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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 1998-2014, we document strong evidence of investment inefficiency, which we explain through a combination of financing constraints and agency problems. Specifically, we argue that firms with cash flow below (above) their optimal level tend to under- (over-)invest as a consequence of financial constraints (agency costs). Furthermore, focusing on under-investing firms, we highlight that the sensitivities of abnormal investment to free cash flow rise with traditionally used measures of financing constraints, whilst for over-investing firms, the sensitivities increase with a wide range of firm-specific measures of agency costs.

Keywords: Under-investment; Over-investment, Free cash flow; Financial constraints; Agency costs; China

JEL classification: G31; G32; O16; O53

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1. Introduction

Problems of information asymmetry between management and financial institutions, and agency conflicts between controlling shareholders and minority investors, as well as between management and shareholders 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 significant 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 both financial constraints and agency problems[1].

China has been seen as a counter-example 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).[2] Internal finance, trade credit, and other informal funds might speak louder than bank or equity finance in explaining the Chinese growth miracle. 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 to access external funding (Allen *et al.* 2005; Héricourt & Poncet 2009; Guariglia *et al.* 2011). 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 to the fact that a substantial number of listed firms are controlled by the state, the stock market is not very efficient and stock prices do not reflect fundamental values (Allen *et al.* 2005; Wang *et al.* 2009). Financial markets in China have therefore not been playing a very efficient role in allocating resources and relieving financial constraints, which are a

[1] Some researchers (e.g. Bernanke & Gertler, 1989) refer to agency costs as those deadweight losses, which, in the presence of asymmetric information, prevent to reach optimal financial arrangements between borrowers and lenders. These agency costs translate themselves in a higher cost of external finance compared to internal funds. Hereafter, we refer to these as financing constraints, and only consider as agency problems those arising from conflicts of interest between majority shareholders and minority shareholders, or between managers and shareholders.

[2] According to the National Bureau of Statistics (NBS) Statistical Yearbook of China (various issues), China has experienced a rapid growth rate, which reached an average of 13.2% per year over the 1998-2014 period in terms of GDP (gross domestic product). This incredibly fast growth relied heavily on investment. Over the period 1998-2014, the country experienced in fact an investment boom (the average annual growth rate for total fixed investment was 19.7%), which was responsible for around 50% of GDP growth (NBS Statistical Yearbook of China, various issues).

significant issue for several Chinese firms, and may lead them to under-invest[3].

At the same time, given the weak legal system and poor corporate governance mechanisms that characterize the country, agency problems are rather severe and likely to lead to over-investment in China's listed sector (Allen *et al.* 2005; Chen *et al.* 2011). For instance, government bureaucrats may use their influence to over-invest in order to achieve their political objectives (Firth *et al.* 2012). These effects may be amplified by the presence of soft budget constraints[4], and widespread corruption (Chow *et al.* 2010; Firth *et al.* 2012). Excessive investment might cause over-heating and over-capacity, and generate inefficiency, which could impair the sustainable development and future wellbeing in China.

Our work makes three main contributions to the literature. First, we examine under- and over-investment at the same time, as we believe that these two types of abnormal investment are likely to coexist in China. Second, unlike most prior research, which examines sensitivities of investment to cash flow (Fazzari *et al.* 1988; Kaplan & Zingales 1997; Cleary 1999; Cummins *et al.* 2006), we focus 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 prevents free cash flow from picking up future investment opportunities. Consequently, in the absence of financing constraints and agency costs, under- and over-investment should not display a systematic response to free cash flow. Our approach provides therefore a powerful and unambiguous test which will help shed light on whether investment inefficiencies in the unique Chinese context can be explained by financial constraints and/or agency problems. Third, our analysis provides evidence on the extent to which heterogeneity in the degree of financing constraints and agency costs faced by firms affects the sensitivities of under- and over-investment to free cash flow.

Our study is conducted using a large panel of listed Chinese firms over the period 1998-2014. We analyze the sensitivity of (under- and over-) investment to free cash 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-

[3] Hereafter, we define over-investment (under-investment) as investment expenditure beyond (below) its optimal level. We therefore refer to both under- and over-investment as abnormal investment. In addition, we argue that the sensitivity of abnormal investment to free cash flow can be seen as evidence of investment inefficiency due to financial constraints and/or agency problems. It should be noted that there are other ways to measure investment inefficiency: for instance, Chen et al. (2014) focus on the sensitivity of investment expenditure to Tobin's *Q*.

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

investment and free cash flow measures. Our empirical results show that a combination of both financing constraints and agency problems explains investment inefficiency in the unique Chinese context. In particular, our findings are consistent with the financial constraints hypothesis (Fazzari *et al.* 1988): higher sensitivities of under-investment to free cash flow are found for the firms with cash flow below their optimal levels, which are more likely to face financing constraints. Our results are also in line with the agency costs hypothesis (Jensen 1986): higher sensitivities of over-investment to free cash flow are spotted in firms with cash flow above their optimal levels, which are more likely to suffer from agency problems. These results are robust to the use of alternative measures of abnormal investment and free cash flow, of different estimation methodologies, and of various alternative criteria to define financial constraints and agency costs.

The remainder of the 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 the methodology we use to measure abnormal investment and free cash flow. Section 4 presents our baseline specifications and estimation methodology. Section 5 describes the main features of the data and presents summary statistics. Section 6 discusses and examines our main empirical results and some robustness tests. Section 7 analyzes the extent to which heterogeneity in the degree of financing constraints and agency costs faced by firms affects the sensitivities of under- and over-investment to free cash flow. Section 8 concludes.

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 their marginal revenue equals their marginal cost. However, substantial empirical evidence has documented a significantly positive correlation between cash flow and investment expenditure (Fazzari *et al.* 1988; Hubbard, 1998; Cleary, 1999; Cumming et al., 2006; Bond & Van Reenen, 2007). The reason for the existence of this positive relation remains, however, controversial.

First, there exists considerable evidence to suggest that the positive correlation between investment and cash flow stems from asymmetric information between corporate insiders and outside creditors (Myers & Majluf 1984; Fazzari *et al.* 1988; Carpenter & Guariglia 2008). This can be explained considering that when external finance such as bank loans, debt and equity are used, the imperfections in capital markets lead to a cost premium.

The cost and/or availability of external funds force firms to use internal finance, like retained earnings, in preference to external finance. In these circumstances, financially constrained firms may have to forego good investment projects to avoid the excessively high cost premiums associated with the use of external finance. Thus, when firms face financial constraints, negative cash flow shocks may lead to under-investment. A high sensitivity of under-investment to free cash flow can therefore be seen as evidence of financial constraints. We refer to this as the financing constraints (*FC*) hypothesis (*H1*):

> *H1: Financing Constraints (FC) Hypothesis: Firms which are ex-ante more likely to face financing constraints, exhibit higher sensitivities of under-investment to free cash flow.*

Second, the positive correlation between investment and cash flow may reflect two types of agency problems: those between controlling shareholder and minority investors, and those between managers and shareholders (Jensen 1986; Stulz 1990; Pawlina & Renneboog 2005). In the Chinese context, given the weak legal system, the high restriction of share trading, and the prevalence of dominant shareholders, the first type of agency problems has been found to be prevalent (Liu & Lu, 2007; Jiang *et al*., 2010). The risk of controlling shareholders expropriating resources from minority investors (tunneling) is in fact severe. As a result, controlling shareholders are likely to 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 (and in particular are more likely to be subject to tunneling), the more free cash flow they have, the more they prefer to invest, which could lead to over-investment. A positive relationship between over-investment and free cash flow can hence be interpreted as evidence of the presence of agency problems. We refer to this as the agency costs (*AC*) hypothesis (*H2*):

> *H2: Agency Cost (AC) Hypothesis: Firms which are ex-ante more likely to face agency problems, exhibit higher sensitivities of over-investment to free cash flow.*

Taken together, financial constraints and agency problems can prevent firms from making optimal investment decisions. In other words, both financial constraints and agency problems may increase the sensitivity of investment expenditure to free cash flow and induce investment inefficiency. To discriminate between these two scenarios within the Chinese context, we test hypotheses *H1* and *H2*. Both hypotheses are focused on the sensitivity of abnormal 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). In the two sections that follow, we outline the methodology that we adopt to test these two hypotheses.

3. Methodology used to measure abnormal investment and free cash flow

3.1. A framework to measure abnormal investment and free cash flow

We measure both under- and over-investment (abnormal investment) and free cash flow (*FCF*) using Richardson's (2006) accounting-based framework. 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[5]. $I\_total_{i,t}$ 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.

[Insert Fig. 1]

New investment expenditure ($I\_new_{i,t}$) can be further split into two components: expected investment expenditure in new positive NPV projects ($I^e\_new_{i,t}$), which is described in the next sub-section, 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*)[6]. 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.

[5] It should be noted that Richardson (2006) also includes acquisitions and Research and Development (R&D) expenditure in his proxy for total investment. We chose to use a more parsimonious proxy for two reasons. The first is that capital expenditure is generally used in the finance and economics literatures as a proxy for investment (Hubbard, 1998). The second is that R&D expenditure is not available in our data. Contrary to us, Richardson (2006) also includes R&D expenditures in his proxy for free cash flow.

[6] The reason why we deduct expected investment expenditure ($I^e\_new_{i,t}$) rather than actual CAPEX to calculate FCF is because actual CAPEX can be influenced by financial constraints or agency costs.

3.2. 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 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 debt to total assets, we estimate the following equation:

$$I\_new_{i,t} = a_0 + a_1 I\_new_{i,t-1} + a_2 Cash_{i,t-1} + a_3 Q_{i,t-1} + a_4 Size_{i,t-1} + a_5 Age_{i,t-1} + a_6 ROA_{i,t-1} + a_7 Leverage_{i,t-1} + v_i + v_t + v_j + v_p + v_{j,t} + \varepsilon_{i,t} \quad (1)$$

where the subscript *i* indexes firms; *t* indexes years (*t*=1998-2014); *j*, industries; and *p*, provinces. 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).

The error term in Eq. (1) is made up of five components. v_i is a firm-specific effect; v_t, a time-specific effect, which we control for by including time dummies capturing business cycle effects; v_j, is an industry-specific effect, which we take into account by including industry dummies; v_p, is a province-specific effect capturing uneven developments across different provinces, which we control for by including province dummies; and $v_{j,t}$ takes into account industry-specific business cycles, which we control by including industry dummies interacted with time dummies. Finally, $\varepsilon_{i,t}$ is an idiosyncratic component.

Estimates of Eq. (1) obtained using the fixed-effects estimator (Fe) and the system GMM estimator (Blundell & Bond, 1998) are presented and discussed in the Appendix. The

[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. 2011; 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 market value of net debt divided by the book value of total assets. Our results were robust to using the growth of real sales instead of Tobin's *Q* to proxy for investment opportunities (Konings et al. 2003). This test is motivated by the fact that in the Chinese context, Tobin's *Q* may be an imperfect measure of investment opportunities.

[9] As firms in a less developed market may not make investment decisions based on market valuation (Wang et al. 2009), contrary to Richardson (2006), we use the return on assets (ROA) instead of stock returns in our dynamic investment model. See the Appendix for complete definitions of all variables.

fitted values of Eq. (1) can be interpreted as a proxy for optimal investment ($I^e\_new_{i,t}$)[10]. 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.

We next test whether there exists a statistically significant relationship between abnormal investment and *FCF* and, if it does, whether it stems from financing constraints and/or agency costs.

4. Baseline specifications

4.1. *Main specification*

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

$$I^u\_new_{i,t} = a_0 + a_1 Dum_{FCF>0} + a_2 FCF_{i,t} * Dum_{FCF<0} + a_3 FCF_{i,t} * Dum_{FCF>0} + v_i + v_t + \varepsilon_{i,t} \quad (2)$$

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 (under-investing) firms are those who have positive (negative) abnormal investment ($I^u\_new_{i,t}$). We then investigate whether the sensitivity of $I^u\_new_{i,t}$ to *FCF* differs for firms facing positive and negative *FCF*, whereby the former are more likely to be affected by agency problems, while the latter are more likely to suffer from financing constraints[11]. To this end, we interact *FCF* with the dummy $Dum_{FCF>0}$ ($Dum_{FCF<0}$), which is equal to 1 if the firm has positive (negative) free cash flow, and 0 otherwise. In accordance with the financing constraints hypothesis (*H1*), we expect a_2 to be positive and precisely determined for under-investing firms, while, in line with the agency costs hypothesis (*H2*), a_3 should be positive and significant for over-investing firms[12]. We also include the dummy $Dum_{FCF>0}$ in the regression, to account for the direct effect that it

[10] All our results were robust to estimating a more parsimonious version of Eq. (1) only including lagged investment, Q, and the dummies.

[11] Because free cash flow is defined as operating cash flow net of depreciation and amortization and net of $I^e\_new_{i,t}$, positive sensitivities of abnormal investment to free cash flow are unlikely to be caused by free cash flow picking up investment opportunities. Our results were generally robust to estimating a dynamic version of Eq. (2) and Eq. (3).

[12] It is important to note that the same firm may face both financial constraints and agency costs at the same time. However, we believe that financing constraints are more pronounced for under-investing firms with negative free cash flow, and that agency costs are more pronounced for over-investing firms with positive free cash flow. See footnotes 21 and 27 for a further discussion of this point.

might have on corporate investment. Finally, we control for business cycle effects.[13]

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

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

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

where *Dum* represents a dummy 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 measured using different criteria, with the aim of investigating the extent to which different groups of firms have different sensitivities of under- and over-investment to free cash flow. These further tests should enable us to shed more light on whether the financing constraints and agency costs hypotheses can explain investment inefficiency in the Chinese context. We estimate Eq. (2) and Eq. (3) using the fixed effects (Fe) estimator to control for time-invariant firm-specific heterogeneity.[14]

5. Main features of the data and descriptive statistics

5.1. The dataset

The data used in this paper are drawn from the China Stock Market and Accounting Research (CSMAR) Database and China Center for Economics Research (CCER) Database. They cover Chinese companies that issue A-share stocks on either the Shanghai Stock Exchange (SHSE) or the Shenzhen Stock Exchange (SZSE), during the period 1998-2014. We exclude financial institutions since the operating, investing and financing activities of these firms are distinct from others. We further winsorize observations in the one percent tails for the main

[13] We do not include industry- and province-specific effects in Eq. (2) and Eq. (3) because we estimate these equations using a fixed-effects estimator and these effects would be cancelled out through the differencing process. Furthermore, industry-specific business cycle effects do not appear in Eq. (2) and Eq. (3) because some of the dummies take on the value 1 for all observations in a cluster, and 0 otherwise (a singleton indicator). This causes singular outer-product-of-gradients (OPG) variance matrices in computing the robust standard errors, which therefore makes it impossible to compute an overall model F-statistic.

[14] 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.

regression variables 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).

Our final panel consists of 2,113 listed firms, which corresponds to 22,373 firm-year observations. The number of firm-year observations of each firm varies from three to seventeen, with number of observations varying from a minimum of 576 in 1998 to a maximum of 2,026 in 2012.[15]

5.2. Initial summary statistics

In order to study the relationship between abnormal (under- or over-) investment and free cash flow, we partition firm-years into 4 sub-groups: Group 1 (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*). These groups are illustrated in Fig. 2. Means and medians for the entire sample and four sub-samples based on their abnormal investments and free cash flow are presented in Table 1.

It can be seen that relative to total assets, the average total investment and new investment expenditure in our sample are respectively 5.8% and 2.8%. 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 -0.01. This small value might suggest that listed firms in China are short of free cash flow, which could be due to financial constraints.

[Insert Table 1 and Fig. 2]

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 observe that firms in Group 1 (under-investing firms with negative *FCF*) have the highest negative unexpected investments and negative free cash flow, which is in line with the hypothesis according to which, due to financial constraints, firms with negative *FCF* tend to under-invest. As for

[15] See Tables A1 and A2 in the Appendix for details on the structure of our sample. Around 18 percent of firms have the full 17-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.

firms in Group 3 (over-investing firms with positive *FCF*), they have the second highest positive unexpected investment and the highest free cash flow, which is in line with the hypothesis 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 compared to firms in other groups, firms in Group 1 (under-investing firms with negative *FCF*) are relatively younger, smaller, and have lower *ROA* and high 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, and have high Tobin's *Q*, which might suggest higher agency problems.[16]

Finally, it is interesting to note that the number of firm-years in Group 1 (6,355 observations) is larger than that in Group 3 (3,785 observations), suggesting that there are more firms facing financial constraints than firms susceptible to agency problems.

6. Main empirical results

6.1. Baseline results

Table 2 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 estimator (Eq. 2). Columns 1 and 2 are based on estimates of $I^u\_new_{i,t}$ obtained by estimating Eq. (1) with system GMM. 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, which are more likely to suffer from financing constraints (Group 1, column 1); and the over-investing firms with positive free cash flow, which are more likely to suffer from agency problems (Group 3, column 2). These findings support our hypotheses *H1* and *H2*. Similar results are found in columns 3 and 4, which are based on estimates of $I^u\_new_{i,t}$ obtained from fixed effects estimates of Eq. (1) [17].

[Insert Table 2]

[16] The p-values associated with the t-tests and the Wilcoxon rank-sum test show significant differences in these variables between firms in Group 1 and those in Group 3.

[17] With the exception of columns 2 and 4, the p-values associated with the Wald tests show significant differences in the free cash flow coefficients between firms facing negative and positive FCF. Yet, in columns 2 and 4, only the coefficient associated with FCF interacted with the dummy for FCF>0 is statistically significant.

6.2. Robustness tests

6.2.1. Using a quantile estimator

To test the robustness of our results, we estimate Eq. (2) using a quantile estimator with fixed effects. Specifically, we run separate regressions for the 20th, 50th and 80th quantiles of the distribution of $I^{u}\_new_{i,t}$, and differentiate the *FCF* coefficients across firms with negative and 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. The results, which are reported in columns 1 to 6 of Table 3, 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*.

More specifically, for under-investing firms, we observe a decreasing trend of the coefficients associated with $FCF*Dum_{FCF<0}$ when we move from the smallest quantile of abnormal investment (0.090) to the largest (0.033). This suggests that for firms with free cash flow below their optimal level, more under-investment goes hand in hand with higher *FCF* sensitivities.

For over-investing firms, we find evidence of an increasing trend for the coefficients associated with $FCF*Dum_{FCF>0}$ moving from the smallest quantile of abnormal investment (0.020) to the largest (0.061). This indicates that for firms with free cash flow above their optimal level, more over-investment is accompanied by higher *FCF* sensitivities. The *p*-values associated with the test for the equality of the free cash flow coefficients between firms with positive and negative *FCF* show that these differences are generally significant. This confirms the robustness of our previous results.

[Insert Table 3]

6.2.2. Alternative ways of measuring under-/over-investing firms

Bergstresser (2006) notes that the distinction between under-investment and over-investment based on Richardson (2006)'s approach might have some flaws as, in a dynamic setting, ex-post abnormal investment may follow ex-ante abnormal investment, causing mean reversion. To take this problem into account, as a further robustness test, predicted abnormal investment is obtained using the fitted values from the model in Eq. (1) estimated in each year using OLS. The results, reported in columns 7 and 8 of Table 3, are consistent with our prior findings: positive and significant coefficients on free cash flow are observed only for under-investing firms with negative *FCF* and over-investing firms with positive *FCF.*

Alternatively, we rank the values of firms' abnormal investment ($I^{u}\_new_{i,t}$) by magnitude within each industry and year, and classify a firm as under-investing (over-investing) when its abnormal investment lies above (below) the median of the distribution. The results, reported, in columns 9 and 10 of Table 3, confirm once again our hypotheses.

Finally, we use the approach proposed by 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[18]. As for free cash flow (*FCF'*), we compute it as the difference between cash flow generated from assets in place ($CF_{AIP,i,t}$) for each firm in each year and the industry median level in that same year ($CF_{AIPj,t}$)[19]. Accordingly, *FCF'* can be either positive or negative.

To examine the relationship between these alternative measures of (under- or over-) investment and free cash flow, we estimate the following dynamic variant of Eq. (1), where $Dum_{FCF'>0}$ is a dummy equal to 1 if the firm has a positive $FCF'_{i,t}$, and 0 otherwise:

$$\begin{aligned} I^{u\prime}\_new_{i,t} = {} & a_0 + a_1 I^{u\prime}\_new_{i,t-1} + a_2 Dum_{FCF'>0} + a_3 FCF'_{i,t} * Dum_{FCF'<0} \\ & + a_4 FCF'_{i,t} * Dum_{FCF'>0} * + a_5 Cash_{i,t-1} + a_6 Q_{i,t-1} + a_7 Size_{i,t-1} + a_8 Age_{i,t} \\ & + a_9 ROA_{i,t-1} + a_{10} Leverage_{i,t-1} + v_i + v_t + v_j + v_p + \varepsilon_{i,t} \quad (4) \end{aligned}$$

We use the system GMM approach (Blundell & Bond, 1998) to estimate Eq. (4), accounting for the possible endogeneity of the regressors, as well as for firm-specific and time-invariant heterogeneity. The results are reported in Table 4. In line with our previous findings, they show that the impact of free cash flow on under-investment is only significantly positive for the firms with negative $FCF'_{i,t}$ (column 1), whilst the impact of fee cash flow on over-investment is only significant for firms with positive $FCF'_{i,t}$ (column 2).

[Insert Table 4]

In summary, we have constructed measures of under- and over-investment and free cash flow, and generally found a positive and significant relationship between investment

[18] As the expected investment estimate based on Bates' method (2005) is an out-of-sample estimate in a group of peer companies, this can tackle the concern that the expected investment based on Richardson's (2006) method might be endogenous. If measuring abnormal investment using both methods delivers similar results, we can conclude that our main results based on Richardson's (2006) model are not driven by endogeneity.

[19] $CF_{AIP,i,t}$ is calculated as ($CFO_{,i,t}$ - $I\_main_{,i,t}$).

and free cash flow only 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 the financing constraints (*FC*) and agency costs (*AC*) hypotheses, 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.

7. To what extent does heterogeneity in the degree of financing constraints and agency costs faced by firms affect the sensitivities of under- and over-investment to free cash flow?

7.1. The financing constraints (FC) hypothesis of under-investment

7.1.1. Measuring financing constraints using the Kaplan and Zingales (KZ) index and the Whited and Wu (WW) index

We now provide further tests of the financing constraints hypothesis of under-investment. To this end, we restrict our sample to under-investing observations, and use two indexes to measure firm-specific levels of the constraints: the Kaplan and Zingales (*KZ*) index (Lamont *et al.* 2001) and the Whited and Wu (*WW*) index (Whited & Wu 2006).

Focusing on the former, we note that Kaplan & Zingales (1997) classify their sample of US firms into five groups on the basis of their degree of financial constraints based on 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 estimation of the categories of constraints on the following five financial ratios, using the original *KZ* sample: cash flow (CF_t, net income + depreciation), dividends (DIV_t), cash and cash equivalents ($Cash_t$) all 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 estimated coefficients that they obtain to construct the Kaplan and Zingales (*KZ*) index of financial constraints in the following way:

$$\begin{aligned} KZ = & -1.002^* CF_t / K_{t-1} + 0.283^* Q_t + 3.139^* Debt_t / TK_t \\ & -39.368^* \left(DIV_t / K_{t-1} \right) - 1.315^* Cash_t / K_{t-1} \end{aligned} \quad (5)$$

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

We also use an alternative index of constraints (the *WW* index), constructed by Whited and Wu (2006). This index is a linear function of the following 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 ($LNTA_t$, 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 as follows, using the estimated coefficients from Whited and Wu's (2006) specification:

$$\begin{aligned} WW = & -0.091 * CF_t / BA_{t-1} - 0.062 * DIVPOS_t + 0.021 * TLTD_t / CA_{t-1} \\ & -0.044 * LNTA_t - 0.035 * SG_t + 0.102 * ISG_t \end{aligned} \tag{6}$$

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

Table 5 presents summary statistics of the two firm-specific indexes of financing constraints across the four groups of firms based on their abnormal investments and free cash flow. We conduct statistical tests for equality of both sample means (*t*-test) and sample medians (Wilcoxon rank-sum test) across groups of firms.

[Insert Table 5]

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 medians of the indicators between the two groups are generally significant at the 5% level. 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 free cash flow for the firms in Group 1.

In order to investigate the extent to which the degree of financial constraints faced by firms affects the sensitivity of under-investment to free cash flow, Table 6 presents fixed effects estimates of Eq. (3), which tests 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, following Almeida *et al.* (2004), we classify firms as facing relatively low (*Low_FC*=1), medium (*Medium_FC*=1), and high (*High_FC*=1) financial constraints in a given year if their *KZ* or *WW* index 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.[20] In this way, we allow firms in our sample to transit among financial constraint categories each year. In columns 2 and 4, we use a 50% threshold.

[Insert Table 6]

Columns 1 and 3 reveal that for under-investing firms, the higher the *KZ* index or the *WW* index, the larger the sensitivities of under-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 reported at the foot of the Table reject the equality of the coefficients of free cash flow between more and less financially constrained groups. This supports our Hypotheses 1: for under-investing firms, the sensitivities of investment to free cash flow increase with the firm's degree of financial constraints[21].

7.1.2. Further tests: Measuring financing constraints using size and age

Next, we use different variables based on the *a priori* likelihood that a firm faces financial constraints to test our Hypothesis 1. If our hypothesis holds, we should expect a stronger relationship between under-investment and free cash flow for firms which are *a priori* more likely to face financial constraints. Specifically, we focus on firms' size (total real assets) and age, which have been commonly used in the literature to partition firms into *a priori* more and less likely to face financing constraints. Small and young firms might not have a sufficiently long track record, leading to increased asymmetric information. In addition, small

[20] 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.

[21] Estimating similar regressions on the sample of over-investing firms delivered similar coefficients across the groups of firms characterized by different degrees of financing constraints. These results, which are not reported for brevity but available on request, confirm that the FC hypothesis is unlikely to hold for over-investing firms.

and young firms are typically characterized by high idiosyncratic risk and high bankruptcy costs, which might exclude them from credit markets, or make their access to external finance more costly (Gertler & Gilchrist 1994; Beck *et al.* 2005; Clementi & Hopenhayn 2006; Guariglia 2008).

The results are reported in Table 7. In columns 1 and 3, we define a firm as facing a high level of financing constraints (*High_FC*=1) in a given year if its size (column 1) and age (column 3) fall in the top three deciles of the distribution of the assets/age of all firms operating in the same industry as that firm in that year. Similarly, we define as firm-years facing a medium level of financing constraints (*Medium_FC*=1) those observations falling in the middle four deciles of the distribution, and as firm-years facing a low level of financing constraints (*Low_FC*=1), those observations falling in the bottom three deciles of the distribution. In columns 2 and 4, we only consider two categories of firm-years: those facing high and low financing constraints split at the median of real assets (column 2) and age (column 4).

The results in column 1 show a clear increasing trend for the coefficients of free cash flow, moving from large, to medium sized, to small firms. The Wald test reported at the foot of the table shows that the differences in the *FCF* coefficients between large and small firm-years are significant at the 1% level. Hence, using firm size as a criterion of financial constraints also supports our Hypothesis 1. Similar results are obtained when firm are split in two size categories (column 2), and when age is used as a partitioning criterion (columns 3 and 4)[22].

[Insert Table 7]

In summary, the results we obtained using conventional variables as proxies for financial constraints, which suggests that for under-investing firms, the sensitivities of investment to free cash flow increase with the firm's degree of financial constraints faced by firms, are highly consistent with our previous findings and Hypothesis 1.

7.2. The agency costs (AC) hypothesis of over-investment

7.2.1. Measuring agency costs using the ratio of other receivables to total assets and the difference between the blockholder's controlling and ownership rights

We now move on to testing the agency costs (*AC*) hypothesis of over-investment. To this end,

[22] Yet, in column 3, the Wald test shows that the difference in the FCF coefficients between older and younger firm-years is not statistically significant.

we focus on over-investing observations. It has been argued that the conflict between controlling shareholders and minority investors (tunneling) is widespread in emerging markets like China since most listed companies tend to have a concentrated ownership structure[23]. 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).

Our initial measures of agency costs emphasize therefore the conflict between controlling shareholders and minority investors. Specifically, following Jiang *et al.* (2010), we first use the ratio of other receivables to total assets (*OREC*) to measure how likely controlling shareholders are of expropriating minority investors[24]. A higher value of *OREC* implies a higher level of expropriation and, hence, a higher level of agency costs. Average other receivables in our sample constitute about 4% of total assets, and the maximum value of the ratio is around 50%, suggesting a high level of agency costs.

Next, inspired by Claessens *et al.* (2002), Lemmon and Lins (2003), and Jiang *et al.* (2010), we proxy the likelihood to tunnel using a dummy equal to 1 if the firm exhibits a difference between its largest shareholder's (also known as blockholder) controlling right (*C*) and cash flow ownership right (*O*), and 0 otherwise. In the presence of a divergence between her/his controlling right and ownership right, the blockholder may control the firm by only holding a relatively low proportion of shares. This is made possible through pyramid structures and cross-holding among firms, which often lead to the expropriation of minority shareholders.

Table 8 presents summary statistics of our two firm-specific indicators of agency costs after we categorize firms into the four groups based on their abnormal investments and free cash flow. As in Table 5, we conduct statistical tests for the equality of both sample means (t-test) and sample medians (the Wilcoxon rank-sum test) across groups.

[Insert Table 8]

Comparing Group 3 (over-investing firms with positive *FCF*) with Group 4 (over-investing firms with negative *FCF*), we observe that the mean level of agency costs measured by both *OREC* and the percentage of firm-year observations exhibiting a difference between the blockholder's controlling and ownership rights (*C/O*) are higher for the former group. As

[23] In China, the ownership of a single dominant shareholder is typically much larger than that of the second shareholder.

[24] According to Jiang et al. (2010), "during 1996-2006, tens of billions of 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". This variable is also used by Quian and Yeung (2015).

for the median, it is higher for Group 3 when we focus on *OREC*, but equal to 0 for both groups of firms when we focus on *C/O* [25]. These statistics suggest that firms in Group 3 suffer from higher agency costs than those in Group 4. This is not surprising as these firms dispose of a higher *FCF*, which they can use for tunneling purposes.

To explore this issue further, Table 9 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 measured using *OREC* (columns 1 and 2) and *C/O* (columns 3). Specifically, in column 1, we classify a firm as facing relatively low (*Low_AC*=1), medium (*Medium_AC*=1), or high (*High_AC*=1) agency costs in a given year if its *OREC* ratio in that year falls respectively in the bottom three, the medium four, or the top three deciles of the corresponding *OREC* ratios of all firms operating in the same industry the firm belongs to in that year. In column 2, we use a 50% threshold. In both cases, we observe that the sensitivity of investment to free cash flow is positive and significant at the 5% level or higher only for firms with a high degree of agency costs.

In column 3, we define a firm as facing high (low) agency costs in a given year if it exhibits (does not exhibit) a divergence between its blockholder's controlling ownership and cash flow ownership. Only those firms characterized by a divergence exhibit a positive and significant sensitivity of over-investment to free cash flow[26]. We can therefore conclude that our results generally provide further support to the agency costs (*AC*) hypothesis[27].

[Insert Table 9]

7.2.2. Further tests: Measuring agency costs using blockholder's and CEO shareholding

To better understand the extent to which agency costs matter for the sensitivity of abnormal investment to free cash flow, in this section, we verify whether our results are robust to partitioning firms on the basis of other variables which have been used in the literature to proxy for the presence of agency problems (Ang *et al.* 2000, Jiang *et al.* 2010).

Our first alternative measure focuses on the percentage of shares controlled by the largest shareholder (Blockholder$_{i,t}$). It has been argued that concentrated ownership is

[25] The statistical tests indicate, however, that only the differences in the means and medians of OREC between the two groups are statistically significant. In the case of C/O, this is not surprising since the median value of the dummy equal to 1 if the firm exhibits a divergence between its blockholder's controlling and ownership rights, and 0 otherwise, is equal to zero for both Group 3 and Group 4.

[26] It should be noted, however, that the Wald tests do not reject the equality of the coefficients of free cash flow between firms with high and low agency costs.

[27] Estimating similar regressions on the sample of under-investing firms delivered similar coefficients across the groups of firms characterized by different levels of agency costs. These results, which are not reported for brevity but available on request, confirm that the AC hypothesis is unlikely to hold for under-investing firms.

positively associated with firms' agency costs. As mentioned earlier, agency costs, arising from the conflict of interest between the controlling shareholder and minority investors, may become apparent when the controlling shareholder extracts private benefits from minority shareholders (tunneling). The ability of the primary owner to expropriate minority investors is expected to increase with his/her ownership. When the interests of the controlling shareholder are not aligned with those of other investors, there is in fact good reason to believe that the former may use his/her power to influence the firm's investment decisions to promote his/her 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, as discussed in the previous sub-section, 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 (Jiang *et al.* 2010). Additionally, investors with a large ownership stake generally have a strong interest in the firm's profit maximization and have 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 is therefore definitely an important determinant of the overall agency costs faced by the firm, but whether it affects these agency costs positively or negatively is ambiguous.

In order to test the extent to which the blockolder's shareholding affects the sensitivity of over-investment to free cash flow, 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 the blockolder's shareholding of firm *i* in year *t* lies respectively in the bottom three, the middle four, and the top three deciles of the distribution of the corresponding shareholding 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 over-investment regressions.

The results are reported in column 1 of Table 10. Interestingly, we observe 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* initially increases with the shares held by the largest shareholder, then decreases.[28] 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 the percentage of shares controlled by the largest shareholder and agency problems. This finding is in line with Jiang *et al.* (2010), according to which agency costs indicated by tunneling are highest when the largest shareholder owns a medium percentage (30%) of the firm's shares.

Our next measure of agency costs is motivated by international evidence that agency costs may arise when managerial interests are not in line with those of the firm's shareholders. Managerial ownership 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.[29] 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 the top executives, including the CEO, 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 over-investment regressions.

The results appear in column 2 of Table 10. 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 and suggests that managerial ownership is negatively associated with the firm's principal-agent problems.[30] Thus, for over-investing firms, agency problems between entrenched managers and shareholders contribute to higher sensitivities of over-investment to free cash flow.

[Insert Table 10]

In summary, these findings are strongly aligned with our previous results and

[28] 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.

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

[30] In our sample, there is often separation between management and ownership. In addition, those few managers who are also shareholders in their company only hold a small percentage of their own shares. Relative low ownership stakes prevent managers from pursuing their own interests at the expense of shareholders, as they are supervised and controlled by the board, as well as by capital markets.

Hypothesis 2: The sensitivity of abnormal investment to free cash flow rises with the degree of agency costs faced by over-investing firms.

8. Conclusions

In this paper, we provide a portrait of the nature and balance of financial constraints and agency problems in China, giving a picture of the extent to which the economy has suffered from efficiency losses due to both under- and over-investment. Two significant conclusions emerge from our main findings: On the one hand, the limited access to capital markets which characterizes many Chinese firms leads to significant under-investment. On the other hand, the weak corporate governance structures lead managers or controlling shareholders to over-invest their free cash flow in projects with negative NPV.

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. In particular, since China's financial system is still dominated by under-developed state-owned banks, in order to sustain the rapid growth of the 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.

In addition, 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 between controlling shareholders and minority shareholders, and to increase the intensity of monitoring by other shareholders or independent institutions. This is particularly important at the local level. Imposing constraints or more restrictive regulations to local government bureaucrats to prevent them from making adverse decisions such as expropriation and misappropriation of funds, which ultimately lead to over-investment, should therefore be on the political agenda.

Positive steps in both directions have already been taken. With regards to financing constraints, the recent reforms to the financial system documented in Borst and Lardy (2015) are likely to have played an important role in making finance more accessible, to the extent that Lardy (2014) documents a significant increase in the flow of loans to the previously financially discriminated against private sector in recent years. Focusing on agency costs, Cumming et al. (2012) and Hou et al. (2012) argue that the 2005 split share structure reform, which allowed restricted shares held mainly by state shareholders to become tradable, and permitted equity-based compensation for executives or directors, enhanced the incentives of controlling state shareholders to monitor managers, ensuring they were disciplined against opportunistic behavior and refrained from the expropriation of minority shareholders[31]. Yet, despite these positive steps, more work needs to be done to completely eradicate investment inefficiency from the Chinese economy.

Appendix

1. Structure of the panel

Table A1 illustrates the structure of our panel. Table A2 presents the per year distribution of observations in our dataset.

2. Definitions of the variables used

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

***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).

[31] To provide evidence on the effectiveness of these positive steps in reducing investment inefficiency in China, we investigated whether the sensitivities of both under- and over-investment to free cash flow change before and after 2008. We found a significant decline in the sensitivities of under-investment to free cash flow in the post-2008 period. Yet, these sensitivities remained positive and highly significant, which suggest that financing constraints did not disappear. As for the sensitivities of over-investment to free cash flow, they became insignificant in the post-2008 period. These results are not reported for brevity, but are available upon request.

I_new: total investment less investment to maintain existing assets in place (*I_total* - *I_main.*).
I^e_new: expected investment expenditure in new positive NPV projects.
I^u_new: unexpected or abnormal investment expenditure.
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)*.
Deflator: The GDP deflator, which is obtained from the National Bureau of Statistics of China, is used to convert all variables to real terms.
Industries: 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; Finance and insurance. Following previous literature, we exclude the Finance & insurance sector from our study.
Provinces: There are 31 provinces in China: Coastal provinces (Beijing, Fujian, Guangdong, Hainan, Hebei, Jiangsu, Liaoning, Shandong, Shanghai, Tianjin, and Zhejiang); Central provinces (Chongqing, Anhui, Heilongjiang, Henan, Hubei, Hunan, Jiangxi, Jilin, and Shanxi); and Western provinces (Gansu, Guangxi, Guizhou, Neimenggu, Ningxia, Qinghai, Shanxi, Sichuan, Xinjiang, and Yunnan).

3. Estimates of the dynamic model of investment expenditure (Eq. 1)

Table A3 provides the fixed effects (Fe), and system GMM estimates of our dynamic model of investment expenditure outlined in Eq. (1). It is worth noting that in a dynamic panel setting, the fixed effects estimator suffers from endogeneity problems. Our preferred estimator is therefore the system Generalized Method of Moments (system GMM) 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. Lagged values of the independent variables are used as instruments to control for the potential endogeneity of the regressors (Baum 2006; Roodman 2009).

In order to evaluate the validity of instruments and the correct specification of the model, two diagnostic tests are used in our GMM estimations. The first is the Hansen (*J*) test for over-identifying restrictions. The second, *m(n)*, tests for the n^{th} order serial correlation of the differenced residuals, and provides a further test for the validity of the specification of the model and the legitimacy of instruments. If the *m(n)* test rejects the null hypothesis, the instruments need to be lagged at least *n*+1 times. Since our models generally reject the null hypothesis of no second-order autocorrelation when the instruments are lagged twice, levels of the 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 2009).[32]

[Insert Table A3]

Column 1 reports the fixed effects estimates, which remove the effect of time-invariant firm characteristics. The ρ coefficient indicates that around 33% of the total error variance is explained by unobserved heterogeneity. Column 2 presents the estimates obtained using our preferred system GMM estimator, which takes unobserved heterogeneity and endogeneity simultaneously into account. More specifically, we treat $I\_new_{i,t}$, Cash $_{i,t}$, $Q_{i,t}$, $Size_{i,t}$, $ROA_{i,t,}$ and $Leverage_{i,t}$ as potentially endogenous variables and instrument them using their own values lagged 3 to 6 times. First-differences of these same variables lagged twice are used as additional instruments in the level equations. Statistical diagnostics (the Hansen *J* test and the *m(3)* test) do not reject the null hypothesis of instrument validity and/or model specification. The system GMM estimate of the coefficient associated with the lagged dependent variable, $I\_new_{i,t-1}$, is 0.411. This positive and precisely determined 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 and *ROA*, and declines with age. It is interesting to note that Tobin's *Q* exhibits a poorly determined coefficient, while *ROA* has a positive and precisely determined coefficient. The 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.

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

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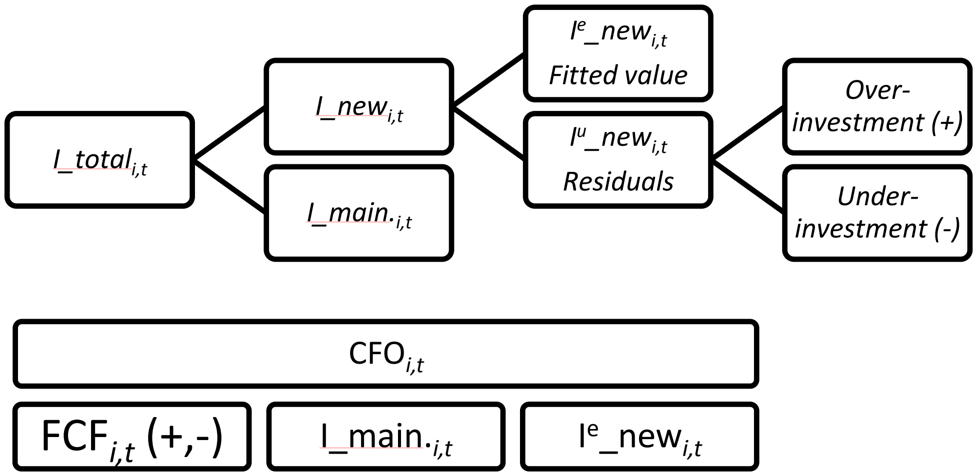

Note: $I\_total_{i,t} = CAPEX_{i,t} - SalePPE_{i,t}$ (Capital expenditure- sale of property, plant, and equipment);

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

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

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

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

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

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

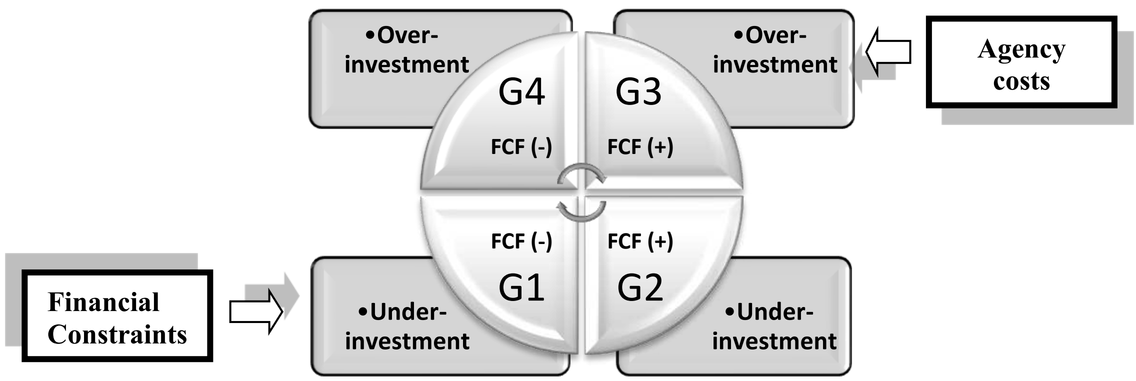

Fig. 2 Four groups of firms based on their abnormal investment and free cash flow (*FCF*)

Table 1
Sample means and medians (in parentheses)

	G1	G2	G3	G4	Total	Diff (G1 vs. G3)
I_total	0.0353	0.0304	0.0826	0.1034	0.0584	0.00***
	(0.0277)	(0.0248)	(0.0714)	(0.0918)	(0.041)	0.00***
I_new	0.0053	-0.0034	0.0522	0.0769	0.0282	0.00***
	(0.0025)	(-0.0025)	(0.0401)	(0.0659)	(0.0135)	0.00***
I^e_new	0.034	0.0213	0.0154	0.0387	0.0282	0.00***
	(0.0298)	(0.0182)	(0.0139)	(0.0357)	(0.0242)	0.00***
I^u_new	-0.0287	-0.0246	0.0368	0.0383	0	0.00***
	(-0.0233)	(-0.0201)	(0.0224)	(0.0239)	(-0.0061)	0.00***
FCF	-0.0622	0.0552	0.0569	-0.0562	-0.0079	0.00***
	(-0.0462)	(0.0408)	(0.0425)	(-0.0439)	(-0.0077)	0.00***
Cash	0.168	0.194	0.142	0.139	0.163	0.00***
	(0.136)	(0.16)	(0.118)	(0.12)	(0.133)	0.00***
Q	1.885	2.049	2.016	1.818	1.937	0.00***
	(1.498)	(1.583)	(1.579)	(1.486)	(1.527)	0.00***
Size	20.62	20.73	20.79	20.84	20.73	0.00***
	(20.49)	(20.59)	(20.68)	(20.71)	(20.6)	0.00***
Age	9.1	10.3	10.6	9.3	9.8	0.00***
	(8)	(10)	(10)	(9)	(9)	0.00***
ROA	0.014	0.045	0.039	0.025	0.029	0.00***
	(0.025)	(0.041)	(0.039)	(0.028)	(0.032)	0.00***
Leverage	0.215	0.171	0.201	0.239	0.207	0.00***
	(0.205)	(0.147)	(0.182)	(0.231)	(0.192)	0.00***
Observations	6,355	4,820	3,785	4,230	19,190	

Notes: Firms are classified into four groups according their level of abnormal investment and *FCF* (free cash flow): Group 1 (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*). 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 debt 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 the GDP deflator. See the Appendix for complete definitions of all variables. *Diff* is the *p*-value associated with the t-test and the Wilcoxon rank-sum test for differences in means and equality of medians of corresponding variables between firms in Group 1 and those in Group 3. *, **, *** indicates significance at the 10%, 5%, and 1% level, respectively.

Table 2
(Under- or over-) investment-free cash flow sensitivities

Dependent variable: $I^u\_new_{i,t}$	(1) Under_gmm	(2) Over_gmm	(3) Under_fe	(4) Over_fe
$Dum\_FCF_{>0}$	0.001**	-0.001	0.001	-0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
$FCF*Dum\_FCF_{<0}$	0.060***	0.014	0.044***	0.008
	(0.005)	(0.015)	(0.005)	(0.012)
$FCF*Dum\_FCF_{>0}$	0.015**	0.028**	0.013*	0.027**
	(0.007)	(0.014)	(0.007)	(0.011)
Firm-fixed effects	yes	yes	yes	yes
Year-fixed effects	yes	yes	yes	yes
R^2	0.35	0.37	0.39	0.40
Adjusted R^2	0.21	0.17	0.24	0.20
P	0.36	0.37	0.39	0.39
Prob>F(overall fit)	34.27	8.23	18.84	6.84
Diff	0.00***	0.49	0.00***	0.27
Observations	11,175	8,015	10,541	8,649

Notes: All 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 Richardson's (2006) method, where over-investing (under-investing) firms are characterized by positive (negative) abnormal investment ($I^u\_new_{i,t}$). *FCF* is free cash flow which is computed by subtracting the optimal level of 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 negative ($FCF<0$), 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 is positive ($FCF>0$), and 0 otherwise. *Under_gmm* (*Over_gmm*) and *Under_fe (Over_fe)* refer to abnormal investment obtained by estimating Eq. (1) using the system GMM and the fixed effects estimator, respectively (see Table A3 in the Appendix). *Diff* is the *p*-value of the Wald statistic 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 3
(Under- or over-) investment-free cash flow sensitivities: further tests

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dependent variable:	Under_gmm	Over_gmm	Under_gmm	Over_gmm	Under_gmm	Over_gmm	Under_gmm	Over_gmm	Under_gmm	Over_gmm
I^u_new$_{i,t}$	20th Quant	20th Quant	50th Quant	50th Quant	80th Quant	80th Quant			<50th	>50th
	Most under-investment —› *Most over*-investment									
Dum_FCF$_{>0}$	0.001	-0.001	0.001	-0.001	0.001*	-0.004	0.001	-0.002	0.002**	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)
FCF*Dum_FCF$_{<0}$	0.090***	0.015*	0.054***	0.006	0.033***	0.004	0.043***	0.007	0.057***	0.012
	(0.016)	(0.008)	(0.007)	(0.013)	(0.005)	(0.022)	(0.005)	(0.017)	(0.005)	(0.013)
FCF*Dum_FCF$_{>0}$	0.020	0.020***	0.013**	0.043***	0.009	0.061**	0.004	0.028*	0.015**	0.036***
	(0.015)	(0.007)	(0.006)	(0.012)	(0.007)	(0.027)	(0.006)	(0.017)	(0.007)	(0.012)
Firm-fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year-fixed effects	no	no	no	no	no	no	yes	yes	yes	Yes
(Pseudo) R^2	0.01	0.01	0.01	0.01	0.01	0.01	0.42	0.41	0.38	0.34
Adjusted R^2							0.31	0.24	0.22	0.16
ρ							0.37	0.40	0.36	0.35
Prob>F(overall fit)							19.77	11.95	35.77	5.72
Diff	0.00***	0.66	0.00***	0.04**	0.00***	0.10*	0.00***	0.40	0.00***	0.19
Observations	11,175	8,015	11,175	8,015	11,175	8,015	13,119	8,678	9,599	9,591

Notes: The specifications in columns 1 to 6 were estimated using a quantile estimator with fixed effects, and those in columns 7 to 10, using a fixed effects estimator. For the quantile regression, we run separate regressions for the 20th, 50th, 80th quantiles of abnormal investment with bootstrapped standard errors (1000 repetitions). 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 using Richardson's (2006) method, where in columns 1 to 6, under-investing (over-investing) firms are characterized by positive (negative) abnormal investment ($I^u\_new_{i,t}$). In columns 7 and 8, under-/over-investment are obtained from the estimation of Eq (1) separately in each year using OLS. In columns 9 and 10, we define under- (over-investment) when in a given year, firm *i*'s abnormal investment is below (above) the median value of the distribution of the abnormal investment of all firms belonging to the same industry as firm *i* in that year. *FCF* is computed by subtracting the optimal level of cash flow from cash flow from operating activities (CFO). Du*m_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 negative (*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 is positive (*FCF>0*), and 0 otherwise. For the fixed effects regression in columns 7 to 10, ρ represents the proportion of the total error variance accounted for by unobserved heterogeneity. *Diff* is the *p*-value of the Wald statistic 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 4
(Under- or over-) investment-free cash flow sensitivities: using Bates (2005)'s definitions of abnormal investment and free cash flow.

Dependent variable: $I^{u'}\_new_{i,t}$	(1) Under_ gmm	(2) Over_ gmm
$I^{u'}\_new_{i,t-1}$	0.267***	-0.001
	(0.020)	(0.027)
Dum_FCF'$_{>0}$	-0.002	-0.002
	(0.003)	(0.004)
FCF'$_{i,t}$**Dum_FCF'*$_{<0}$	0.091***	0.002
	(0.033)	(0.061)
FCF'$_{i,t}$**Dum_FCF'*$_{>0}$	0.001	0.142***
	(0.037)	(0.052)
$Cash_{i,t-1}$	0.154***	0.182***
	(0.012)	(0.019)
$Q_{i,t-1}$	-0.002*	-0.004**
	(0.001)	(0.002)
$Size_{i,t-1}$	0.001	0.001
	(0.001)	(0.002)
$Age_{i,t}$	0.001***	0.000
	(0.000)	(0.000)
$ROA_{i,t-1}$	0.106***	0.204***
	(0.017)	(0.055)
$Leverage_{i,t-1}$	0.012	0.048**
	(0.008)	(0.019)
Year-fixed effects	yes	yes
Industry-fixed effects	yes	yes
Province-fixed effects	yes	yes
Prob>F(overall fit)	21.31	8.21
Hansen J test (p-value)	0.00***	0.00***
m2/m3 test (p-value)	0.01**	0.12
Diff	0.09*	0.09*
Observations	9,789	9,401

Notes: All specifications were estimated using the system GMM estimator. Test statistics and standard errors (in parentheses) of all variables in the regressions are asymptotically robust to heteroscedasticity. Adopting the method of Bates (2005), the dependent variable is $I^{u'}\_new_{i,t}$, the difference between a firm's new investment expenditure ($I\_new_{i,t}$) in a given year and that of the median firm in the industry in which the firm operates (I_new_t) in that year. Under-investing (over-investing) firms are characterized by positive (negative) abnormal investment ($I^{u'}\_new_{i,t}$). *FCF'*$_{i,t}$ is calculated as the difference between the firm's cash flow generated from assets in place in a given year ($CF_{AIP,i,t}$) and that of the median firm in the industry in which the firm operates in that year ($CF_{AIP,i.}$). *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 (proxied by the firm's industry's median $CF_{AIP,i.}$), and 0 otherwise. *Dum_FCF'*$_{>0}$ is a dummy variable, which is equal to 1 in a given year if a firm's $CF_{AIP,i,t}$ exceeds its optimal level (i.e. the median of the firm's 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. *m2/m3* is a test for (second-) 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 $I^{u'}\_new$, *FCF'*, Cash, Q, *Size*, *ROA,* and $Leverage_{i,t}$ as potentially endogenous variables. Levels of these variables lagged twice or longer are used as instruments in the first-differenced equations and first-differences of these same variables lagged once, as additional instruments in the level equations. *Diff* is the *p*-value of the Wald statistic 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 5

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	-5.131	15.115	-4.672	-0.804	0.866	6,351
Under_ $FCF_{<0}$	WW	-0.941	0.073	-0.986	-0.942	-0.890	6,347
G2	KZ	-5.639	14.554	-5.529	-1.370	0.604	4,819
Under_ $FCF_{>0}$	WW	-0.951	0.073	-0.997	-0.953	-0.900	4,818
Diff (G1 vs. G2)	KZ	0.04**		*Diff* (G1 vs. G2)	0.00***		
(Mean)	WW	0.00***		(Median)	0.00***		
G3	KZ	-3.973	12.692	-3.860	-0.815	0.770	3,782
Over_ $FCF_{>0}$	WW	-0.955	0.080	-1.004	-0.957	-0.900	3,779
G4	KZ	-3.716	11.725	-3.678	-0.846	0.712	4,230
Over_ $FCF_{<0}$	WW	-0.955	0.071	-1.000	-0.956	-0.909	4,227
Diff (G3 vs. G4)	KZ	0.17		*Diff* (G3 vs. G4)	0.83		
(Mean)	WW	0.74		(Median)	0.53		
Total	KZ	-4.719	13.838	-4.425	-0.945	0.752	19,182
	WW	-0.949	0.074	-0.995	-0.951	-0.899	19,171

Notes: KZ and *WW* represent firm-specific levels of financial constraints: the Kaplan and Zingales (*KZ*) index (Lamont *et al.* 2001) and the Whited and Wu (*WW*) index (Whited & Wu 2006). Firms are classified into the following four groups: Group 1 (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 t-test and the Wilcoxon rank-sum test for differences in means and equality of medians of the *KZ* (*WW*) indexes between groups of under-investing firms (Group 1 and Group 2) or between groups of over-investing firms (Group 3 and Group 4). *, **, *** indicates significance at the 10%, 5%, and 1% level, respectively.

Table 6
Under-investment-free cash flow sensitivities: accounting for financial constraints using the *KZ* and *WW* indexes

Dependent variable: $I^u\_new_{i,t}$	*(1)* *KZ_under*	*(2)* *KZ_under*	*(3)* *WW_under*	*(4)* *WW_under*
Medium_FC$_{(30-70)}$	0.001		-0.002***	
	(0.001)		(0.001)	
High_FC$_{(>70)}$	0.003***		-0.002**	
	(0.001)		(0.001)	
$FCF_{i,t}$* *Low_FC$_{(<30)}$*	0.036***		0.036***	
	(0.005)		(0.005)	
$FCF_{i,t}$* *Medium_FC$_{(30-70)}$*	0.050***		0.043***	
	(0.004)		(0.004)	
$FCF_{i,t}$* *High_FC$_{(>70)}$*	0.054***		0.057***	
	(0.005)		(0.005)	
High_FC$_{(<50)}$		0.002***		-0.000
		(0.001)		(0.001)
$FCF_{i,t}$* *Low_FC$_{(<50)}$*		0.040***		0.039***
		(0.004)		(0.004)
$FCF_{i,t}$* *High_FC$_{(>50)}$*		0.054***		0.053***
		(0.004)		(0.004)
Firm-fixed effects	yes	yes	yes	yes
Year-fixed effects	yes	yes	yes	yes
R^2	0.35	0.35	0.35	0.35
Adjusted R^2	0.21	0.21	0.21	0.21
ρ	0.36	0.36	0.36	0.36
Prob>F(overall fit)	30.30	33.51	30.55	33.07
Diff	0.01**	0.01**	0.00***	0.00***
Observations	11,170	11,170	11,165	11,165

Notes: All 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 Richardson's (2006) method, where under-investing (over-investing) firms are characterized by positive (negative) abnormal investment ($I^u\_new_{i,t}$). $FCF_{i,t}$ 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. Specifically, in columns 1 and 3, we consider a firm to be financially constrained (unconstrained) in a given year 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 that 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 the firm belongs to in that year, and financially unconstrained otherwise. *Diff* is the *p*-value of the Wald statistic for the equality of the free cash flow coefficients across various categories of firms. *, **, *** indicates significance at the 10%, 5%, and 1% level, respectively.

Table 7
Under-investment-free cash flow sensitivities: accounting for financial constraints using size and age

Dependent variable: $I^u\_new_{i,t}$	(1)	(2)	(3)	(4)
	Total Assets	*Total Assets*	*Age*	*Age*
$Low\_FC_{(<30)}$	0.007***		0.000	
	(0.001)		(0.001)	
$Medium\_FC_{(30\text{-}70)}$	0.004***		0.003***	
	(0.001)		(0.001)	
$FCF_{i,t}$* $Low\_FC_{(<30)}$	0.039***		0.040***	
	(0.006)		(0.005)	
$FCF_{i,t}$* $Medium\_FC_{(30\text{-}70)}$	0.038***		0.046***	
	(0.004)		(0.004)	
$FCF_{i,t}$* $High\_FC_{(>70)}$	0.064***		0.052***	
	(0.005)		(0.006)	
$High\_FC_{(>50)}$		0.004***		0.001*
		(0.001)		(0.001)
$FCF_{i,t}$ * $Low\_FC_{(<50)}$		0.037***		0.042***
		(0.004)		(0.004)
$FCF_{i,t}$ * $High\_FC_{(>50)}$		0.055***		0.051***
		(0.004)		(0.004)
Firm-fixed effects	Yes	Yes	yes	yes
Year-fixed effects	Yes	Yes	yes	yes
R^2	0.36	0.36	0.35	0.36
Adjusted R^2	0.21	0.21	0.21	0.21
ρ	0.36	0.36	0.36	0.35
F-value	33.39	35.34	30.68	32.86
Diff	0.00***	0.00***	0.12	0.08*
Observations	11,175	11,175	11,175	11,175

Notes: All 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 Richardson's method (2006), where under-investing firms are characterized by negative abnormal investment ($I^u\_new_{i,t}$). $FCF_{i,t}$ is computed by subtracting the optimal level of cash flow from cash flow from operating activities (*CFO*). *Low_FC*, *Medium_FC*, and *High_FC* are dummy variables equal to 1 in a given year, respectively, if the firm is likely to face low, medium, and high financial constraints relatively to all firms operating in the same industry it belongs to in that year, and 0 otherwise. Specifically, in columns 1 and 2, we consider a firm facing low (high) financial constraints in a given year if its *size* (real total assets*)* and *age* respectively lie in the bottom (top) half of the distribution of the corresponding values of all firms belonging to the same industry in that year. In columns 2 and 4, we consider a firm facing low (high) financial constraints in a given year if its *size* (real total assets) and *age* respectively lie in the bottom (top) half of the distribution of the corresponding variables of all firms belonging to the same industry in that year. The remaining firm-years will be those who face a medium level of financial constraints. *Diff* is the *p*-value of the Wald statistic for the equality of the free cash flow coefficients across various categories of firms. *, **, *** indicates significance at the 10%, 5%, and 1% level, respectively.

Table 8
Summary statistics of agency costs (*OREC* and *C/O*) for under- and over- investing firms

	FC index	*Mean*	*St. Dev.*	*P25*	*P50*	*P75*	*N Obs*
G1	*OREC*	0.054	0.114	0.026	0.041	0.054	6,352
*Under_* $FCF_{<0}$	*C/O*	46.70%	49.90%	0	0	1	4,869
G2	*OREC*	0.218	11.375	0.029	0.047	0.069	4,819
*Under_* $FCF_{>0}$	*C/O*	48.43%		0	0	1	3,669
Diff (G1 vs. G2)	*OREC*	0.00***		*Diff* (G1 vs. G2)	0.00***		
(Mean)	*C/O*	0.06*		(Median)	0.11		
G3	*OREC*	0.055	0.094	0.026	0.044	0.067	4,228
*Over_* $FCF_{>0}$	*C/O*	46.70%	49.90%	0	0	1	3,357
G4	*OREC*	0.044	0.045	0.022	0.037	0.055	3,783
*Over_* $FCF_{<0}$	*C/O*	45.34%	49.79%	0	0	1	2,880
Diff (G3 vs. G4)	*OREC*	0.00***		*Diff* (G3 vs. G4)	0.00***		
(Mean)	*C/O*	0.14		(Median)	0.28		
Total	*OREC*	0.093	5.702	0.026	0.042	0.063	19,182
	C/O	46.8%	49.90%	0	0	1	14,775

Notes: OREC (other receivable scaled by total assets) and *C/O* (dummy equal to 1 if the firm exhibits a divergence between controlling and ownership rights, and 0 otherwise) represent firm-specific levels of agency costs. Firms are classified into the following four groups: Group 1 (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 25^{th} ($50^{th}/75^{th}$) percentile of the distribution of the relevant variable. *Diff* is the *p*-value associated with the t-test and the Wilcoxon rank-sum test for differences in means and equality of medians of the firm-level agency costs between groups of under-investing firms (Group 1 and Group 2) or between groups of over-investing firms (Group 3 and Group 4). *, **, *** indicates significance at the 10%, 5%, and 1% level, respectively.

Table 9
Over-investment-free cash flow sensitivities: accounting for agency costs using *OREC* and *C/O*

Dependent variable: $I^u\_new_{i,t}$	(1) *OREC*	(2) *OREC*	(3) *C/O*
Medium_ $AC_{(30\text{-}70)}$	-0.001		
	(0.001)		
High_ $AC_{(>70)}$	-0.007***		
	(0.002)		
$FCF_{i,t}$* *Low_ $AC_{(<30)}$*	0.015		
	(0.012)		
$FCF_{i,t}$* *Medium_ $AC_{(30\text{-}70)}$*	0.013		
	(0.011)		
$FCF_{i,t}$* *High_ $AC_{(>70)}$*	0.028**		
	(0.012)		
High_$AC_{(>50)}$		-0.006***	0.002
		(0.001)	(0.002)
$FCF_{i,t}$* *Low_$AC_{(<50)}$*		0.016*	0.016
		(0.010)	(0.011)
$FCF_{i,t}$* *High_ $AC_{(>50)}$*		0.021**	0.031***
		(0.010)	(0.011)
Firm-fixed effects	yes	yes	yes
Year-fixed effects	yes	yes	yes
R^2	0.38	0.38	0.42
Adjusted R^2	0.18	0.18	0.18
P	0.37	0.37	0.40
Prob>F(overall fit)	8.37	9.37	8.64
Diff	0.47	0.71	0.35
Observations	8,015	8,015	6,237

Notes: All 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 Richardson's (2006) method, where under-investing (over-investing) firms are characterized by positive (negative) abnormal investment ($I^u\_new_{i,t}$). $FCF_{i,t}$ is computed by subtracting the optimal level of cash flow from cash flow operating from activities (*CFO*). *High_AC, Medium_AC* and *Low_AC* are dummy variables, equal to 1 in a given year if a firm faces respectively high, medium, and low agency costs compared to all firms belonging to the same industry it belongs to, and 0 otherwise. Specifically, in columns 1, we define a firm as facing high (low) agency costs in a given year if its *OREC* lies in the top (bottom) three deciles of the distribution of the *OREC*s of all firms operating in its same industry in that year. The remaining firm-years will be the ones with medium agency costs. The remaining firm-years will be the ones who face a medium level of agency costs. As for column 2, a firm is considered as facing high (low) agency costs in a given year if its *OREC* exceeds (is below) the median value of the distribution of the *OREC*s of all firms operating in the same industry it belongs to in that year. In columns 3, a firm is considered as facing high (low) agency costs in a given year if its blockholder's controlling right exceeds (does not exceed) its cash-flow right in a given year. *Diff* is the *p*-value of the Wald statistic for the equality of the free cash flow coefficients across various categories of firms. *, **, *** indicates significance at the 10%, 5%, and 1% level, respectively.

Table 10
Under-investment-free cash flow sensitivities: accounting for agency costs using blockholder's and CEO shareholding

Dependent variable: $I^u\_new_{i,t}$	(1) Blockholder	(2) Shareholding_CEO
Insider		0.002
		(0.002)
$FCF_{i,t}$* *Outsider*		0.031***
		(0.010)
$FCF_{i,t}$* *Insider*		0.016
		(0.015)
Medium_ Share$_{(30\text{-}70)}$	-0.000	
	(0.002)	
High_ Share $_{(>70)}$	-0.001	
	(0.002)	
$FCF_{i,t}$* *Low_ Share $_{(<30)}$*	0.016	
	(0.012)	
$FCF_{i,t}$* *Medium_ Share $_{(30\text{-}70)}$*	0.023**	
	(0.011)	
$FCF_{i,t}$* *High_ Share $_{(>70)}$*	0.014	
	(0.012)	
Firm-fixed effects	Yes	yes
Year-fixed effects	Yes	yes
R^2	0.38	0.40
Adjusted R^2	0.17	0.16
P	0.37	0.40
F-value	7.40	7.19
Diff(Low $_{VS}$ Medium)	0.66	
Diff (Medium $_{VS}$ High)	0.58	
Diff (Low $_{VS}$ High)	0.92	0.40
Observations	8,015	6,146

Notes: All 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 Richardson's (2006) method, where over-investing firms are characterized by positive abnormal investment ($I^u\_new_{i,t}$). $FCF_{i,t}$ is computed by subtracting the optimal level of cash flow from cash flow from operating activities (*CFO*). *Blockhoder* 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 the blockholder in a given firm lies in the top (bottom) three deciles of the distribution of the corresponding percentage of all firms operating in the same industry in that year, and 0 otherwise. For the remaining firm-years, the dummy *Medium_Share* will be equal to 1. In the column labeled *Shareholding_CEO*, *Insider(Outsider)* is a dummy variable that takes the value of 1 if the firm's CEO is (not) holding shares in his/her own company, and 0 otherwise. *Diff* is the *p*-value of the Wald statistic for the equality of the free cash flow coefficients across various categories of firms. *, **, *** indicates significance at the 10%, 5%, and 1% level, respectively.

Table A1
Structure of the unbalance panel

No. of obs. Per firm	No. of obs.	Percent	Cumulative
3	279	1.25%	1.25%
4	704	3.15%	4.39%
5	1,055	4.72%	9.11%
6	510	2.28%	11.39%
7	840	3.75%	15.14%
8	1,024	4.58%	19.72%
9	756	3.38%	23.1%
10	830	3.71%	26.81%
11	1,320	5.9%	32.71%
12	1,560	6.97%	39.68%
13	1,638	7.32%	47%
14	2,212	9.89%	56.89%
15	2,655	11.87%	68.76%
16	2,944	13.16%	81.92%
17	4,046	18.08%	100%
Total	22,373	100.00%	

Table A2
Distribution of firm-year observations by year

Year	No. of obs.	Percent	Cumulative
1998	576	2.57%	2.57%
1999	689	3.08%	5.65%
2000	791	3.54%	9.19%
2001	867	3.88%	13.06%
2002	953	4.26%	17.32%
2003	1,046	4.68%	22%
2004	1,127	5.04%	27.04%
2005	1,129	5.05%	32.08%
2006	1,165	5.21%	37.29%
2007	1,358	6.07%	43.36%
2008	1,477	6.6%	49.96%
2009	1,554	6.95%	56.91%
2010	1,763	7.88%	64.79%
2011	1,896	8.47%	73.26%
2012	2,026	9.06%	82.32%
2013	2,012	8.99%	91.31%
2014	1,944	8.69%	100%
Total	22,373	100.00%	

Table A3
Dynamic model of investment expenditure

Dependent variable: $I\_new_{i,t}$	(1) Fixed effects	(2) GMM_system
$I\_new_{i,t-1}$	0.324***	0.411***
	(0.007)	(0.030)
$Cash_{i,t-1}$	0.103***	0.098***
	(0.004)	(0.012)
$Q_{i,t-1}$	0.001**	0.000
	(0.000)	(0.001)
$Size_{i,t-1}$	-0.004***	0.000
	(0.001)	(0.001)
$Age_{i,t}$	-0.002	-0.001***
	(0.002)	(0.000)
$ROA_{i,t-1}$	0.082***	0.121***
	(0.006)	(0.025)
$Leverage_{i,t-1}$	-0.024***	0.013
	(0.004)	(0.010)
Year-fixed effects	yes	yes
Industry-fixed effects	no	yes
Province-fixed effects	no	yes
(Year-fixed)* (Industry-fixed) effects	yes	yes
R^2	0.49	
Adjusted R^2	0.42	
ρ	0.33	
F-value	26.21	17.51
Hansen J test (p-value)		0.13
m3 test (p-value)		0.54
Observations	19,190	19,190

Notes: Estimates in column 1 were obtained using the fixed effects estimator. Estimates in column 2 were obtained using the system GMM estimator. Test statistics and standard errors (in parentheses) of all variables in the regressions are asymptotically robust to heteroscedasticity. Adopting Richardson's (2006) method, the dependent variable is $I\_new_{i,t}$, the difference between I_{total} and I_{main} (see Fig. 1 for definitions of these variables).. All variables except $Q_{i,t-1}$, $Size_{i,t-1}$ and $Age_{i,t}$ are scaled by total assets. 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.