firms in Group 1 (under-investing firms with negative *FCF*) are relatively younger, smaller, have lower Tobin's *Q* and *ROA*, and higher cash reserves. This could suggest the presence of financial constraints. On the other hand, firms in Group 3 (over-investing firms with positive *FCF*) are relatively mature, large, have higher Tobin's *Q* and *ROA*, and hold less cash reserves, which might suggest higher agency problems.

5. Empirical results

5.1. Baseline results

5.1.1 Dynamic model of investment expenditure

Table 4 provides the pooled OLS, fixed effects, and system GMM estimates of our dynamic model of investment expenditure outlined in Eq. (1).

[Insert Table 4]

Column 1 reports the pooled OLS estimates based on cluster-robust standard errors,

which take into account arbitrary heteroscedasticity and intra-cluster correlation. The coefficients on all explanatory variables are statistically significant at the 1 percent level. According to the adjusted R-square, the model is able to explain 31% of the variation in firms' new investment expenditure ($I\_new_{i,t}$). However, as discussed in section 4, the pooled estimates are more likely to be biased because of unobserved firm-specific herogeneity and possible endogenous regressors.

Column 2 reports the fixed effects estimates, which remove the effect of time-invariant firm characteristics. The ρ coefficient indicates that around 37% of the total error variance is explained by unobserved heterogeneity.

Column 3 presents the estimates using our preferred system GMM estimator, which takes the two possible biases (unobserved heterogeneity and endogeneity) simultaneously into account. More specifically, we take first differences of the regressors and treat $I\_new_{i,t-1}$, $Cash_{i,t-1}$, $Q_{i,t-1}$, $Size_{i,t-1}$, $ROA_{i,t-1}$ and $Leverage_{i,t-1}$ as potentially endogenous variables. Given the relatively large number of time periods available, to keep the number of instrument manageable, we specify that the GMM instruments are only constructed for lags 3 to6 of these endogenous variables. First-differences of these same variables lagged twice are used as additional instruments in the level equations to tackle the two biases. Statistical diagnostics (the Hansen *J* test and the *m(3)* test) do not reject the null hypothesis of instrument validity and/or model specification, suggesting that our estimates based on the system GMM regression are convincing. The system GMM estimate of the coefficient associated with the lagged dependent variable, $I\_new_{i,t-1}$, is 0.314, which precisely lies within the range attained using the fixed effects (0.254, lower bound) and the pooled OLS (0.441, upper bound) estimators. The positive and precisely determined prior investment expenditure coefficient suggests that investment behavior is sluggish and smooth. In addition, firms' new investment expenditure ($I\_new_{i,t}$) goes up following increases in cash holdings, *ROA*, and declines with age.[34] It is interesting to note that Tobin's *Q* exhibits a poorly determined coefficient, while *ROA* has a positive and precisely determined coefficient. The point estimate (0.165) indicates that the elasticity of new investment reacting to a change in *ROA*, evaluated at sample means is 0.173 (the mean of *I_new* is 0.0267 and the mean of *ROA* is 0.028).[35] This suggests that a 10 % increase in the return on assets is associated with a 1.73% rise in investment. The

[34] As mentioned before, since market value might not be able to proxy for firms' real performance in the Chinese context, we replace stock return in our dynamic investment model with return on assets (*ROA*).

[35] The elasticity of *ROA* is defined as the ratio of the change of $I\_new_{i,t}$ for a relative change in *ROA*, and is given by 0.173=0.165*0.028/0.0267.

profitability of Chinese firms has therefore a greater impact on their investment than the market valuation on investment. This is consistent with the finding from Wang *et al.* (2009), who show that in inefficient markets like China, higher profits are associated with higher investment.

Although our results based on the three estimators are quantitatively consistent, we use the system GMM estimates to predict expected investment expenditure in new positive NPV projects ($I^e\_new_{i,t}$) and unexpected investment ($I^u\_new_{i,t}$). Hence, the subsequent analysis, based on the partitioning of our observations into groups of over-investing and under-investing firms, is based on the estimates of $I^u\_new_{i,t}$ obtained from the system GMM estimates of Eq. (1). Results based on the OLS and fixed effects estimates are also presented for robustness.

5.1.2 The effects of free cash flow on (under- and over-) investment

Table 5 presents the key results from the estimation of the relationship between under- and over-investment and negative/positive free cash flow obtained using the fixed effects and the pooled OLS estimators (Eq. (2)). Columns 1 to 4 are based on estimates of $I^u\_new_{i,t}$ obtained from the system GMM estimates of Eq. (1). Column 1 and 2 report pooled OLS estimates. We observe that the free cash flow coefficients are only significantly positive (at the 1% level) for the under-investing firms with negative free cash flow (Group 1, column 1) and the over-investing firms with positive free cash flow (Group 3, column 2). Similar results are obtained when the fixed effects estimator is used (columns 3 and 4). The *p*-values associated with Wald tests show significant differences of the free cash flow coefficients between firms facing negative and positive *FCF*.

[Insert Table 5 and Fig. 2]

To check robustness, we also run pooled OLS and fixed effects estimates of Eq. (2), based on estimates of $I^u\_new_{i,t}$ obtained using the OLS and fixed-effects estimators.[36] The results, reported in columns 5 to 8, confirm our previous findings.[37] Additionally, Fig. 2 compares fitted values of the sensitivities of abnormal investment to free cash flow among

[36] In other words, both Eq. (1) and Eq. (2) are estimated using the same estimator (either the fixed effects or the pooled OLS estimator).

[37] As mentioned earlier, sales growth might be more effective to control for investment opportunities. Thus, we also replace *Q* by sales growth in Eq. (1). The results, not reported for brevity, were consistent with our main findings.

the four groups of firms. Positive trends of fitted values only appear for Group 1 firms (under-investing firms with negative *FCF*) and Group 3 firms (over-investing firms with positive *FCF*).

Our findings can be explained considering that firms tend to adjust their investmeng to changes in FCF differently during the four stages outlined in Fig. 3 and 4. These stages are discussed below.

[Insert Fig. 3 and 4]

Stage1: When firms' free cash flow becomes negative (*FCF*<0), these firms tend to have poor liquidity positions, and are likely to face more severe financial constraints, which, hence contribute to their under-investment.[38,39] According to the financial constraints (FC) hypothesis, these firms might not be able to access capital markets and have to rely on their free internal finance due to the cost premium to use external finance. Thus, when their free cash flow rises, they tend to increase investment in order to bring it to the desired level and generate sufficient revenue. This leads to the significantly positive responsiveness of abnormal investment to free cash flow shown for firms in Group 1.

Stage2: As firms are able to generate more free cash flow (*FCF*>0), the responsiveness of under-investment to free cash flow starts to shrink as the firms are no longer financially constrained (Group 2). Positive free cash flow can be seen as evidence that the firms are in the right direction and are able to generate enough revenue. Under these circumstances, lenders are willing to provide more loans. The firms are able to close the gap between their existing and desired stock of capital through external funding for investment rather than by heavily relying on internal finance. This explains why firms in Group 2 generally exhibit poorly determined sensitivities of under-investment to *FCF*.

Stage3: During this phase, firms accumulate a substantial amount of free cash flow (*FCF*>0). According to the free cash flow (FCF) hypothesis, these firms might face rather severe agency costs, and are hence more likely to over-invest.[40] This explains the positive and significant *FCF* coefficients obtained for Group 3 firms.

[38] The decrease of free cash flow and liquidity may result in adverse selection and moral hazard problems. This increases the risk of firms going bankrupt and makes it more difficult for lenders to know whether the firms are able to pay their bills. Therefore, lenders might be less willing to lend, and the firms are more likely to face financial constraints.

[39] In this stage, firms experience the highest negative free cash flow and unexpected investment.

[40] In this stage, firms have the highest positive free cash flow and unexpected investment.

Stage4: Once firms' free cash flow becomes negative, the strength of the relation between over-investment and free cash flow is muted as these firms generally face less agency conflicts and have less cash flow at hand (Group 4). Namely, when firms are subject to cash shortfalls from operating activities, managers might invest their internal finance more rationally in order to bring their free cash flow back to the optimal levels. Another reason can be that when firms are short of free cash flow, they might be forced to access more external finance to enhance liquidity and avoid bankruptcy. Capital markets lead to more frequent monitoring and disciplining of free internal funds for investment, which could explain the poorly determined over-investment *FCF* sensitivities observed for firms in Group 4.[41]

5.2. Robustness tests

5.2.1. Using alternative measures of under- and over- investment and free cash flow

To address concerns about the robustness of these primary findings, we first use an alternative approach taken from Bates (2005) to compute under- and over-investment and free cash flow. Following this approach, we compute the abnormal investment for a given firm in a given year ($I^{u'}\_new_{i,t}$) as the difference between the firm's new investment expenditure ($I\_new_{i,t}$) and the industry median level of new investment ($I\_new_{j,t}$) in that year. This difference ($I^{u'}\_new_{i,t}$) can be either positive or negative, corresponding respectively to over-investment or under-investment. As for free cash flow (*FCF'*), we compute it as the difference between $CF_{AIP,i,t}$ for each firm in each year and the industry median level in that same year ($CF_{AIPj,t}$).[42] Accordingly, *FCF'* can be either positive or negative.

To test for the relationship between (under- or over-) investment and free cash flow, we estimate the following dynamic investment expectation model, where $Dum_{FCF'>0}$ is a dummy equal to 1 if the firm has positive free cash flow (*FCF'*), and 0 otherwise:

$$\begin{aligned} I^{u'}\_new_{i,t} = {} & a_0 + (a_1 I^{u'}\_new_{i,t-1}) + a_2 Dum_{FCF'>0} + a_3 FCF'_{i,t} * Dum_{FCF'>0} + a_4 FCF'_{i,t} * (1 - Dum_{FCF'>0}) \\ & + a_5 Cash_{i,t-1} + a_6 Q_{i,t-1} + a_7 Size_{i,t-1} + a_8 Age_{i,t} + a_9 ROA_{i,t-1} + a_{10} Leverage_{i,t-1} \\ & + \sum Year + \sum Industry + \sum Year * Industry + \upsilon_i + \varepsilon_{i,t} \end{aligned} \quad (6)$$

[41] This explanation is confirmed by evidence from our summary statistics, which show that firms in Group 4 have the highest leverage.

[42] $CF_{AIP,i,t}$ is calculated as ($CFO_{,i,t}$ - $I\_main_{,i,t}$) and represents cash flow generated from assets in place.

In columns 1 and 2 of Table 6, we report the fixed effects estimates using a static version of the investment expectation model in Eq.(6). The results show that the impact of free cash flow on abnormal investment is only significantly positive for the firms in Group 1 and Group 3. To further check robustness, in columns 3 and 4, we use the system GMM approach to estimate the dynamic version of Eq.(6), accounting for the possible endogeneity of the regressors, as well as for firm-specific and time-invariant heterogeneity. Once again the results confirm our hypotheses.[43, 44]

[Insert Table 6]

5.2.2. Using a quantile estimator

To further test the robustness of our results, we estimate Eq. (2) using a quantile estimator. Specifically, we run separate regressions for the 25th, 50th and 75th quantiles of the distribution of $I^{u}\_new_{i,t}$, calculated separately for firms with negative and positive *FCF*. The results, which are reported in columns 1 to 6 of Table 7, are in line with our prior findings: we observe a positive and significant relationship between free cash flow and abnormal investment, stronger for the under-investing firms with negative FCF and the over-investing firms with positive *FCF*. The advantage of using this estimator is that it enables us to examine how free cash flow influences firms' abnormal investment for firms with different levels of abnormal investment.

For under-investing firms, we observe a decreasing trend of the coefficients associated with $Dum_{FCF<0}$ when we move from the smallest quantile of abnormal investment (0.056) to the largest (0.035). This suggests that firms with free cash flow below their optimal level exhibit higher *FCF* sensitivities when they suffer from more under-investment.

For over-investing firms, we find evidence of an increasing trend for the coefficients associated with $Dum_{FCF>0}$ moving from the smallest quantile of abnormal investment (0.012) to the largest (0.122). This indicates that the more over-investment firms experience, the higher their *FCF* sensitivities. The *p*-values associated with the testing for the equality of the

[43] We use the growth of real sales ($SGR_{i,t-1}$) instead of Tobin's Q to proxy for investment opportunities (Konings et al. 2003; Ding et al. 2010). This test is motivated by the fact that in the Chinese context, Tobin's Q may be an imperfect measure of investment opportunities. The results obtained using real sale growth ($SGR_{i,t-1}$) are very similar to the estimates using Tobin's Q. For brevity, these results are not reported, but are available upon request.

[44] For the dynamic model, the *J*-tests reject the null that the over-identifying restrictions are valid. This could be due to the fact that the presence of intra-cluster correlation or heteroskedasticity causes standard statistics to over -reject the null (Arellano & Bond 1991; Hall & Horowitz 1996; Hoxby & Paserman 1998). However, since the *m(n)* tests do not indicate any serial correlation of the differenced residuals, we believe that our instruments and specification are generally acceptable.

free cash flow coefficients between firms, who are facing positive and negative *FCF* show that, with one exception (column 2), these differences are significant.[45] This confirms the robustness of our previous results.[46]

[Insert Table 7]

Bergstresser (2006) notes that the distinction between under-investment and over-investment based on Richardson (2006)'s approach might have some flaws, as ex-post over-investment (under-investment) may be suspected to follow ex-ante under-investment (over-investment) in a dynamic setting. To take this problem into account, as a further robustness test, we define under- and over- investing firms as those firms with two consecutive years of under- and over- investment, respectively. The results, reported in columns 7 and 8 of Table 7, are once again consistent with our prior findings. Significant differences in free cash flow sensitivities are found between firms facing negative and positive *FCF*, for both under- and over-investing firms.

In summary, we have followed Richardson (2006) to construct under- and over-investment and free cash flow, and found a positive relationship between investment and free cash flow for Group 1 firms (under-investing firms with negative *FCF*) and Group 3 firms (over-investing firms with positive *FCF*). We interpreted these findings as evidence in favor of financing constraints and agency costs, respectively. We next dig deeper into these interpretations by analyzing these sensitivities for firms facing higher/lower degrees of financing constraints and agency costs, measured using a variety of different criteria.

5.3. Financial constraints, agency costs and the sensitivity of abnormal investment to *FCF*

5.3.1. The financial constraints (FC) hypothesis of under-investment

We now focus on testing the financing constraints hypothesis of under-investment. To this end, we focus on under-investing observations. Table 8 presents summary statistics of two

[45] The insignificance of the Wald statistic for the equality of the coefficients in column 2 may be associated with the fact that neither the *FCF* coefficients are precisely determined.

[46] Additional evidence shows that that the sensitivities of under-investment to free cash flow for the 5^{th} and 95^{th} quantile regressions are 0.109 and 0.006, respectively; while those of over-investment are 0.006 and 0.266, respectively. We also find similar results using the 20^{th}, 40^{th}, 60^{th} and 80^{th} quantile regressions. These results are not reported for brevity, but are available upon request.

firm-specific proxies of financing constraints across the four groups of firms based on their abnormal investments and free cash flow. The Kaplan and Zingales (*KZ*) index (Lamont *et al.* 2001) and the Whited and Wu (*WW*) index (Whited & Wu 2006) are used to measure the firm-specific level of financial constraints. The higher these indices, the higher the degree of financing constraints faced by the firms. We conduct statistical tests for equality of both sample means (*t*-test) and sample medians (*Wilcoxon* rank-sum test) across groups of firms.

According to the financial constraints (FC) hypothesis, firms are more likely to under-invest if they face a higher degree of financing constraints. To test this hypothesis, we compare the two indexes across under-investing firms in Group 1 and Group 2. We find that, regardless of whether we use the mean or the median, the level of financial constraints (measured using both the *KZ* and *WW* indices) for Group 1 (under-investing firms with negative *FCF*) is larger than that for Group 2 (under-investing firms with positive *FCF*). As can be seen from the *p*-values of both tests, the differences in the means and the median of the indicators are generally significant at the 5% level. Consistent with our Hypotheses 1, this suggests that differences in the financial constraints faced by firms are a key factor in distinguishing between the firms in Group 1 and Group 2. Thus, as discussed in the former section, financial constraints may contribute to the higher responsiveness of under-investment to negative free cash flow for the firms in Group 1.

[Insert Table 8]

Table 9 presents fixed effects estimates of Eq. (3), which intends to test the effects of free cash flow on under-investment for firms characterized by different degrees of financial constraints, calculated using the *KZ* index (columns 1 and 2) and the *WW* index (columns 3 and 4). In columns 1 and 3, firms are partitioned into three categories, based on terciles of the two indices, while in columns 2 and 4, they are partitioned into two categories, based on the median of the two indices.

[Insert Table 9]

Columns 1 and 3 reveal that for under-investing firms, the higher the *KZ* index or the *WW* index, the larger the sensitivities of investment to free cash flow. This suggests that sensitivities of abnormal investment to free cash flow tend to increase monotonically with the degree of external financial constraints faced by firms. Similar results are found in columns 2

and 4 when we use a 50% threshold. The *p*-values of the Wald tests reject the equality of the coefficients of free cash flow between more and less financially constrained groups. This supports our Hypotheses 1, according to which the more financial constraints under-investing firms face, the higher their responsiveness of abnormal investment to free cash flow.

5.3.2. Can conventional variables for financial constraints be used to explain the financial constraints (FC) hypothesis of under-investment?

In this section, we use different variables based on the *a priori* likelihood of being financially constrained to test our Hypothesis 1. In other words, if our hypothesis holds, we should expect a stronger relationship between under-investment and free cash flow for firms who are more likely to face financial constraints. To this end, we first split firm-years on the basis of their size, measured by their total real assets and number of employees. Firm size has in fact been considered as a popular determinant of financial constraints in the literature (Gertler & Gilchrist 1994; Beck *et al.* 2005; Clementi & Hopenhayn 2006; Guariglia 2008). Columns 1 (where size is measured using total assets) and 2 (where the number of employees is used as a proxy for size) of Table 10 show a decreasing clear trend for the coefficients of free cash flow, moving from small, to medium sized, to large firms. The Wald tests show these differences in the FCF coefficients between groups are significant at the 1% level. Hence, using firm size as a criterion of financial constraints also supports our Hypothesis 1.

[Insert Table 10]

Columns 3 and 4 report the estimates after we categorize firm-years respectively based on their dividend payout ratio and dividend payout policy, which are also commonly used indicator of financing constraints (Fazzari *et al.* 1988; Kaplan & Zingales 1997; Cleary 1999; Almeida *et al.* 2004; Almeida & Campello 2007). The FCF coefficients for the under-investing firm-years who have low dividend payout ratio or do not pay any dividends are larger than those of observations with high dividend payout ratio or that pay dividends. This confirms once again our prediction that the sensitivity of investment to free cash flow increases in the degree of financial constraints encountered by under-investing firms. The differences between the coefficients for firms with high dividend payout ratio (paying dividends) and those with low dividend payout ratio (not paying dividends) are significant at the 1% level.

In summary, the results we obtained using conventional variables as proxies for

financial constraints are highly consistent with the previous results and our Hypothesis 1, which suggests that for under-investing firms, the sensitivities of investment to free cash flow increase with the firm's degree of financial constraints.

5.3.3. The free cash flow (FCF) hypothesis of over-investment

We next focus on testing the free cash flow hypothesis of over-investment. To this end, we focus on over-investing observations. Table 11 presents summary statistics of two firm-specific indicators of agency costs after we categorize firms into the four groups based on their abnormal investments and free cash flow. The ratio of operating expenses to total assets (*AC1*) and the ratio of other receivable scaled by total assets (*AC2*) are used to proxy for the two types of agency problems that firms face, which are in turn the conflicts between firm managers and shareholders and those between controlling shareholder and minority investors. As in Table 8, we conduct statistical tests for the equality of both sample means (*t*-test) and sample medians (the *Wilcoxon* rank-sum test).

[Insert Table 11]

Comparing Group 3 (over-investing firms with positive *FCF*) with Group 4 (over-investing firms with negative *FCF*), we observe that the level of agency costs (*AC1* or *AC2*) of the former group is larger than that of the latter group. All statistical tests indicate that the differences in the means and medians between the two groups are significant at the 1% level. These statistics are in line with the free cash flow (FCF) hypothesis, and hence with our Hypothesis 2, according to which firms endowed with excess free cash flow are likely to overinvest. The summary statistics demonstrate that the level of agency costs is a crucial factor in differentiating between the firms in Group 3 and those in Group 4.

To explore this issue further, Table 12 presents the fixed effects estimates of Eq. (3), aimed at testing the effects of changes in free cash flow on over-investment for firms characterized by different levels of agency costs. In columns 1 and 3, a firm is assumed to face more (less) agency problems in a given year if its *AC1* or *AC2* index lies in the top (bottom) three deciles of the distribution of the corresponding index for all firms belonging to its same industry in that year. In columns 2 and 4, we consider a firm to face more (less) agency costs if its *AC1* or *AC2* exceed (are below) the median value within its industry in a given year.

[Insert Table 12]

We observe that, with only one exception in column 3, the sensitivity of investment to free cash flow tends to increase monotonically with the degree of agency costs faced by firms.[47] The Wald tests generally reject the equality of the coefficients of free cash flow between high-agency-cost and low-agency-cost firms. This provides support for our Hypothesis 2, according to which for over-investing firms, higher agency costs are associated with a higher responsiveness of abnormal investment to free cash flow.

5.3.4. Can ownership structure be used to explain the free cash flow (FCF) hypothesis of over-investment?

To better understand the extent to which agency costs matter for the sensitivity of abnormal investment to free cash flow, in this section, we partition firms on the basis of their ownership structure. The results are reported in Table 13. In column 1, we observe that a firm managed by an outsider has a significantly higher sensitivity of over-investment to free cash flow. This can be explained considering that outside managers may not have closely aligned interests with the firm's shareholders. Furthermore, managerial ownership is negatively associated with firm's principal-agent problems.[48] This is in line with our expectation that, for over-investing firms, agency problems between entrenched managers and shareholder contribute to higher sensitivities of over-investment to free cash flow.

[Insert Table 13]

In column 2, we conduct a test using the shareholding from the largest shareholder (*Blockhoder)* as a proxy for agency costs. Observations are divided into large (top three deciles), medium (medium four deciles) and low (bottom three deciles) shareholding. Interestingly, we find that the coefficient associated with free cash flow is the largest for the medium shareholding category. This suggests that, the sensitivity of over-investment to *FCF*

[47] Even in column 6, though, it is the firms characterized by higher agency costs which exhibit the highest sensitivity of over-investment to free cash flow. Firms with low or medium agency costs display insignificant *FCF* coefficients.

[48] In our sample, there is separation between management and ownership. Only 33.6% of firm-years have managers who are also shareholders in their companies. It is worth noting that in our sample, managers only hold on average around 0.27% of their own shares. Relative low ownership stakes prevent managers from pursuing their own interests at the expense of firms, as they are supervised and controlled by the board, as well as by capital markets.

initially increases with the shares held by the largest shareholder, then decreases.[49] These differences between categories can be explained in part considering that, as previously discussed, there are arguments both in favor and against a positive relationship between controlling share ownership and agency problems. This finding is also in line with Jiang *et al.* (2010), according to which agency costs, indicated by tunneling (*AC2*) are highest when the largest shareholder owns a medium percentage (30%) of the firm's shares.

Lastly, we use ownership concentration (the sum of squares of shareholding percentage of top 10 shareholders excluding the largest shareholder, *Share2_10)* to test for the intensity of competition for controlling shareholder. Once again, observations are divided on the basis of deciles of this variable. Column 3 shows that smaller (around 0.03) and insignificant free cash flow coefficients exist for over-investing firms with medium or high *Share2_10,* compared with larger (0.13) and significant (at the 1%) coefficients for those with low *Share2_10.* These findings confirm that in countries without good shareholder protection such as China, other large shareholders, as potentials contestants, are able to effectively monitor and restrain the largest shareholder and managers, reducing in this way the firm's agency costs, intended in terms of the principal-agent problems, as well as the expropriation of minority investors.

In summary, these findings are strongly aligned with the previous results and our Hypothesis 2: The sensitivity of abnormal investment to free cash flow rises with the degree of agency costs faced by over-investing firms.

5.4. Exploring firm's special status: "ST" and M&As

In this section, we attempt to provide some further in-depth evidence in which our financial constraints (FC) and agency costs (AC) hypotheses can be confirmed. We do this focusing on the "Special Treatment" ("ST") warning and firms' expanding behavior through M&As.

5.4.1. "ST" warning

As described in Appendix 3, a "ST" warning is issued to firms which have suffered from negative net income for two consecutive years, or who have shown negative shareholders' equity in one year. It signals the abnormal financial situation of the companies, giving a

[49] It should be noted, however, that *p*-values associated with the Wald tests cannot significantly reject the equality of the impact of free cash flow on investment between firms characterized by different percentages of shares owned by the largest shareholders.

delisting risk warning to investors. Estimates of our abnormal investment equations differentiating firms into "ST" and "non-ST" groups are presented in columns 1 and 2 of Table 14. We observe that that "ST" firms exhibit higher sensitivities of abnormal investment to free cash flow than their "non_ST" counterparts. This finding applies both to under- and over- investing firms. In both cases, the Wald tests reject the equality of the coefficients between "ST" and "non_ST" firms. The likely explanation for this result is that "ST" firms generally face both higher financial constrained and agency problems.

[Insert Table 14]

Columns 3 and 4 of Table 14 further differentiate between the pre- and post- periods of "ST". Interestingly, we observe that firms in the post-ST period display a higher degree of financial constraints and lower agency costs compared to those in the pre-ST period.[50] These findings suggest that firms that have poor corporate governance, indicated by most severe agency problems, are more likely to acquire "ST" status in the future. However, after firms are designated "ST", they are edgy to restore profitability in order to avoid being de-listed. As argued in Liu & Lu (2007), given the strong incentive to maintain the listed status, incumbent controlling shareholders, under the pressure from regulators and the markets tend to restructure the firm's business as well as its corporate governance. However, if the incumbent controlling shareholder is not able to force the firm's performance to turn around, under the encouragement from the government, a fierce contest over corporate control will be triggered. Typically, other large or potential shareholders may wish to take control of the firms by means of mergers and acquisitions or offering a better restructuring process. Consequently, the majority of "ST" firms have their controlling shareholders changed one or two years after being designated "ST". Yet, since these "ST" firms are rarely de-listed or go into actual bankruptcy, it is believed that improvements in firms' performance as well as governance (such as discipline of firm managers or protection for minority shareholders) are triggered after labeling a firm as "ST".

Focusing on under-investment, "ST" firms are generally relatively more financially constrained than "non-ST" firms both before and after the "ST" warning is issued. The "ST" announcement may play a signaling role to the markets and investors, and consequently, "ST" firms are likely to face more pressure from credit markets. This may explain why these firms

[50] *P*-values associated with the Wald tests only reject the equality of the impact of free cash flow on investment between firms in the pre- and post- ST periods for over-investing firms.

display higher sensitivities of investment to free cash flow not only before, but also after they are designated "ST".

In summary, our results so far indicate that, on the one hand, acquiring "ST" status is associated with higher agency problems. Consequently, in order to avoid being de-listed from the exchanges, "ST" firms have strong incentives to improve their governance and restore profitability. On the other hand, our results also suggest that "ST" firms generally display financial difficulties both before and after the warning is issued.

5.4.2. M&As

Next, we consider firms' Mergers & Acquisitions activity. Column 6 of Table 14 presents the results differentiating over-investing firms who become bidders in the next fiscal year and those who do not. As expected, the *FCF* coefficients are higher for the former. However, the difference in the sensitivities between the two groups is not statistically significant. As a further check, we define as agency problematic or aggressive those frequent acquirers, i.e. those firms that have more than one bidding activity in two consecutive years. In column 8, those frequent bidding firms have much higher coefficient (0.104) associated with free cash flow than other firms (0.046). The Wald test here rejects the equality of the estimates in the two sub-groups. In brief, our results suggest that frequent bidding increases the likelihood of agency problems faced by firms. This is consistent with Billett & Qian (2008) who show that frequent acquisitions are value-destructive. A possible explanation may be that due to hubris or entrenchment, managers or controlling shareholders rely on multiple acquisition transactions to pursue private benefits.

Turning to the under-investing firms, we observe similar sensitivities of investment to free cash flow between bidding and non-bidding firms: participating in M&As does not seem to affect firms' financial constraints status.

5.5. Exploring other dimensions of firm heterogeneity

5.5.1. Estimating Eq. (3) for different ownership types

Columns 1 and 2 of Table 15 present estimates of Eq. (3) for sub-samples split based on ownership. Interestingly, for the under-investing group, there seem to be marginally significant differences in *FCF* sensitivities across firms owned by different agents: the sensitivities of under-investment to free cash flow for state-owned enterprises are lower than those for non-SOEs (column 1). This suggests that state-controlled enterprises face less

financial constraints compared with non-state-controlled firms. This result may be explained considering that SOEs have a duty to maintain social stability and achieve other political objectives. For this reason, they find it easier to obtain credit from state-owned banks (Boyreau-Debray 2003; Bai *et al.* 2006). This is in line with Allen *et al*. (2007), who point out that state-controlled firms take up the majority of loans, and with Guariglia *et al.*(2011), who show that the growth of SOEs is not affected by the availability of internal funds.

[Insert Table 15]

We also observe a positive *FCF* coefficient for over-investing state-controlled firms, but not for their non-state-controlled counterparts (column 2). This suggests that only listed firms whose controlling shareholders are state entities are likely to invest above their optimal levels, suggesting that state-controlled firms have higher agency problems than non-state-controlled firms. Managers of SOEs are in fact more likely to undertake suboptimal projects in order to pursue private benefits or better career opportunities. The presence of soft budget constraints may also enhance the agency problems faced by Chinese SOEs (Chow *et al.* 2010).[51] As they can always be bailed out by the government, these firms tend in fact to engage in excessive investment. Moreover, due to the fact that most of listed firms in China are carve-outs or spin-offs from former SOEs, the state shareholders have higher ownership stakes (control rights) compared to non-SOEs, thus they are likely to extract resources from these listed firms. Another possible explanation might be due to the fact that higher state ownership tends to increase the separation between control rights and cash flow rights. Thus, these firms might have political and social objectives, which might not coincide with shareholders' interests. Particularly, the managers of SOEs, who are selected by the government, may have to sacrifice efficiency by being asked to increase employment or offer more social welfare to their employees, so as to avoid social instability, or to meet output growth targets to achieve political objectives (Shleifer & Vishny 1994; Qian 1996; Allen *et al.* 2005; Wei *et al.* 2005; Chen *et al.* 2010). [52]

In columns 3 and 5, we separate state-controlled enterprises into those controlled by local governments (e.g. town village enterprises) and those controlled by central agencies,

[51] In the presence of soft budget constraints, state-owned enterprises are always bailed out even if they suffer from chronic losses.

[52] Political costs which come from political interference can be regarded as a form of agency costs as politicians can be seen as one of most important agents in the unique Chinese context.

using a relative small ownership sub-sample from 2003 to 2010. Recent studies show that a distinction should be made among SOEs affiliated with the central (SOECGs) or local (SOELGs) government (Cheung *et al.* 2008; Chen *et al.* 2009; Chen *et al.* 2010; Jiang *et al.* 2010). We find that both SOEs affiliated with the central and local governments display lower sensitivities of under-investment to free cash flow compared those non-SOEs, suggesting that it is much easier for SOEs to access credit.

However, SOEs affiliated with the local governments display the highest sensitivity of over-investment to free cash flow. On the contrary, the sensitivity of over-investment to free cash flow for SOEs affiliated with the central government is poorly determined. The differences in the coefficients between different ownership groups are statistically significant. There are four possible explanations for the higher agency problems faced by firms affiliated with local governments or state asset management bureaus at the local government level. First, despite the fact that local governments manage state assets according to national law and regulations, they have more freedom to make their own influencing policies. Second, it is more difficult for the press or central and judicial authorities to apply or enforce laws and regulations further away from the center of power, and hence local governments often act independently of the central government and are subject to higher corruption, and less likely of be prosecuted for misappropriation of state funds. Third, local governments have higher incentives to intervene and expand the firms they control due to higher soft budget constraints: when they incur losses, additional financial assistance, cuts in taxes, and other compensations are generally offered by local governments to maintain their listing. Finally, SOELGs tend to have higher agency problems due to weaker supervision and management (Cheung *et al.* 2008; Chen *et al.* 2009; Chen *et al.* 2010).

By contrast, SOECGs are controlled by the central government under the State-owned Assets Supervision and Administration Commission (SASAC). These companies are usually large and nation-wide, and operate in strategically vital sectors such as banking, energy, utilities, transportation etc., which matter for national economic development and social stability. Under the well-established policy of "grasp the large and let go of the small" (*Zhua Da Fang Xiao),* there is more strict supervision and monitoring for these firms from departments under the central government including the National Audit Office (NAO). Furthermore, the board of directors or general managers of firms controlled by the central government often have higher qualifications and abilities. They have greater incentives to perform well in their jobs to prevent them from endangering their chances of promotion to higher government echelons. This is indicated by the fact that many of these chairmen

become vice ministers of the state. Therefore, central-government-controlled enterprises may face lower agency costs.

Our findings are in line with previous research by Chen *et al*.(2009), according to which, SOELGs are less effective as controlling shareholders of listed firms than SOECGs due to the different objectives and degrees of monitoring they face. Chen *et al.* (2009) also find that SOECGs actually perform better than listed non-SOEs. Our results are also consistent with Cheung *et al.* (2008), who point out that entities of local government are subject to expropriations through related party transactions, while the presence of central government ownership benefits shareholders; and with Jiang *et al.* (2010), who show that SOEs controlled by local governments are more likely to have tunneling problems than SOEs controlled by the central government.

5.5.2. Estimating Eq. (3) for different locations

Estimates for sub-samples split on the basis of location are presented in columns 5 and 6 of Table 15. We observe that the firms located in coastal regions have lower free cash flow sensitivities compared with those in non-coastal regions. However, the differences in the sensitivities between the two groups are not statistically significant both for under-investing and over-investing firms. Our results are different from Guariglia *et al.* (2011) who concludes that firms operating in coastal regions face higher financial constraints than those operating in central and western regions. The difference in findings may be due to our focus on Chinese listed firms rather than relative small non-listed firms operating in the manufacturing and mining sectors, or may be due to more recent data used in our research. Although firms in central and western areas may be favored by regional development policies, coastal regions have a more developed financial system. Our evidence shows that China may have evolved toward a more integrated economy.

5.5.3. Estimating Eq. (3) for exporters and non-exporters

The results presented in column 7 of Table 15 show that the effect of free cash flow on under-investment is significantly smaller for exporters compared with non-exporters. This finding is in line with Campa & Shaver (2002), Greenaway et al. (2007), and Guariglia & Mateut (2006), suggesting that exporting relaxes the financial constraints faced by firms.

There are several possible explanations for this finding. First, it is easier for exporters to access international finance, which allows them to diversify their financial resources and ease liquidity stress. Second, exporting can reduce the effects of negative domestic demand

shocks.[53] Third, exporting can help firms relieve their financial constraints by stabilizing their sales, smoothing their income, and generating more internal funds. Fourth, exporters are more likely to be favored by Chinese authorities, and to benefit from policies such as export tax rebates (Ganesh-Kumar *et al.* 2001; Girma *et al.* 2004; Garcia-Vega & Guariglia 2011).

Column 8 shows insignificant differences between the free cash flow sensitivities for over-investing exporters and non-exporters. This suggests that in the Chinese context, participating in exporting does not influence firms' degree of agency costs.

5.6. Split share structure reform

5.6.1. Background of China's split share structure reform

One of the major problems of China's stock markets after its establishment in 1990, was the split share structure characterizing it. This structure stemmed from the "politicization of privatization" ideology. In the early 1990s, the Chinese government allowed state-owned enterprises to sell a small portion of ownership to private investors. This constituted the majority of tradable shares. Yet, the Chinese government still retained influence on these firms by making the majority (two thirds) of their shares non-tradable. These non-tradable shares were typically held by the government itself or government entities (Allen *et al.* 2007; Jiang *et al.* 2010; Li *et al.* 2011).[54, 55]

This split share structure hindered the quality of corporate governance and firms' performance for the following reasons. First, the lack of market trading enabled the non-tradable holders, who typically owned the majority of shares, to be indifferent to market performance. Thus, controlling shareholders were likely to expropriate minority shareholders (tradable holders). Second, a prominent feature of the split share structure was the "one-share, one-vote" scheme, in which the non-tradable shares were entitled the same voting and cash flow rights as tradable shares. The government or government entities were therefore able to appoint board members based on political and social objectives, and did not use incentive-

[53] This relies on the assumption that business cycles and demand shocks are not perfectly correlated across countries.

[54] Prior to the reform (in 2005), the ratio of the non-tradable shares to total shares was 62% (59% in our data sample). Restricted shares include state-owned shares and those owned by legal entities. Both of them are mainly held by central and local governments via their agencies or affiliated state-owned enterprises. The latter can be also held by private entities (Firth *et al.* 2006). However, in line with prior literature, in this study, we separate Chinese listed firms into SOEs and non-SOEs according to their ultimate controlling shareholders.

[55] Prior to the reform, non-tradable shares were only allowed to trade or auction under the authorities' approval and thus their trading price was far below than the stock price and was often set close the book value (Firth *et al.* 2006).

based compensation to align the interests of managers with those of shareholders. Third, due to a lack of large owners responsible for the consequence of poor firm performance and efficiency, the management of the firms with a split share structure was less likely to be monitored against opportunistic behavior which could reduce firms' value. Hence, non-tradable shares were harmful to the corporate governance of the listed firms, causing higher agency costs (Beltratti & Bortolotti 2007; Li *et al.* 2011) and conflict between the controlling (non-tradable) and minority (tradable) shareholders or outside investors.

In order to improve corporate governance and facilitate the privatization process, in May of 2005, the Chinese Securities Regulatory Commission's (CSRC) initiated the split share structure reform, by floating the non-tradable shares through the open markets. In order to make government-owned shares legally tradable, state shareholders were required to compensate tradable shareholders through a share conversion process. This effectively diluted the government-owned share portion, attenuating government-related agency costs. [56] By the end of 2007, 1,254 firms which constitute over 97% of the Chinese A-share market capitalization had completed the structure reform (Li *et al.* 2011).[57]

It has been shown that the impact of this reform on agency costs was pronounced among companies held by state-controlled entities or with higher state ownership, as it allowed restricted shares held mainly by state shareholders to become tradable, and enhanced the incentives of controlling state shareholders to monitor managers (Cumming *et al.* 2012; Hou *et al.* 2012). In addition, following the reform, equity-based compensation for executives or directors was allowed. In this way, their interests and wealth became aligned with stock return performance and decreased their conflicts of interest with outsider investors. Specifically, given higher incentives to boost their stock performance, controlling state shareholders needed to enhance investors' confidence and strengthen firms' corporate governance by disciplining management against opportunistic behavior and refraining from the expropriation of outsider investors.

On the other hand, the reform is expected to have a smaller influence on non-state-owned firms in terms of their agency costs for the following reasons. First, blockholders in these companies are relatively small compared with those in SOEs. They are therefore less likely to suffer from tunneling problems since they can be overseen by other competing

[56] Generally, SOEs have a larger dominant/controlling state shareholder compared with non-SOEs, whose non-state controlling shareholding is relatively small. Larger control rights may increase blockholders' misconduct. However, following the reform, the controlling holding from the government dropped significantly, increasing monitoring of SOEs by other competing shareholders or institutions, and, consequently, reducing political interference from the state, and agency problems.

[57] In our data sample, 89% of the firms had started their structure reform by the end of 2010.

shareholders. Second, controlling shareholders in non-SOEs are typically individuals or private entities or institutions, whose wealth is aligned with the movement of the stock prices. Third, non-SOEs investors normally have good education and are able to monitor management and run the company more efficiently. In order to maximize firms' value, these controlling shareholders are usually active improving corporate governance and likely to sit on the board to monitor managers. For these reasons, non-SOEs have been found to have lower agency problems compared with SOEs even before the reform (Qian 1996; Allen *et al.* 2005; Chen *et al.* 2010).[58]

5.6.2 Difference-in-difference analysis

The split share structure reform offers us a natural experiment to examine changes in agency costs through changes in the sensitivities of over-investment to free cash flow. Specifically, we hypothesize that the split share structure reform eases the agency costs faced by SOEs more than those faced by non-SOEs. In other words, we expect that the changes in the sensitivities of over-investment to free cash flow following the reform to be significantly higher among state-controlled listed firms than non-state-controlled listed firms.

To examine the change in the sensitivities of abnormal investment to free cash flow before and after the reform, we use a difference-in-differences approach. This method offers a way to assess the effects of the introduction of the split share structure reform, which can be seen as an exogenous shock, on the sensitivity of under- or over-investment to free cash flow. To test our hypothesis, we estimate the following regression:

$$I^{u}\_new_{i,t} = a_0 + a_1 FCF_{i,t} + a_2 FCF_{i,t} * Post + a_3 FCF_{i,t} * Treat + a_4 FCF_{i,t} * Treat * Post + \sum Year + \sum Industry + \upsilon_i + \varepsilon_{i,t} \quad (7)$$

where *Treat* is a dummy variable, which equals 1 if a firm has a state entity as its ultimate controlling shareholder, and zero otherwise. *Post* denotes a dummy for the post-reform time period: it equals one in the year of and the years after a firm announced the structure reform, and zero otherwise. The coefficient on *FCF*Post*, $\alpha_{2,}$ captures changes in the sensitivities of abnormal investment to free cash flow over time. The coefficient on *FCF*Treat*, $\alpha_{3,}$ captures the ownership effect on the sensitivities of investment to free cash flow prior to the reform. We expect this term to be positive because the agency problems for our treatment group

[58] As mentioned in section 5.5.1., we also find that agency costs are higher for SOEs compared with non-SOEs.

(SOEs) are expected to be higher than those for the control group (non-SOEs). The coefficient of interest is that associated with the term *FCF*Treat*Post*, α_4 (the difference-in-differences effect). This term measures the change in the sensitivities of investment to free cash flow between SOEs and non-SOEs due to the reform. Naturally, this method removes biases in the sensitivity differences that could be the result from permanent differences between SOEs and non-SOEs, as well as biases from differences over time that could be the result of trends. According to our hypothesis, we expect this term to be negative, which means that the split share structure reform is associated with a decline of state-owned firms' agency problems (measured by the sensitivities of over-investment to free cash flow) compared to those of non state-owned firms.

[Insert Table 16]

Column 1 of Table 16 shows the results focusing on over-investing firms. As expected, we observe that the coefficient on *FCF*Treat* is significantly positive, which suggests that, prior to the reform, state-controlled firms have higher agency problems than their non-state-controlled counterparts. The coefficient on the triple interaction term ($FCF_{i,t}$**Treat*Post*) is significantly negative (-0.11), which indicates that following the reform, the sensitivity of over-investment to free cash flow declined for the treatment group (SOEs). This finding can be explained considering that by eliminating the trading restriction on shares, the reform eased agency problems in SOEs in comparison with those of non-state-controlled firms. The magnitude of the coefficient of the triple interaction term is economically nontrivial: it is around 17% larger than the coefficient (α_3) measuring the difference in the coefficient of free cash flow between SOEs and non-SOEs prior the reform.

These results support our hypotheses that the reform relieved the degrees of SOEs' agency costs, and are in line with Cumming *et al.* (2012) and Hou *et al.* (2011; 2012) who show that the split share structure reform significantly strengthened state-controlled listed firms' corporate governance in terms of improving their managerial accountability and share price informativeness, as well as the relationship between executive pay and stock market performance.

Still focusing on over-investing firms, column 2 of Table 16 further separates state-owned firms into local and central agencies using a restricted sub-sample from 2003 to 2010. We classify non-SOEs as the control group and both SOEs affiliated with the central (SOECGs) and local (SOELGs) government as the treatment group. We find that coefficients

on the triple interaction terms are only significantly negative for SOEs affiliated with the local (SOELGs) government. This finding can be explained considering that lifting the trading restriction had less positive impact on SOECGs. Under the policy of "grasp the large and let go of the small", the Chinese government tried in fact to maintain central government control of SOECGs, which are more concerned with national interests. Thus, even though the shareholders in SOECGs were allowed to be free to trade, they were not willing to sell their stakes. Moreover, SOECGs may be less sensitive to the reform due to lower agency problems compared with other counterparts. Therefore, SOECGs benefited less form the split share structure reform in terms of agency costs.

Column 3 of Table 16 reports the result when we only focus on under-investing firms. We find significantly negative coefficient on *FCF*Treat*, which suggest that state-controlled firms faced lower financial constraints compared with non-state-controlled firms prior to the reform. However, based on the insignificant triple interaction term (*FCF*Treat*Post*) as well as (*FCF*Post)* term, we conclude that the split share structure reform did not have significant impact on the level of financial constraints faced by listed firms in China.

In summary, our results indicate that following the reform, there has been a drop in the sensitivities of abnormal investment to free cash flow, which was, however, restricted to over-investing firms (proxying for firms' agency costs). Furthermore, the fall in the sensitivities affected state-controlled firms, and more specifically, firms controlled by local governments, rather than their non-state-controlled counterparts. The most important appeal of our DID approach is to circumvent endogeneity issues. The exogenous policy reform was in fact expected to reduce agency costs for SOEs, decreasing their sensitivities of over-investment to free cash flow. Other competing alternative hypothesis could be related to over-investment (agency costs) only, to the split share structure reform only, or to state-controlled firms (particularly SOELGs) only, but not to all of these factors together. Finally, by comparing with a control group, this approach rules out time-invariant unobserved factors such as omitted investment opportunities.

5.7. Policy and managerial implications

Two significant implications emerge from our main findings with regard to our Hypotheses 1 and 2. On the one hand, in order to make investment more efficient, under-investing firms should be given more access to capital markets to ease their financial stress. On the other hand, firms' governance structure should be improved in order to make investment more efficient, preventing managers or controlling shareholders from over-investing their free cash

flow in projects with negative NPV. Meanwhile, the credit markets should enhance their discipline on the use of free cash flow.

Our findings provide a portrait of the nature and balance of financial constraints and agency costs across different dimensions of China, giving a picture of the extent to which the Chinese economy has suffered from efficiency losses due to under- and over-investment. In particular, different types of ownership have different influences on the investment inefficiency of Chinese listed firms. First, under a state-dominated financial system, non-SOEs competing with dominant state-owned enterprises face higher financial constraints and have to depend more on their internal funds for their investment, which hinders their growth. Thus, for the sake of economic efficiency, an effective capital market should be put in place to allocate financial resources in a more productive or market-based way including banking and intermediation sectors.

Next, focusing on capital-intensive and investment-driven strategies of growth, Chinese listed firms are likely to suffer from high efficiency losses. In addition to politically-motivated issues and a dominant share holding, SOEs, especially those affiliated with local governments, tend to expropriate their positive free cash flow and invest above their optimal levels, which are not in the best interests of minority shareholders. In order to improve firms' investment efficiency, further ownership transformation, separation of ownership and control or management, and restrictions of the disparity between voting (control) rights and cash flow rights would be beneficial. In addition, more effective supervision and legal protection for shareholders should be established to increase managerial incentives to maximize profits, reduce potential expropriation from controlling shareholders, and foster investment efficiency.

Our findings also provide insights about the value of some acts for the solution of investment inefficiency in China. First, the "ST" policy effectively gives a risk warning to outside investors by signaling the abnormal financial situation of listed firms. Our findings support the view that week corporate governance and higher agency problems are likely to be reasons why firms experience financial distress. Thus, higher quality of information disclosure and better corporate governance should be promoted to improve investor protection rights. Second, relying on multiple acquisitions rather than managing own assets may not be a very efficient way to grow due to possible hubris or entrenchment issues. Third, export promotion policies may further ease Chinese listed firms' financial constraints.

Last but not least, despite considerable progresses made to date, and despite the positive effects of the split share structure reform, in reducing agency costs, we still find a high degree of both financing constraints and agency costs in the Chinese economy. Since

China's financial system is still dominated by under-developed state-owned banks, in order to sustain the rapid growth of Chinese economy, especially in the private sector, more widespread access to credit markets should be a priority in order to increase firms' investment efficiency. In the long run, the establishment of an effective credit-rating system and the development of equity finance could be a way to achieve this target.

Moreover, considering that China's listed firms are still dominated by state shareholders, a further reduction in state ownership may need to be carried out to reduce conflicts of interests among controlling shareholders and outside shareholders, and to increase the intensity of monitoring by other blockholders. In addition, more market-based executive remuneration schemes should be offered to align the interests between managers and investors. Finally, a shake-up of the legal system aimed at improving the protection of property rights would also be beneficial.

6. Conclusions

Using a panel of Chinese listed firms, we provide evidence that both financial constraints and agency problems result in investment inefficiency. To this end, we test how financial constraints and agency costs affect the sensitivities of under- and over-investment to free cash flow, for firms with different characteristics. We find strong evidence of investment being positively and significantly associated with free cash flow for under-investing firms with negative free cash flow. This is consistent with the financing constraints hypothesis. We also find a significantly positive association between investment and free cash flow for over-investing firms with positive free cash flow, which is consistent with the agency costs hypothesis.

We also show some evidence that in the Chinese context various conventional variables like firm size and dividend payout ratio (policy) can be used to assess the degree of financial constraints faced by firms. We find a clear decreasing trend for the sensitivities of under-investment to free cash flow with firm size and dividend payout ratio. We subsequently study how the ownership structure of Chinese firms may influence the degree of agency problems faced by firms. Specifically, first, we find that managerial ownership reduces Chinese listed firms' agency costs (measured as the sensitivities of over-investment to free cash flow). This can be explained considering that managers who own the firm are more likely to have closely aligned interests with shareholders. Second, the relationship between blockholder ownership and agency costs is not linear due to the offsetting effects of incentive alignment and entrenchment. It is firms with a medium percentage of shares owned by the

largest shareholders which tend to face higher agency costs. Third, a higher ownership share of the top ten shareholders excluding the largest increases the intensity of competition and the efficiency of the monitoring of controlling shareholders, reducing thus firms' agency problems.

We next focus on the effects of firms' "ST" status on the degree of financing constraints and agency costs that they face. First, we find that "ST" firms generally have higher sensitivities of under-investment to free cash flow, suggesting they face higher credit constraints. Financial difficulties become worse once a firm "ST" status is announced. Second, agency costs are significantly positively associated with the likelihood of being designated "ST". However, after a firm is labeled as a "ST" firm, under the pressures of being de-listed from the stock exchanges, this firm is more likely to achieve improvement of governance and profitability, and we observe reduced sensitivities of over-investment to free cash flow. Furthermore, focusing on M&A activity, we find that frequent bidding significantly positively affects the extent to which firms' over-investment depends on free cash flow, suggesting higher likelihood of agency problems. We argue that the possible reason may be due to hubris or entrenchment of managers or controlling shareholders, who rely on multiple acquisition transactions to pursue private benefits rather than managing assets to grow.

Our results also suggest that financial constraints and agency problems have different effects across firms which differ according to ownership, as well as exporting status. Specifically, we find that non-SOEs are more subject to financing constraints, probably because of "crowding out" from SOEs. In contrast, state-owned firms face relatively less financial constraints due to the support they receive from the government and state-owned banks, as a consequence of their role in maintaining social stability and achieving political and economic objectives. In addition, SOEs affiliated with local governments (SOELGs) face higher agency problems, which may be caused by less effective management, supervision and legal enforcement. It is also interesting to note that SOECGs, being owned by the central government, perform best in both in terms of financial condition and corporate governance.

We also find that the divergence of the degrees of financial constraints and agency costs between coastal and interior regions is not significant, which may be due to regional development policies. Moreover, Chinese listed companies ease their financial constraints by engaging in exporting.

Finally, using a difference-in-differences (DID) method, we find that state controlled firms, and particularly SOELGs, show a larger response to the exogenous 2005 split share

structure reform: the sensitivities of over-investment to free cash flow decrease in fact significantly for these firms.

The identification of financial constraints and agency problems as explanations for under- and over-investment suggests that in order to improve investment efficiency in China, both the financial and the legal system need to be reformed.

Appendix 1. Chinese provinces and the division of the Chinese territory in three broad regions

From an administrative viewpoint, China consists of 31 provincial units, which are divided into three categories: 22 provinces or *sheng*; 4 autonomous regions or *zizhiqu* (Xinjiang,Inner Mongolia, Tibet, Ningxia, and Guangxi); and 4 municipal cities or *zhixiashi*, under direct supervision of the central power (Shanghai, Tianjin, Beijing, and, since 1997, Chongqing).

According to the Chinese National Bureau of Statistics, the 31 provinces can be split into another three categories by means of geography: Coastal (Beijing, Fujian, Guangdong, Hainan, Hebei, Jiangsu, Liaoning, Shandong, Shanghai, Tianjin, and Zhejiang); Central (Chongqing, Anhui, Heilongjiang, Henan, Hubei, Hunan, Jiangxi, Jilin, and Shanxi); and Western (Gansu, Guangxi, Guizhou, Neimenggu, Ningxia, Qinghai, Shaanxi, Sichuan, Xinjiang, and Yunnan).

Appendix 2. Definitions of the variables used

Market value of assets: sum of market value of tradable stocks, book value of non-tradable stocks, and book value of debt.

Tobin's Q: ratio of market value of assets to book value of total assets.

Return on assets (*ROA*): ratio of net income to total assets.

Leverage: ratio of the sum of short-term and long-term debt to total assets.

Cash: ratio of the sum cash and cash equivalents to total assets.

Size: natural logarithm of total assets.

Age: number of years since listing.

Sales growth: rate of growth of real sales.

Payout ratio: ratio of cash dividend payments to net income

CAPEX: capital expenditures, i.e. cash paid to acquire and construct fixed assets, intangible assets and other long-term assets.

SalePPE: sale of property, plant and equipment, i.e. net cash received from disposals of fixed assets, intangible assets, and other long-term assets.

I_total: total investment, i.e. capital expenditure less receipts from sale of property, plant and equipment (*CAPEX – SalePPE*).

I_main.: investment to maintain existing assets in place (depreciation + amortization).

I_new: total investment less investment to maintain existing assets in place (*I_total - I_main.*).

CFO: Net cash flow from operating activities, i.e. difference between cash inflow from operating activities and cash outflow from operating activities.

CF_{AIP}: cash flow generated from assets in place *(CFO - I_main.).*

FCF: free cash flow (*CFO- I_main. -I^e_new).*

A GDP deflator, which is obtained from National Bureau of Statistics of China, is used to convert all variables to real terms.

Appendix 3. Special treatment regulation in China's Stock Exchanges (rules governing the listing of shares on the Shanghai/Shenzhen Stock Exchanges)

Since 1998, the Chinese Securities Regulatory Commission's (CSRC) implemented the Special Treatment (ST) or the Particular Treatment (PT) regulation as a mechanism to signal the abnormal financial situation of listed companies and give a risk warning to investors.[59] The so-called "abnormal financial situation" refers to an unusual financial position, which exposes a firm to the risk of its shares being de-listed.

The Exchange is entitled to issue a special treatment condition (ST) on the stocks of listed companies which suffer from at least one of the following circumstances:

(1) The audited reports for the two most recent financial year reveal negative net income;

(2) The audited reports for the latest financial year show negative shareholders' equity (i.e. shareholders' equity is lower than registered capital);

(3) Based on the audit results for the most recent financial year, a disclaimer of opinion or adverse opinion by a Certified Public Accounting (CPA) firm is issued.

"ST" or "*ST" stocks operate under various trading and financial restrictions, which are:

(1) Putting "ST" or "*ST" in front of the names of their stocks to distinguish them to those of healthy firms;

[59] According to Chinese Company Law, "ST" listed companies are the ones which have been making losses for two consecutive years, whereas, "PT" (particular treatment) firms are the ones which have three-consecutive-year losses. These "PT" firms are suspended from the exchanges and only allowed to be traded on Fridays, with a maximum of 5% limit to the previous Friday's close price. "PT" firms will be permanently terminated from the stock exchanges if they cannot make a turnaround within one year. The "PT" regulation was abolished on 1st of May 2005, and replaced with a "*ST" regulation.

(2) Their daily share movements are limited to 5% (10% for normal stocks);

(3) Their interim reports are required to be audited.

After being issued a delisting risk warning, if the company successfully engages in major asset restructuring in accordance with the relevant regulations of the CSRC (China Securities Regulatory Commission), and if its principal business activities are back to normal and its net income (after deducting non-recurring gains and losses) becomes positive, the firm may apply to the Exchange for lifting the special treatment (ST) or de-listing risk warning (*ST).

Firms who fail to disclose their annual or interim report or fail to turn around after being issued a de-listing risk warning, might be suspended or even permanently excluded from the stock exchanges.

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Table 1
Structure of the unbalance panel.

No. of obs. Per firm	No. of obs.	Percent	Cumulative
3	411	4.32%	4.32%
4	400	4.21%	8.53%
5	540	5.68%	14.21%
6	912	9.59%	23.80%
7	882	9.28%	33.08%
8	1,032	10.85%	43.93%
9	1,116	11.74%	55.67%
10	1,620	17.04%	72.71%
11	1,155	12.15%	84.85%
12	1,440	15.15%	100.00%
Total	9,508	100.00%	

Table 2
Distribution of the number of firm-year observations by year.

Year	No. of obs.	Percent	Cumulative
1999	415	4.36%	4.36%
2000	521	5.48%	9.84%
2001	609	6.41%	16.25%
2002	667	7.02%	23.26%
2003	737	7.75%	31.02%
2004	793	8.34%	39.36%
2005	836	8.79%	48.15%
2006	851	8.95%	57.1%
2007	927	9.75%	66.85%
2008	1,081	11.37%	78.22%
2009	1,075	11.31%	89.52%
2010	996	10.48%	100.00%
Total	9,508	100.00%	

Table 3
Sample means and medians (in parentheses).

	G1	G2	G3	G4	Total
I_total	0.0283	0.0249	0.0859	0.1013	0.0529
	(0.0238)	(0.0208)	(0.0774)	(0.0935)	(0.0383)
I_new	0.0034	-0.0035	0.0586	0.0771	0.0267
	(0.0012)	(-0.0035)	(0.0483)	(0.0687)	(0.0129)
I^e*_new*	0.0305	0.0208	0.0183	0.0374	0.0267
	(0.027)	(0.0186)	(0.0196)	(0.0368)	(0.0247)
I^u*_new*	-0.0271	-0.0243	0.0403	0.0397	0.0000
	(-0.0231)	(-0.0204)	(0.0261)	(0.0266)	(-0.0086)
FCF	-0.0534	0.0509	0.0546	-0.0495	-0.0021
	(-0.04)	(0.0396)	(0.0408)	(-0.0386)	(-0.0032)
Cash	0.150	0.176	0.143	0.139	0.154
	(0.127)	(0.147)	(0.124)	(0.122)	(0.131)
Q	1.606	1.737	1.772	1.644	1.683
	(1.334)	(1.391)	(1.449)	(1.357)	(1.372)
Size	20.562	20.587	20.568	20.685	20.594
	(20.482)	(20.465)	(20.493)	(20.572)	(20.498)
Age	8.10	9.20	9.34	8.04	8.64
	(8)	(9)	(9)	(7)	(8)
ROA	0.016	0.036	0.038	0.027	0.028
	(0.024)	(0.036)	(0.038)	(0.03)	(0.031)
Leverage	0.233	0.194	0.232	0.265	0.228
	(0.229)	(0.180)	(0.227)	(0.260)	(0.224)
Observations	3,120	2,657	1,884	1,847	9,508

Notes: Firms are classified into four groups according their level of abnormal investment and *FCF* (free cash flow): Group1 (under-investing firms with negative *FCF*); Group 2 (under-investing firms with positive *FCF*); Group3 (over-investing firms with positive *FCF*); Group 4 (over-investing firms with negative *FCF*). Total investment ($I\_total_{i,t}$) is defined as capital expenditure less receipts from the sale of property, plant and equipment. *I_new* is total investment less investment to maintain existing assets in place. I^e*_new* represents the expected investment expenditure in new positive NPV projects. I^u*_new* represents the abnormal investment (under- or over- investment). *FCF* is free cash flow which is computed by subtracting the optimal level of cash flow from operating activities (*CFO*). *Cash* is the ratio of the sum of cash and cash equivalents to total assets. *Q* is the market-to-book ratio. *Size* is the natural logarithm of total assets. *Age* is the number of years elapsed since the firm listed. *ROA* is return on assets. *Leverage* is the ratio of the sum of short- and long-term debts to total assets. All variable except *Size* and *Age* are expressed in percentage terms. All investment expenditure variables are scaled by total assets. All variables except *Age* are deflated using a GDP deflator. See Appendix 2 for complete definitions of all variables.

Table 4
Dynamic model of investment expenditure.

Dependent variable: $I\_new_{i,t}$	*(1)* *OLS (pooled)*	*(2)* *Fixed effects*	*(3)* *GMM_system*
$I\_new_{i,t-1}$	0.441***	0.254***	0.314***
	(0.013)	(0.010)	(0.049)
$Cash_{i,t-1}$	0.055***	0.113***	0.048*
	(0.006)	(0.006)	(0.028)
$Q_{i,t-1}$	0.003***	0.003***	-0.0001
	(0.001)	(0.001)	(0.002)
$Size_{i,t-1}$	0.003***	-0.004***	0.002
	(0.001)	(0.001)	(0.002)
$Age_{i,t}$	-0.001***	-0.001	-0.001***
	(0.000)	(0.003)	(0.000)
$ROA_{i,t-1}$	0.059***	0.039***	0.165***
	(0.017)	(0.007)	(0.043)
$Leverage_{i,t-1}$	0.003	-0.036***	-0.006
	(0.004)	(0.005)	(0.017)
Year-fixed effects	yes	yes	yes
Industry-fixed effects	yes	no	yes
(Year-fixed) (Industry-fixed) effects*	yes	yes	yes
R^2	0.32	0.47	
Adjusted R^2	0.31	0.38	
ρ		0.37	
F-value	26.84	12.89	10.59
Hansen J test (p-value)			0.18
m3 test (p-value)			0.45
Observations	9,508	9,508	9,508

Notes: Test statistics and standard errors (in parentheses) of all variables in the regressions are asymptotically robust to heteroscedasticity. Time dummies, industry dummies and time dummies interacted with industry dummies were included in all specifications. Adopting the method of Richardson (2006), the dependent variable is $I\_new_{i,t}$, the difference between I_{total} and I_{main}. All variables except $Q_{i,t-1}$, $Size_{i,t-1}$ and $Age_{i,t}$ are scaled by total assets. For the pooled regression, standard errors (in parentheses) are asymptotically cluster-robust to heteroscedasticity and intra-cluster correlation is accounted for at the firm level. For the fixed effects regression, ρ represents the proportion of the total error variance accounted for by unobserved heterogeneity. For the system GMM regression, *m3* is a test for third-order serial correlation of the differenced residuals, asymptotically distributed as $N(0,1)$ under the null of no serial correlation. The Hansen *J* test of over-identifying restrictions is distributed as *Chi*-square under the null of instrument validity. We treat $I\_new_{i,t-1}$, $Cash_{i,t-1}$, $Q_{i,t-1}$, $Size_{i,t-1}$, $ROA_{i,t-1}$ and $Leverage_{i,t-1}$ as potentially endogenous variables; levels of these variables dated t-3 and further are used as instruments in the first-differenced equations and first-differences of these same variables lagged twice are used as additional instruments in the level equations. *, **, *** indicates significance at the 10%, 5%, and 1% level, respectively.

Table 5
The effects of free cash flow on (under- and over-) investment.

Dependent variable: $I^u\_new_{i,t}$	*(1)* *Under_gmm*	*(2)* *Over_gmm*	*(3)* *Under_gmm*	*(4)* *Over_gmm*	*(5)* *Under_fe*	*(6)* *Over_fe*	*(7)* *Under_ols*	*(8)* *Over_ols*
Dum_FCF	0.000	-0.001	-0.000	-0.003	0.001	0.000	0.001	-0.0001
	(0.001)	(0.002)	(0.001)	(0.003)	(0.001)	(0.002)	(0.001)	(0.0019)
$FCF*Dum\_FCF_{<0}$	0.055***	0.002	0.054***	-0.034	0.030***	-0.020	0.072***	-0.0326
	(0.008)	(0.027)	(0.014)	(0.022)	(0.008)	(0.019)	(0.009)	(0.0212)
$FCF*Dum\_FCF_{>0}$	0.013	0.103***	0.002	0.108*	0.018*	0.043***	0.009	0.0460**
	(0.009)	(0.022)	(0.008)	(0.061)	(0.009)	(0.016)	(0.007)	(0.0222)
Firm-fixed effects	yes	yes	No	No	yes	yes	No	No
Year-fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Industry-fixed effects	No	No	yes	yes	No	No	yes	yes
R^2	0.37	0.40	0.06	0.03	0.45	0.43	0.06	0.04
Adjusted R^2	0.19	0.13	0.05	0.03	0.27	0.19	0.06	0.03
ρ	0.39	0.36			0.44	0.42		
F-value	11.31	3.82	10.93	3.42	5.01	2.55	13.91	4.68
Diff	0.00***	0.00***	0.00***	0.03**	0.32	0.01***	0.00***	0.012**
Observations	5,777	3,731	5,777	3,731	5,266	4,242	5,716	3,792

Notes: The specifications were estimated using the fixed effects (column 1, 2, 5 and 6) and the pooled OLS (column 3, 4, 7 and 8) estimators. Test statistics and standard errors (in parentheses) of all variables in the regressions are asymptotically robust to heteroscedasticity. The dependent variable is unexpected investment ($I^u\_new_{i,t}$) calculated adopting the method of Richardson (2006), *FCF* is computed by subtracting the optimal level of cash flow from cash flow from operating activities (*CFO*). $Dum\_FCF_{<0}$ is a dummy variable, which is equal to 1 in year t if a firm's free cash flow in that year is below its optimal level (*FCF<0*), and 0 otherwise. $Dum\_FCF_{>0}$ is a dummy variable, which is equal to 1 in year t if a firm's free cash flow in that year exceed its optimal level (*FCF>0*), and 0 otherwise. *Under_gmm* (*Over_gmm*), *Under_fe (Over_fe*) *and Under_ols* (*Over_ols*) refer to abnormal investment being obtained by estimating in Eq. (1) using the system GMM, the fixed effects and the pooled estimators, respectively (see Table 4). For the pooled regression, standard errors (in parentheses) are asymptotically cluster-robust to heteroscedasticity and intra-cluster correlation is accounted for at the firm level. For the fixed effects regression, ρ represents the proportion of the total error variance accounted for by unobserved heterogeneity. *Diff* is the *p*-values of the Wald statistics for the equality of the free cash flow coefficients for firms facing positive and negative *FCF*. *, **, *** indicates significance at the 10%, 5%, and 1% level, respectively.

Table 6
The effects of free cash flow on (under- and over-) investment: using Bates (2005)'s definitions of unexpected investment and free cash flow.

Dependent variable: $I^{u'}\_new_{i,t}$	*(1)* *Under_ fe*	*(2)* *Over_ fe*	*(3)* *Under_ gmm*	*(4)* *Over_ gmm*
$I^{u'}\_new_{i,t-1}$			0.452***	0.320***
			(0.040)	(0.049)
Dum_FCF'	-0.000	0.000	-0.002	0.003
	(0.001)	(0.002)	(0.003)	(0.005)
$FCF'*Dum\_FCF'_{<0}$	0.020**	0.028	0.184***	-0.025
	(0.008)	(0.027)	(0.045)	(0.084)
$FCF'*Dum\_FCF'_{>0}$	0.008	0.050**	-0.046	0.131*
	(0.009)	(0.023)	(0.050)	(0.077)
$Cash_{i,t-1}$	0.025***	0.092***	0.045*	0.114***
	(0.004)	(0.009)	(0.027)	(0.033)
$Q_{i,t-1}$	0.001	0.001	0.007***	-0.005
	(0.001)	(0.001)	(0.002)	(0.003)
$Size_{i,t-1}$	0.006***	-0.012***	0.001	0.003
	(0.001)	(0.002)	(0.002)	(0.003)
$Age_{i,t}$	-0.003***	0.008*	0.000**	0.000
	(0.001)	(0.004)	(0.000)	(0.000)
$ROA_{i,t-1}$	0.020***	0.074***	0.083***	0.061
	(0.003)	(0.020)	(0.029)	(0.054)
$Leverage_{i,t-1}$	-0.008***	-0.027***	0.004	0.019
	(0.003)	(0.009)	(0.012)	(0.022)
Year-fixed effects	yes	yes	yes	yes
Industry-fixed effects	No	No	yes	yes
(Year-fixed) (Industry-fixed)effects*	yes	yes	yes	yes
R^2	0.52	0.47		
Adjusted R^2	0.35	0.27		
P	0.64	0.76		
F-value	4.03	3.24	9.19	33.50
Hansen J test (p-value)			0.01**	0.00***
m3 test (p-value)			0.41	0.29
Diff	0.35	0.54	0.00***	0.17
Observations	4,792	4,716	3,951	3,711

Notes: The specifications were estimated using the fixed effects (column 1 and 2) and the system GMM (column 3 and 4) estimators. Test statistics and standard errors (in parentheses) of all variables in the regressions are asymptotically robust to heteroscedasticity. Time dummies and time dummies interacted with industry dummies were included in all specifications. Adopting the method of Bates (2005), the dependent variable is $I^{u'}\_new_{i,t}$,the difference between a firm's new investment expenditure ($I\_new_{i,t}$) and that of the median firm in the industry (I_new_t) in a given year. *FCF'* is calculated as the difference between the firm's cash flow ($CF_{AIP,i,t}$) and that of the median firmin the industry ($CF_{AIP,i.}$). $Dum\_FCF'_{<0}$ is a dummy variable, which is equal to 1 in a given year if a firm's $CF_{AIP,i,t}$ is below its optimal level (median industry's $CF_{AIP,i.}$), and 0 otherwise. $Dum\_FCF'_{>0}$ is a dummy variable, which is equal to 1 in a given year if a firm's $CF_{AIP,i,t}$ exceed its optimal level (median industry's $CF_{AIP,i.}$), and 0 otherwise. All variables except $Q_{i,t-1}$, $Size_{i,t-1}$ and $Age_{i,t}$ are scaled by total assets. For the system GMM regression, *m3* is a test for third-order serial correlation of the residuals in the differenced equations, asymptotically distributed as $N(0,1)$ under the null of no serial correlation. The Hansen *J* test of over-identifying restrictions is distributed as *Chi*-square under the null of instrument validity. We treat $I^{u'}\_new_{i,t-1}$, *FCF'*, $Cash_{i,t-1}$, $Q_{i,t-1}$, $Size_{i,t-1}$, $ROA_{i,t-1}$ and $Leverage_{i,t-1}$ as potentially endogenous variables. Levels of these variables lagged 3 or longer are used as instruments in the first-differenced equations and first-differences of these same variables lagged 2 as additional instruments in the level equations. *Diff* is the *p*-values of the Wald statistics for the equality of the free cash flow coefficients for firms facing positive and negative *FCF*. *, **, *** indicates significance at the 10%, 5%, and 1% level, respectively.

Table 7
The effects of free cash flow on (under- and over-) investment: further tests.

Dependent variable: $I^u\_new_{i,t}$	*(1)* *Under_gmm* *25^{th} Quant*	*(2)* *Over_gmm* *25^{th} Quant*	*(3)* *Under_gmm* *50^{th} Quant*	*(4)* *Over_gmm* *50^{th} Quant*	*(5)* *Under_gmm* *75^{th} Quant*	*(6)* *Over_gmm* *75^{th} Quant*	*(7)* *Under_gmm* *Conti.*	*(8)* *Over_gmm* *Conti.*
	Most under-investment —› Most over-investment							
Dum_FCF	-0.000	-0.000	0.001	-0.000	0.001	-0.001	0.002**	-0.002
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.004)	(0.001)	(0.003)
*FCF*Dum_FCF$_{<0}$*	0.056***	-0.009	0.033***	-0.036	0.012**	-0.050	0.035***	0.017
	(0.012)	(0.011)	(0.007)	(0.026)	(0.006)	(0.046)	(0.009)	(0.031)
*FCF*Dum_FCF$_{>0}$*	0.002	0.012	0.001	0.034*	-0.004	0.072*	0.008	0.122***
	(0.014)	(0.009)	(0.008)	(0.021)	(0.007)	(0.040)	(0.009)	(0.025)
Firm-fixed effects	No	No	No	No	No	No	yes	yes
Year-fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Industry-fixed effects	yes	yes	yes	yes	yes	yes	No	No
(Pseudo) R^2	0.04	0.01	0.04	0.02	0.03	0.02	0.39	0.42
Adjusted R^2							0.20	0.13
ρ							0.36	0.37
F-value							9.38	3.38
Diff	0.00***	0.15	0.00***	0.04**	0.09*	0.05**	0.03**	0.01***
Observations	5,777	3,731	5,777	3,731	5,777	3,731	4,537	3,043

Notes: The specifications were estimated using the quantile and fixed effects estimators. The dependent variable is unexpected investment ($I^u\_new_{i,t}$) calculated using the method of Richardson (2006). *FCF* is computed by subtracting the optimal level of cash flow from cash flow from operating activities (*CFO*). *Dum_FCF$_{<0}$* is a dummy variable, which is equal to 1 in year t if a firm's free cash flow in that year is below its optimal level (*FCF<0*), and 0 otherwise. *Dum_FCF$_{>0}$* is a dummy variable, which is equal to 1 in year t if a firm's free cash flow in that year exceed its optimal level (*FCF>0*), and 0 otherwise. In columns 7 and 8, under- or over- investment are defined when firms have two consecutive under- or over- investment years. For the quantile regression, we run separate regressions for the 25^{th}, 50^{th}, 75^{th} quantiles of abnormal investment. For the fixed effects regression, we report ρ, which represents the proportion of the total error variance accounted for by unobserved heterogeneity. *Diff* is the *p*-values of the Wald statistics for the equality of the free cash flow coefficients for firms facing positive and negative *FCF*. *, **, *** indicates significance at the 10%, 5%, and 1% level, respectively.

Table 8
Summary statistics of financial constrains (*KZ* and *WW* indexes) for under- and over- investing firms.

	FC index	*Mean*	*St. Dev.*	*P25*	*P50*	*P75*	*N Obs*
G1	KZ	-2.513	6.718	-3.225	-0.480	0.865	3,120
Under_ FCF$_{<0}$	WW	-0.930	0.064	-0.974	-0.929	-0.882	3,120
G2	KZ	-2.895	7.166	-3.784	-0.796	0.706	2,656
Under_ FCF$_{>0}$	WW	-0.939	0.063	-0.983	-0.939	-0.890	2,657
Diff (G1 vs. G2)	KZ	0.04**		*Diff* (G1 vs. G2)	0.00***		
(Mean)	WW	0.00***		(Median)	0.00***		
G3	KZ	-1.703	5.006	-2.566	-0.315	0.942	1,884
Over_ FCF$_{>0}$	WW	-0.937	0.066	-0.983	-0.938	-0.886	1,883
G4	KZ	-2.257	5.894	-3.135	-0.643	0.791	1,847
Over_ FCF$_{<0}$	WW	-0.941	0.063	-0.985	-0.942	-0.895	1,847
Diff (G3 vs. G4)	KZ	0.00***		*Diff* (G3 vs. G4)	0.00***		
(Mean)	WW	0.03**		(Median)	0.03**		
Total	KZ	-2.410	6.406	-3.188	-0.584	0.827	9,507
	WW	-0.936	0.064	-0.981	-0.937	-0.887	9,507

Notes: KZ and *WW* represent the firm-specific levels of financial constraint: the Kaplan and Zingales (*KZ*) index of constraints (Lamont *et al.* 2001) and the Whited and Wu (*WW*) index of constraints (Whited & Wu 2006). Firms are classified into four groups according to the difference between the levels of investment and *FCF* (free cash flow) and their optimal levels: Group1 (under-investing firms with negative *FCF*); Group 2 (under-investing firms with positive *FCF*); Group 3 (over-investing firms with positive *FCF*); Group 4 (over-investing firms with negative *FCF*). *P25* (*50/75*) is the 25th (50th/75th) percentile of the respective distribution. *Diff* is the *p*-value associated with the Wald test and the Wilcoxon rank-sum test for differences in means and equality of medians of the financial constraints *KZ* (*WW*) index between groups of under-investing firms (Group 1 and Group 2) or between groups of over-investing firms (Group3 and Group4). *, **, *** indicates significance at the 10%, 5%, and 1% level, respectively.

Table 9
The sensitivity of under-investment to free cash flow accounting for financial constraints.

Dependent variable: $I^u\_new_{i,t}$	*(1)* *KZ_under*	*(2)* *KZ_under*	*(3)* *WW_under*	*(4)* *WW_under*
Medium_FC(30-70)	-0.000		-0.003***	
	(0.001)		(0.001)	
High_FC(>70)	0.001		-0.002*	
	(0.001)		(0.001)	
FCF Low_FC(<30)*	0.023***		0.017**	
	(0.007)		(0.007)	
FCF Medium_FC(30-70)*	0.037***		0.027***	
	(0.006)		(0.006)	
FCF High_FC(>70)*	0.052***		0.065***	
	(0.008)		(0.007)	
High_FC(<50)		0.001		-0.000
		(0.001)		(0.001)
FCF Low_FC(<50)*		0.028***		0.026***
		(0.005)		(0.006)
FCF High_FC(>50)*		0.045***		0.045***
		(0.006)		(0.006)
Firm-fixed effects	yes	Yes	yes	yes
Year-fixed effects	yes	Yes	yes	yes
R^2	0.37	0.37	0.37	0.37
Adjusted R^2	0.19	0.19	0.20	0.19
ρ	0.38	0.38	0.39	0.38
F-value	9.76	10.83	11.46	10.85
Diff	0.00***	0.04**	0.00***	0.01***
Observations	5,777	5,777	5,776	5,776

Notes: The specifications were estimated using the fixed effects estimator. Test statistics and standard errors (in parentheses) of all variables in the regressions are asymptotically robust to heteroscedasticity. ρ represents the proportion of the total error variance accounted for by unobserved heterogeneity. The dependent variable is unexpected investment ($I^u\_new_{i,t}$) calculated adopting the method of Richardson (2006). *FCF* is computed by subtracting the optimal level of cash flow from cash flow from operating activities (*CFO*). *High_FC*, *Medium_FC* and *Low_FC* are dummy variables, equal to 1 in a given year if a firm faces high, medium, or low financial constraints, and 0 otherwise. In columns 1 and 3, we consider a firm to be financially constrained (unconstrained) if its *KZ* or *WW* index lies in the top (bottom) three deciles of the distribution of the corresponding variables for all firms belonging to the same industry in a given year. The remaining firm-years will be the ones, who face a medium level of financial constraints. In columns 2 and 4, a firm is considered to be financially constrained in a given year if its *KZ* or *WW* index exceeds the median value of the index calculated in the industry that the firm belongs to, and financially unconstrained otherwise. *Diff* is a test, distributed as *Chi*-square, for equality of the coefficients across various categories of firms. Specifically, we report *p*-values of the Wald statistics for the equality of the free cash flow coefficients associated with under-investment between financial constrained and unconstrained firm-years. *, **, *** indicates significance at the 10%, 5%, and 1% level, respectively.

Table 10
The sensitivity of under- investment to free cash flow: distinguishing firm-years on the basis of conventional proxies for financial constraints.

Dependent variable: $I^u\_new_{i,t}$	(1)	(2)	(3)	(4)
	Total Assets	*No. of Employees*	*Payout Ratio*	*Dividend Paying*
Medium_ FC$_{(30-70)}$	0.002*	0.002	-0.000	
	(0.001)	(0.001)	(0.001)	
Low_ FC$_{(>70)}$	0.006***	0.004***	-0.001	
	(0.001)	(0.001)	(0.001)	
FCF High_ FC*$_{(<30)}$	0.055***	0.058***	0.047***	
	(0.007)	(0.007)	(0.006)	
FCF Medium_ FC* $_{(30-70)}$	0.033***	0.026***	0.034***	
	(0.006)	(0.007)	(0.009)	
FCF Low_ FC* $_{(>70)}$	0.022***	0.027***	0.019**	
	(0.008)	(0.008)	(0.007)	
Div_yes				-0.001
				(0.001)
FCF Div_no*				0.047***
				(0.006)
FCF Div_yes*				0.025***
				(0.006)
Firm-fixed effects	yes	yes	yes	yes
Year-fixed effects	yes	yes	yes	yes
R^2	0.37	0.38	0.37	0.37
Adjusted R^2	0.20	0.20	0.20	0.19
ρ	0.387	0.394	0.387	0.38
F-value	11.028	10.817	9.782	11.07
Diff	0.00***	0.00***	0.00***	0.00***
Observations	5,777	5,514	5,716	5,777

Notes: The specifications were estimated using the fixed effects estimator. Test statistics and standard errors (in parentheses) of all variables in the regressions are asymptotically robust to heteroscedasticity. ρ represents the proportion of the total error variance accounted for by unobserved heterogeneity. The dependent variable is unexpected investment ($I^u\_new_{i,t}$) calculated adopting the method of Richardson (2006). *FCF* is computed by subtracting the optimal level of cash flow from cash flow from operating activities (*CFO*). Based on different criteria: *Firm Size* (total assets or the number or employees), *Age*, *Payout Ratio*, *Dividend Payout Status*, we split firm-years into the following three groups: *High_FC*, *Medium_FC and Low_FC*, which are dummy variables, equal to 1 respectively if a firm is more likely to face the highest, medium and lowest financial constraints relatively to all firms operating in the same industry they belong to in a given year and 0 otherwise. In columns 1 to 3, we consider a firm to be financially constrained (unconstrained) if its *size* (total assets or the number or employees*), age*, and *payout ratio* lies in the bottom (top) three deciles of the distribution of the corresponding values of all firms belonging to the same industry each year. The remaining firm-years will be the ones, whose face medium level of financial constraints. In columns 4, we partition firms according to their dividend payout status, which equals 1 (*Div_yes*) if the firm is paying dividends in a given year, and 0 otherwise. *Diff* is a test, distributed as *Chi*-square, for equality of the coefficients across various categories of firms. Specifically, we report *p*-values of the Wald statistics for the equality of the free cash flow coefficients associated with under-investment between firm-years, who are more likely to face financial constrained and those, who are less likely to face financial constraints. *, **, *** indicates significance at the 10%, 5%, and 1% level, respectively.

Table 11
Summary statistics of agency costs (*AC1* and *AC2*) for under- and over- investing firms.

	FC index	*Mean*	*St. Dev.*	*P25*	*P50*	*P75*	*N Obs*
G1	*AC1*	0.523	0.398	0.248	0.416	0.679	3,120
Under_ FCF$_{<0}$	*AC2*	0.057	0.080	0.010	0.026	0.071	3,120
G2	*AC1*	0.590	0.428	0.286	0.482	0.777	2,656
Under_ FCF$_{>0}$	*AC2*	0.045	0.065	0.008	0.020	0.054	2,657
Diff (G1 vs. G2)	*AC1*	0.00***		*Diff* (G1 vs. G2)	0.00***		
(Mean)	*AC2*	0.00***		(Median)	0.00***		
G3	*AC1*	0.545	0.412	0.251	0.436	0.709	1,884
Over_ FCF$_{>0}$	*AC2*	0.047	0.070	0.008	0.022	0.056	1,884
G4	*AC1*	0.477	0.349	0.235	0.386	0.612	1,847
Over_ FCF$_{<0}$	*AC2*	0.041	0.059	0.007	0.019	0.050	1,847
Diff (G3 vs. G4)	*AC1*	0.00***		*Diff* (G3 vs. G4)	0.00***		
(Mean)	*AC2*	0.00***		(Median)	0.01***		
Total	*AC1*	0.537	0.402	0.255	0.431	0.699	9,507
	AC2	0.049	0.071	0.008	0.022	0.058	9,508

Notes: AC1 (operating expense scaled by total assets) and *AC2* (other receivable scaled by total assets) represent firm-specific levels of agency costs. Firms are classified into four groups according to the difference between the levels of their investment and *FCF* (free cash flow) and their optimal levels: Group1 (under-investing firms with negative *FCF*); Group 2 (under-investing firms with positive *FCF*); Group 3 (over-investing firms with positive *FCF*); Group 4 (over-investing firms with negative *FCF*). *P25* (*50/75*) is the 25th (50th/75th) percentile of the distribution of the relevant variable. *Diff* is the *p*-value associated with the Wald test and the Wilcoxon rank-sum test for differences in means and equality of medians of the firm-level agency costs *AC1* (*AC2*) between groups of under-investing firms (Group1 and Group2) or between groups of over-investing firms (Group3 and Group4). *, **, *** indicates significance at the 10%, 5%, and 1% level, respectively.

Table 12
The sensitivity of over-investment to free cash flow accounting for agency costs.

Dependent variable: $I^u\_new_{i,t}$	*(1)* *AC1_over*	*(2)* *AC1_over*	*(3)* *AC2_over*	*(4)* *AC2_over*
Medium_ $AC_{(30-70)}$	-0.002		-0.006***	
	(0.002)		(0.002)	
High_ $AC_{(>70)}$	-0.009**		-0.013***	
	(0.003)		(0.003)	
FCF Low_ $AC_{(<30)}$*	0.020		0.036	
	(0.021)		(0.022)	
FCF Medium_ $AC_{(30-70)}$*	0.065***		0.026	
	(0.018)		(0.018)	
FCF High_ $AC_{(>70)}$*	0.076***		0.092***	
	(0.022)		(0.019)	
High_$AC_{(>50)}$		-0.005*		-0.012***
		(0.002)		(0.002)
FCF Low_$AC_{(<50)}$*		0.026		0.033**
		(0.016)		(0.016)
FCF High_ $AC_{(>50)}$*		0.080***		0.068***
		(0.016)		(0.016)
Firm-fixed effects	yes	yes	yes	yes
Year-fixed effects	yes	yes	yes	yes
R^2	0.40	0.40	0.41	0.41
Adjusted R^2	0.13	0.13	0.41	0.14
P	0.36	0.36	0.36	0.36
F-value	3.44	3.81	4.50	5.86
Diff	0.06*	0.02**	0.05**	0.11
Observations	3,731	3,731	3,731	3,731

Notes: The specifications were estimated using the fixed effects estimator. Test statistics and standard errors (in parentheses) of all variables in the regressions are asymptotically robust to heteroscedasticity. ρ represents the proportion of the total error variance accounted for by unobserved heterogeneity. The dependent variable is unexpected investment ($I^u\_new_{i,t}$) calculated using the method of Richardson (2006). *FCF* is computed by subtracting the optimal level of cash flow from cash flow operating activities (*CFO*). *High_AC, Medium_AC or Low_AC* are dummy variables, equal to 1 in a given year if a firm faces the highest, medium, lowest agency costs in the same industry they belong to and 0 otherwise. In columns 1 and 3, we define a firm as facing high (low) agency costs in a given year if its *AC1* or *AC2* lies in the top (bottom) three deciles of the distribution of the corresponding variables of all firms operating in its same industry in that year. The remaining firm-years will be the ones with medium agency costs. As for columns 2 and 4, a firm is considered to face high (low) agency costs in a given year if its *AC1* or *AC2* exceeds (is below) the median value of the distribution of the corresponding variables of all firms operating in the same industry it belongs to in that year. *Diff* is a test, distributed as *Chi*-square, for equality of the coefficients across different categories of firms. Specifically, we report *p*-values of the Wald statistics for the equality of free cash flow associated with over-investment between sub-samples of firms characterized by high and low agency costs. *, **, *** indicates significance at the 10%, 5%, and 1% level, respectively.

Table 13
The sensitivity of over-investment to free cash flow: distinguishing firm-years on the basis of ownership structure.

Dependent variable:	*(1)*	*(2)*	*(3)*
$I^u\_new_{i,t}$	*Shareholding_CEO*	*Blockholder*	*Concentration*
Insider	-0.001		
	(0.002)		
FCF Outsider*	0.065***		
	(0.014)		
FCF Insider*	0.013		
	(0.022)		
Medium_ Share (30-70)		0.001	0.001
		(0.003)	(0.003)
High_ Share (>70)		0.002	-0.000
		(0.004)	(0.004)
FCF Low_ Share L(<30)*		0.043**	0.134***
		(0.022)	(0.024)
FCF Medium_ Share (30-70)*		0.084***	0.032
		(0.020)	(0.022)
FCF High_ Share (>70)*		0.050**	0.036
		(0.023)	(0.028)
Firm-fixed effects	yes	yes	Yes
Year-fixed effects	yes	yes	Yes
R^2	0.40	0.43	0.45
Adjusted R^2	0.13	0.13	0.11
ρ	0.36	0.39	0.38
F-value	3.42	3.31	4.52
Diff(Low VS Medium)		0.17	0.00***
Diff (Medium VS High)		0.26	0.90
Diff (Low VS High)	0.04**	0.83	0.00***
Observations	3,721	3,332	2,834

Notes: The specifications were estimated using the fixed effects estimator. Test statistics and standard errors (in parentheses) of all variables in the regressions are asymptotically robust to heteroscedasticity. ρ represents the proportion of the total error variance accounted for by unobserved heterogeneity. The dependent variable is unexpected investment ($I^u\_new_{i,t}$) calculated adopting the method of Richardson (2006) *FCF* is computed by subtracting the optimal level of cash flow from cash flow from operating activities (*CFO*). In the column labeled *Shareholding_CEO, Insider(Outsider)* is a dummy variable that takes the value of 1 if the firm CEO is (not) holding shares in his/her own company, and 0 otherwise. *Blockhoders* is the percentage of shares controlled by the largest shareholder. *High_Share (Low_Share)* is a dummy variable equal to 1 in a given year if the percentage of shares controlled by blockholders in a given firm lies in the top (bottom) three deciles of the distribution of the corresponding variables of all firms operating in the same industry in that year. For the remaining firm-years, the dummy *Medium_Share* will be equal to 1. *Concentration* is a Herfindahl-type of index. *Share2_10*, is the sum of squares of shareholding percentages of the top 10 shareholders excluding the largest shareholder. *Low_share*, *Medium_share* and *High_share* refer in turn to dummy variables, equal to 1 if *Share2_10* lies in the bottom three deciles, the middle four deciles and the top three deciles of the distribution of *Share2_10* of all the firms operating in the same industry to which the firm belongs to, and 0 otherwise. *Diff* is a test, distributed as *Chi*-square, for equality of the coefficients across different categories of firms. Specifically, we report *p*-values of the Wald statistics for the equality of the free cash flow coefficients between the indicated groups. *, **, *** indicates significance at the 10%, 5%, and 1% level, respectively.

Table 14
(Under- or over-) investment-free cash flow sensitivity: distinguish firm-years based on whether they become "ST" or bidders.

Dependent variable: $I^u\_new_{i,t}$	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
	ST		*ST*		*Bidder*		*Bidder_con.*	
	Under	*Over*	*Under*	*Over*	*Under*	*Over*	*Under*	*Over*
ST(Bidder)					0.000	-0.000	0.001	-0.001
					(0.001)	(0.002)	(0.001)	(0.003)
FCF Non_ST(Bidder)$_1$*	0.029***	0.033**			0.034***	0.044***	0.036***	0.046***
	(0.005)	(0.014)			(0.005)	(0.013)	(0.004)	(0.012)
FCF ST(Bidder)$_2$*	0.052***	0.088***			0.046***	0.073***	0.032**	0.104***
	(0.007)	(0.020)			(0.009)	(0.022)	(0.014)	(0.034)
Pre_ST			0.004***	-0.005				
			(0.001)	(0.005)				
FCF Non_ST$_1$*			0.028***	0.033**				
			(0.005)	(0.014)				
FCF Pre_ST$_2$*			0.050***	0.131***				
			(0.010)	(0.028)				
FCF Post_ST$_3$*			0.061***	0.034				
			(0.010)	(0.029)				
Firm-fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Year-fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.37	0.40	0.37	0.40	0.37	0.40	0.37	0.40
Adjusted R^2	0.19	0.13	0.19	0.13	0.19	0.13	0.19	0.13
ρ	0.38	0.36	0.39	0.36	0.38	0.36	0.38	0.36
F-value	11.81	3.79	10.81	3.71	10.58	3.25	10.51	3.35
Diff ($1_{VS}2$)	0.00***	0.03**	0.06*	0.00***	0.20	0.27	0.78	0.10*
Diff ($2_{VS}3$)			0.44	0.02**				
Diff ($1_{VS}3$)			0.00***	0.98				
Observations	5,777	3,731	5,777	3,731	5,777	3,731	5,777	3,731

Notes: The specifications were estimated using the fixed effects estimator. Test statistics and standard errors (in parentheses) of all variables in the regressions are asymptotically robust to heteroscedasticity. *ρ*

represents the proportion of the total error variance accounted for by unobserved heterogeneity. The dependent variable is unexpected investment ($I^u\_new_{i,t}$) calculated using the method of Richardson (2006). *FCF* is computed by subtracting the optimal level of cash flow from operating cash flow (*CFO*). *ST* is a dummy variable that takes the value of 1 if a firm has been issued a special treatment or a de-listing risk warning, and 0 otherwise. *Pre_ST* (*Post_ST*) is a dummy variable, which equals one if a firm is in the pre- (post-) period of "ST", and 0 otherwise. *Bidder* is a dummy variable that takes the value of 1 if a firm becomes a bidder in the next fiscal year, and 0 otherwise. *Bidder_con* is a dummy variable that takes the value of 1 if a firm has been a bidder in two consecutive years, and 0 otherwise. *Diff* is a test, distributed as *Chi*-square, for equality of the coefficients across different categories of firms. Specifically, we report *p*-values of the Wald statistics for the equality of free cash flow between the indicated groups. *, **, *** indicates significance at the 10%, 5%, and 1% level, respectively.

Table 15
The effects of free cash flow on (under- and over-) investment: distinguishing firms on the basis of other dimensions of firm heterogeneity specific to the Chinese context.

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(6)*
Dependent variable: $I^u\_new_{i,t}$	*Ownership*		*Ownership (2003-2010)*		*Region*		*Exporting*	
	Under	*Over*	*Under*	*Over*	*Under*	*Over*	*Under*	*Over*
Dum_CH	0.001	0.000			0.003	0.008	-0.000	-0.002
	(0.001)	(0.004)			(0.005)	(0.017)	(0.001)	(0.003)
FCF(1-Dum_CH)*	0.046***	0.023			0.038***	0.056***	0.039***	0.038**
	(0.007)	(0.021)			(0.007)	(0.018)	(0.006)	(0.019)
*FCF*Dum_CH*	0.032***	0.064***			0.035***	0.049***	0.020**	0.036
	(0.005)	(0.014)			(0.005)	(0.015)	(0.008)	(0.024)
$(SOE\_local)_2$			-0.003	-0.001				
			(0.002)	(0.006)				
$(Non\_SOE)_3$			-0.003	0.001				
			(0.003)	(0.007)				
FCF $(SOE\_Central)_1$*			0.037***	0.016				
			(0.012)	(0.035)				
FCF $(SOE\_local)_2$*			0.031***	0.104***				
			(0.007)	(0.020)				
FCF $(Non\_SOE)_3$*			0.053***	0.041*				
			(0.008)	(0.025)				
Firm-fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Year-fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.37	0.40	0.47	0.45	0.37	0.40	0.52	0.48
Adjusted R^2	0.19	0.13	0.26	0.11	0.19	0.13	0.31	0.12
ρ	0.38	0.36	0.50	0.38	0.39	0.37	0.57	0.40
F-value	10.71	3.35	10.89	4.01	10.49	3.18	10.05	1.96
Diff $(1_{VS}2)$	0.11	0.10*	0.65	0.03**	0.75	0.76	0.07*	0.94
Diff $(2_{VS}3)$			0.04**	0.05**				

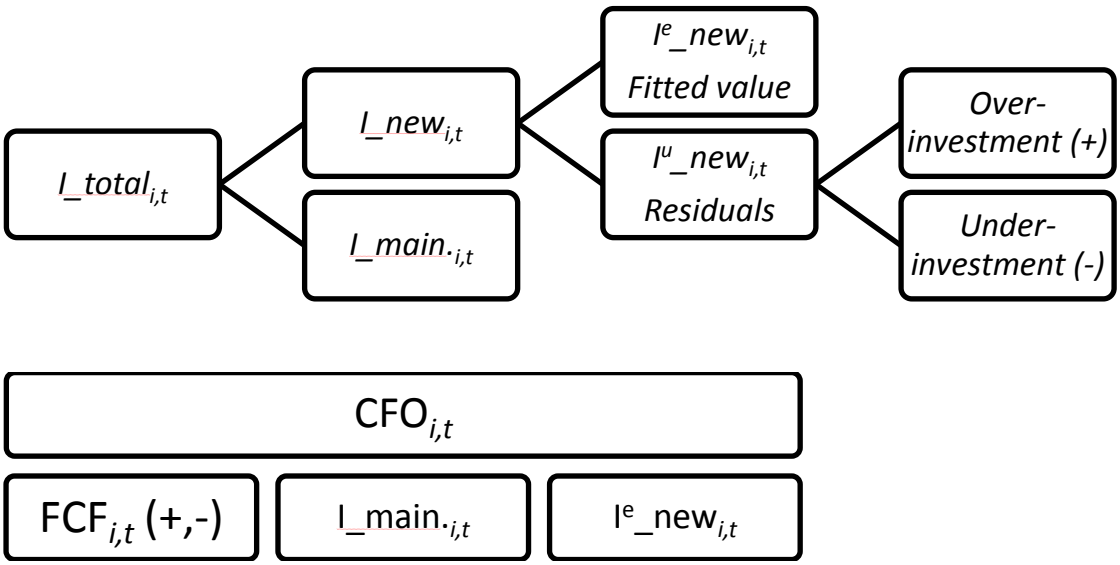
Diff ($1_{VS}3$)			0.27	0.56				
Observations	5,771	3,728	4,300	2,825	5,777	3,731	3,958	2,601

Notes: The specifications were estimated using the fixed effects estimator. Test statistics and standard errors (in parentheses) of all variables in the regressions are asymptotically robust to heteroscedasticity. ρ represents the proportion of the total error variance accounted for by unobserved heterogeneity. The dependent variable is unexpected investment ($I^u\_new_{i,t}$) calculated using the method of Richardson (2006). *FCF* is computed by subtracting the optimal level of cash flow from cash flow from operating activities (*CFO*). *Dum_CH (Ownership)* is a dummy variable, which is equal to 1 in a given year if a firm is stated owned, and 0 otherwise. *Dum_CH (Region)* is a dummy variable, which is equal to 1 in a given year if a firm is located in the coastal regions of China, and 0 otherwise. *Dum_CH (Exporting)* is a dummy variable, which is equal to 1 if a firm participates in exporting in a given year and 0 otherwise. *SOE_central (SOE_local / non_SOE)* is a dummy variable, which is equal to 1 in a given year if a firm is a stated owned enterprise affiliated with the central government (a stated owned enterprise affiliated with local governments / a non- state owned enterprise), and 0 otherwise. Due to the data availability, the results of different ownership structure in column 1 and 2 are based on a sub-sample from 2003 to 2010. *Diff* is a test, distributed as *Chi*-square, for equality of the coefficients across different groups of firms. Specifically, we report *p*-values of the Wald statistics for the equality of the free cash flow coefficients across sub-samples. *, **, *** indicates significance at the 10%, 5%, and 1% level, respectively.

Table 16
The effects of the split share structure reform on the sensitivities of (under- and over-) investment to free cash flow.

Dependent variable: $I^u\_new_{i,t}$	*(1)* *Over*	*(2)* *Over(2003-2010)*	*(3)* *Under*
FCF	-0.018	-0.011	0.054***
	(0.030)	(0.040)	(0.011)
*FCF*Post*	0.083**	0.081*	-0.017
	(0.041)	(0.048)	(0.015)
*FCF*Treat$_{(SOE/SOELG)}$*	0.097***	0.179***	-0.022*
	(0.035)	(0.050)	(0.013)
*FCF*Treat$_{(SOE/SOELG)}$*Post*	-0.114**	-0.199***	0.010
	(0.049)	(0.062)	(0.018)
*FCF*Treat$_{(SOECG)}$*		-0.066	
		(0.066)	
*FCF*Treat$_{(SOECG)}$*Post*		0.091	
		(0.085)	
Firm-fixed effects	yes	yes	Yes
Year-fixed effects	yes	yes	Yes
R^2	0.39	0.45	0.35
Adjusted R^2	0.13	0.12	0.19
ρ	0.35	0.37	0.36
F-value	3.63	4.99	9.48
Observations	3,509	2,636	5,487

Notes: The specifications were estimated using the fixed effects estimators. Test statistics and standard errors (in parentheses) of all variables in the regressions are asymptotically robust to heteroscedasticity. ρ represents the proportion of the total error variance accounted for by unobserved heterogeneity. The dependent variable is unexpected investment ($I^u\_new_{i,t}$) calculated adopting the method of Richardson (2006). *FCF* is computed by subtracting the optimal level of cash flow from cash flow from operating activities (*CFO*). *Treat $_{(SOE)}$* is a dummy variable, which equals 1 if a firm has a state entity as its ultimate controlling shareholder, and zero otherwise. *Treat $_{(SOELG/SOECG)}$* is a dummy variable, which equals 1 if a firm is stated owned enterprise affiliated with the local/the central government in a given year, and zero otherwise. *Post* is equal to 1 in the year of and the years following the firm's announcement of the restricting reform, and zero otherwise. The triple term (*FCF*Treat*Post*) is aimed at capturing the difference-in-differences effect. Due to the data availability, the results in column 2 are based on a sub-sample covering the years 2003 to 2010.*, **, *** indicates significance at the 10%, 5%, and 1% level, respectively.



Note: $I\_total_{i,t} = CAPEX_{i,t} - SalePPE_{i,t}$ (Capital expenditure- sale of property, plant, and equipment);

$I\_main._{i,t} = Depreciation_{i,t} + Amortization_{i,t}$;

$I\_new_{i,t} = I\_total_{i,t} - I\_main._{i,t}$;

$CFO_{i,t}$ = Net cash flow from operating activities;

$CF_{AIP,i,t=}$ Cash flow generated from assets in place;

$FCF_{i,t} = CF_{AIP,i,t} - I^e\_new_{i,t} = CFO_{,} - I\_main._{i,t} - I^e\_new_{i,t}$.

Fig.1. Framework for the construction of (under- or over-) investment and free cash flow

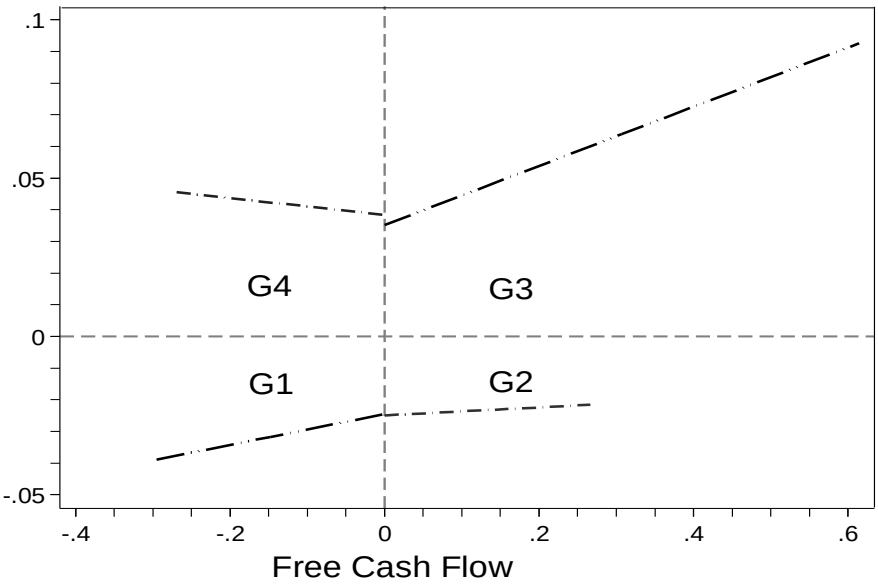


Fig.2 Fitted values of the sensitivities of abnormal investment to free cash flow

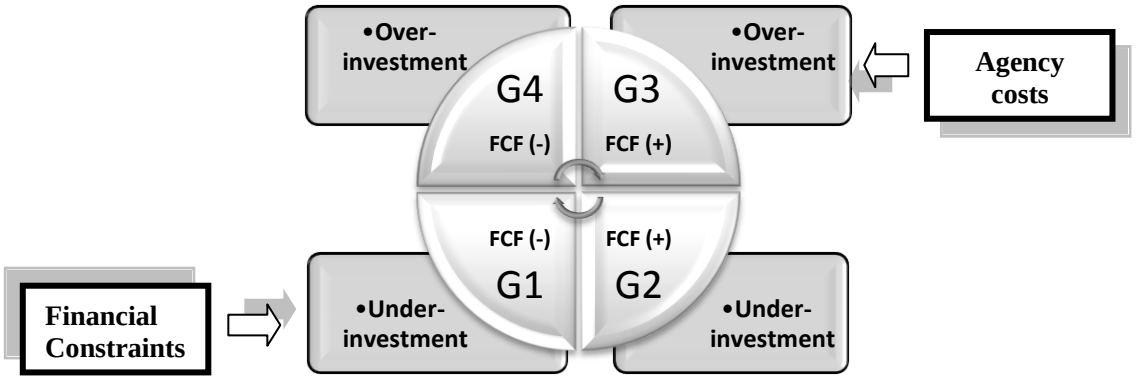


Fig.3 Four groups of firms based on their abnormal investment and free cash flow (*FCF*)

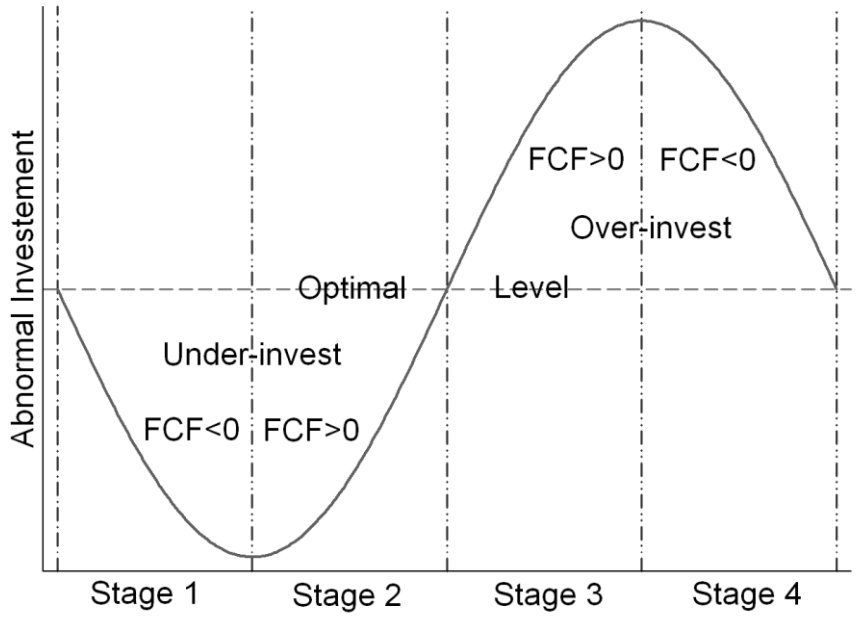


Fig.4 Diagrams of four phases of firms' abnormal investment and free cash flow