The Trends and Gaps in the Sensitivity of Investment to Cash Flow: Evidence from China

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Abstract: The ability of using internally generated funds to finance investments affects corporate sustainability. We empirically examine trends and gaps in the reliance of company’s investments on internally generated funds. We collect financial data of Chinese listed companies from 1998 to 2020, use corporate cash flow as a proxy for internally generated funds, control for corporate investment opportunity Q, and specify a two-way fixed effects model of investment on cash flow. We find that investment-cash flow sensitivity exhibits a decreasing trend over time; firm size, government equity, and the HP and WW indices effectively explain the gaps in the sensitivity of investment to cash flow between two types of firms with tighter and looser financing constraints, but cash dividends do not explain the gaps; and the gaps in the sensitivity of investment to cash flow are narrowing in the long term. These empirical findings indicate that compared to external funding, internal funding is becoming less important in supporting a firm’s investment-induced sustainability.

Keywords: investment; cash flow; sensitivity; trend; gap

1. Introduction

Investment decisions have long-term effects on a company’s continuous earnings and growth potential and hence investment decisions are arguably a fundamental issue in corporate sustainability. Financial markets are subject to frictions, such as taxes, issuance costs, agency conflicts, bankruptcy costs, and asymmetric information. Therefore, investment decisions are affected by a wedge between the costs of a firm’s internal and external funds. The degree of dependence of investments on internal funds is commonly measured by the sensitivity of investment to cash flow.

The sensitivity of investment to cash flow was originally proposed in the seminal study of Fazzari et al. [1]. They find firms facing tighter financing constraints have to depend more on internally generated funds to invest. Their findings have been further corroborated by rich empirical literature [2–4]. Another strand of literature diverges from the findings and argues that less financially constrained firms are linked to larger estimates of sensitivity [5,6]. Allayannis and Mozumdar argue the finding that investment is more sensitive to cash flow for the least financially constrained firms can be explained by negative cash flow observations or be driven by a few outlying observations in a small sample [7]. Erickson and Whited argue that the measurement error in Tobin’s Q, a proxy for marginal Q, can affect the estimate of investment-cash flow sensitivity and hence most of the stylized facts resulted from regression of investment on cash flow and marginal Q are artifacts of the measurement error [8,9]. The connection between various measures of financial performance and firm value and environmental management have been explored in the context of China [10].

An emerging tranche of literature has started to explore the trend in the sensitivity of investment to cash flow worldwide. Chen and Chen and Larkin et al. find that there is a decline in the sensitivity of investment to cash flow over time and even a complete
disappearance in the U.S. [4,11]. Moshirian et al. show a decrease in the sensitivity of investment to cash flow and attribute the decrease to fall in capital intensity and rising R & D [12]. Similarly, Machokoto et al. find the sensitivity is disappearing over time in the U.K., even for constrained firms during the last global financial crisis when financial constraints were more apparent and binding [13]. Lewellen and Lewellen, however, still find a considerably higher estimate on the sensitivity coefficient on cash flow and argue that methodological issues and the use of noisy measure of cash flow both contribute substantially to low sensitivity in previous literature [14]. The mixed results demonstrate the debate on the sensitivity of investment to cash flow is far from being fully settled.

We follow the literature on trend in the sensitivity of investment to cash flow. Our study not only discusses whether there is evidence of a downward trend in investment-cash flow sensitivity in China, but also first defines a gap in the sensitivity of investment to cash flow between firms with tighter versus looser financial constraints and then explores the trend of the gap. Firms’ external financing constraints exhibit heterogeneity, so that firms with tighter versus looser financing constraints exhibit differences in the sensitivity of investment to cash flow. We define this difference as the gap in the sensitivity of investment to cash flow. If the gap exhibits a tendency to converge to zero, it suggests that the universal effect of decreasing frictions in financial markets on the firm’s financing constraints prevails. In contrast, it suggests that the selective effect of external suppliers of funds to firms with different financing constraints dominates. We are aware that defining a gap in the sensitivity of investment to cash flow and then exploring its trend is instructive for understanding and measuring the degree of frictions and integration in financial markets. To the best of our knowledge, the existing theory does not discuss the gap in the sensitivity of investment to cash flow and its trend, and the extant empirical studies do not provide any evidence on them; our study fills the gap in the literature.

Our study makes two marginal contributions to the existing literature. First, considering access to financing investment affects corporate sustainability, we define the gap in the sensitivity of investment to cash flow between the firms with tighter and looser external financing constraints and then examine the trend. To this end, we classify Chinese listed companies based on traditional classification schemes of financing constraints, such as firm size, cash dividends, government equity, and the HP and WW indices. Based on these classification schemes, we estimate gaps in the sensitivity of investment to cash flow. We run a series of regressions based on rolling subsamples over five-year periods to examine the long-term trends of the gaps. We find that the gaps exhibit a convergence to zero in the long run. It suggests that, of the universal versus investor selection effects on gaps in the sensitivity, the universal effect prevails.

Second, we develop a cash flow identity under Chinese accounting standards and then propose an alternative measure of corporate investment. A commonly used measure of investment is a firm’s capital expenditures [1,10,15], but this measure of investment does not capture the firm’s expenditures on many assets, such as the purchase of patents and technologies from other firms and cash payments for mergers and acquisitions. However, these expenditures do affect the company’s growth potential and profitability. Therefore, a company’s investment expenditures should include these expenditures. Recent literature reflects this change in investment measurement [14,16]. They propose to measure a firm’s investment based on cash flow identity using flow-of-funds data. The papers that use cash flow identity to measure investment address the U.S. cases. We cannot simply apply the cash flow identity in these papers to measure investment but should modify it to meet China’s accounting standards. It is clear that interest expense is one of the largest expenses of a company and there is a difference in accounting standards regarding the placement of interest payments in cash flows between the U.S. and China. According to the GAAP, interest payments are classified as operating cash flows, while under the China’s accounting standards, interest payments are classified as financing cash flows. To the best of our knowledge, the extant literature related to Chinese corporate investment basically defines investment in terms of capital expenditures or net fixed assets [17–20]. Therefore, the
cash flow identity approach of investment measurement that we propose here under China’s accounting standards is instructive for future research on investment of China’s companies.

The rest of the paper is organized as follows. Section 2 is a very brief theoretical review with predictions. Section 3 presents empirical designs. In Section 4, we report empirical results. Section 5 discusses asymmetric changes in the sensitivity of investment to cash flow. The final section concludes.

2. Theoretical Review and Prediction Development

2.1. Theoretical Review

To provide a theoretical basis for empirical specification, we start with a very brief theoretical review of the link between investment and cash flow.

The value of a firm is given by the expected present value of its future sustainable profits as follows:

$$\max \{ \sum_{s=1}^{\infty} \beta_s \pi(K_{it}, \theta_{is}) - C(I_{it}, K_{it}, \lambda_{is}) - I_{it} \}$$

where $E \{ \cdots \} $ is the expectation operator and $\beta$ denotes the constant discount factor; $i$ and $t$ represent the firm and the period of time, respectively. The profit function is $\pi(K_{it}, \theta_{is})$. The beginning-of-period capital stock is $K_{is}$ and $\theta_{is}$ denotes an exogenous stochastic shock. We assume that there are convex costs of adjusting the capital stock $K_{it}$ and $C(I_{it}, K_{it}, \lambda_{is})$ includes three arguments, the capital stock $K_{is}$, investment $I_{is}$, and an exogenous stochastic shock $\lambda_{is}$. We further assume that exogenous stochastic shocks $\theta_{is}$ and $\lambda_{is}$ follow Markov processes.

The objective function (1) is subject to the capital accumulation constraint that evolves through time according to $K_{is} = (1 - \delta)K_{is-1} + I_{is}$. We assume new capital resulting from investment becomes productive within the current period.

We solve the constrained maximization problem and attain the first-order condition with respect to investment as follows:

$$1 + C_I(I_{it}, K_{it}) = E \{ \sum_{s=0}^{\infty} \beta_s \pi(K_{it+s}, \theta_{it+s}) - C_K(K_{it+s}, \lambda_{it+s}) \}$$

(2)

where $C_I(\cdots)$ is partial derivative with respect to investment $I$. The left-hand term in Equation (2) is the marginal cost resulting from each additional unit of investment and the right-hand term is the corresponding marginal revenue (the expected discounted value of the future profits from each additional unit of investment). The right-hand term $E \{ \sum_{s=0}^{\infty} \beta_s \pi(K_{it+s}, \theta_{it+s}) - C_K(K_{it+s}, \lambda_{it+s}) \}$ is denoted as $Q_{it}$ and it measures a firm’s investment opportunity.

To make Equation (2) concrete for empirical design, we next assume the adjustment cost to be typically quadratic in $I_{it}/K_{it}$ as follows:

$$C(I_{it}, K_{it}) = 0.5 \alpha(I_{it}/K_{it} - \alpha_i - \lambda_{it})^2 K_{it}$$

(3)

where $\alpha$ denotes an adjustment-cost parameter. Substituting the specification of the adjustment cost into Equation (2) yields an investment model including marginal $Q_{it}$. After a series of arrangements and simplifications, we have:

$$I_{it}/K_{it} = \alpha_i + 1/\alpha(Q_{it} - 1) + \lambda_{it}$$

(4)

Equation (4) is representative of a model under frictionless capital markets. It illustrates that investment should be unrelated to a firm’s net worth and depends solely on marginal $Q_{it}$ in a world without financial frictions.

In the real world, financial markets are always full of frictions. The frictions lead to a firm facing a high premium in the cost of external financing relative to internal financing, and shifts in a firm’s net worth affect its investment. Accordingly, a firm’s net worth should be included as an independent variable to explain a firm’s investment behavior. A firm’s cash flow is commonly employed to measure a change in net worth. We further assume
that $\lambda_i$ is unobservable noise, then we can express the relation between investment and marginal $Q_{it}$ in the real world as follows:

$$\frac{I_{it}}{K_{it}} = a_i + b\left(\frac{CF_{it}}{K_{it}}\right) + cQ_{it} + \varepsilon_{it} \quad (5)$$

where the coefficient $b$ measures the sensitivity of investment to cash flow.

2.2. Prediction Development

Based on the theoretical review, we know that in a world without financial frictions, investment cash flow sensitivity should be zero if marginal $Q$ captures the firm’s investment opportunities perfectly. The real world has financial frictions. Financial frictions lead to a wedge between external and internal funding costs and the firm’s investment cash flow sensitivity should be significantly positive. That is, the coefficient $b$ in Equation (5) is significantly positive. In summary, we make the first prediction that the estimate of the sensitivity of investment to cash flow is significantly positive.

Although the financing constraints faced by firms always exist, the status of the financing constraints changes continuously with social evolution, institutional changes, and technological advances [21,22], e.g., the company has higher value collateral available to creditors, the company strives to improve corporate governance to protect the interests of all stakeholders, the company operates in an environment where contracts are fairly signed and effectively enforced, advances in financial technology reduce information asymmetry, and so on. These forces of social evolution, institutional change, and technological advancement reduce friction in financial markets. The company’s investments are more easily financed with external funds and the company further reduces its reliance on internal funding. As a result, the sensitivity of investments to cash flow in the long term has been decreasing. Therefore, we present a second prediction that investment-cash flow sensitivity exhibits a continued downward trend.

The widespread and perpetual existence of firm heterogeneity causes differences in the ease and availability of external financing for firms. Some firms have tighter external financing constraints, while others are relatively loose. As a result, these two types of firms exhibit differences in their reliance on internal funding for investment. On the one hand, social evolution, institutional changes, and technological advances are universal and all companies will thus be less constrained by external financing. The universal effect facilitates the closing of the gaps in sensitivity. On the other hand, the limited rationality of external financiers and their quest for funds safety and profitability may make them reluctant to finance firms with poor operations, lack of cash flow, insufficient valuable collateral, or slow technological advances [23–25]. External financing thus becomes more difficult to obtain for these companies. The selection effect of funders can cause the gap in sensitivity to expand. Thus, there are two opposing effects that lead to changes in the investment cash flow sensitivity gap. One is the reduction of the gap due to the universal effect caused by social evolution, institutional change, and technological progress, and the other is the widening of the gap due to the selection effect of external fund providers. For the gap in the sensitivity of investment to cash flow and its trend in the long run, no prediction is given by the existing theory and no evidence is given by the extant empirical studies. We do not know which of these two opposing effects on the change in the gap dominates. It is likely to be an empirical problem. We randomly pick one of the two possibilities as the third prediction that gaps in the sensitivity of investment to cash flow between firms with tighter and looser financing constraints exist. Moreover, the gaps continue to get wider as time goes on.
3. Empirical Designs

3.1. Specification

3.1.1. Baseline Model

The theoretical review sheds light on why our baseline model is quite parsimonious and only includes proxies for marginal Q and cash flow CF to investigate trends and gaps in the sensitivity of investment to cash flow [26]. Marginal Q is unobservable, and Tobin’s Q is commonly employed to be a proxy for the marginal Q. To control for the possible heteroskedasticity due to differences in firms’ size, we scale the investment and cash flow using the total assets of the end of last year. Therefore, the baseline model is specified as follows:

$$\frac{I_{it}}{K_{i,t-1}} = \beta_1 \left( \frac{CF_{it}}{K_{i,t-1}} - 1 \right) + \beta_2 Q_{i,t-1} + \alpha_i + \mu_{ind,t} + \epsilon_{it}$$

(6)

where $I_{i,t}$, scaled by its total assets of the end of last year, represents the total investment of a firm $i$ for the current year $t$; $CF_{i,t}$ is a firm $i$’s cash flow divided by its total assets of the end of last year; $Q_{i,t-1}$ is a proxy for investment opportunities; and $\alpha_i$ and $\mu_t$ denote firm and industry-year fixed effects, respectively. $\epsilon_{it}$ is error. We first examine overall trends based on nineteen rolling five-year subperiods. Then, the sample is divided by firm size, whether cash dividends are paid, whether government ownership is present, and the WW and the HP indices. Based on the above subsamples, gaps in the sensitivity of investment to cash flow and their trends are examined.

3.1.2. The Definitions of Key Variables

Cash flow CF is commonly calculated as profits plus depreciation [1,15]. The calculation includes a true cash component from operation and a noncash component in the form of working capital accruals. Recent literature suggests that the empirical relation between investment and cash flow is mainly explained by the naturally positive correlation between investment and working capital accruals [14,16]. In order to mitigate the concern that the empirical results are driven by the natural positive correlation, we measure cash flow using data from the statement of cash flows and define cash flow CF as a firm’s operating cash flows in the statement of cash flows net of the change in working capital. We treat the change in working capital as a component of investment here.

In addition to capital expenditures, measures of firm investment should include expenditures that affect a firm’s earnings and growth potential, such as expenditures for patents and cash for mergers and acquisitions. Recent literature echoes this change in the measure of investment, and they propose to measure firm investment based on the firm’s cash flow identity using flow-of-funds data [14,16]. The identity is as follows.

$$CF + EXT = INV + CASH + DIVD$$

(7)

where the sources of funds include the internally generated cash flow CF and external financing EXT that includes net debt issuance and net equity issuance. The uses of funds consist of investment INV, the change in cash holdings CASH, and cash dividends DIVD. We follow these lines of literature on investment measurement to measure investment as accurately as possible. It is worth noting that those literature are based on the U.S. listed firms, while we use data from Chinese listed firms, and we cannot directly apply the firm cash flow identity proposed by those literature in measuring firm investment. Interest expense is one of the most important expenses of a company; it is accounted for as operating cash flow under the U.S. GAAP, but as financing cash flow in Chinese accounting standard. In order to measure corporate investment of listed companies in China as accurately as possible, we modify the cash flow identity (7) to:

$$CF + EXT = INV + CASH + DIVD + INTR$$

(8)

where INTR denotes interest payments. Based on Equation (8), we measure INV as $INV = CF + EXT - CASH - DIVD - INTR$. Following literature [15,27], we mea-
sure Tobin’s Q as the market value of a firm’s common stock, plus the book value of preferred stock, long-term debt, inventories, and current liabilities minus current assets and then divided by the book value of the firm’s total assets.

3.2. Data Description and Summary Statistics

3.2.1. Data Description

To explore the link between investment and cash flow, we select firms that issue A share and are listed on the Shanghai Stock Exchange and the Shenzhen Stock Exchange in China. Our data are from the China Stock Market and the Accounting Research Database. We employ data from the statement of cash flows to measure cash flow. China’s Ministry of Finance issued Accounting Standard for Businesses No. 31-Statement of Cash Flows on 20 March 1998. It requires listed companies in China to produce and publicly disclose a statement of cash flows from 1998 onwards. Therefore, we select the sample since 1998. To make the sample more homogenous, the listed firms in financial industry are dropped. Firm-year observations are also dropped if the value for net fixed assets or sales is less than or equal to zero. Extreme observation values of marginal Q measure exceeding 20 are also eliminated. After that, 2415 publicly traded firms with 19,864 firm-year observations are left. We scale level variables by one-period lag of total assets and then all variables are winsorized annually at their 1st and 99th percentiles to reduce the impact of outliers.

Table 1 presents the definitions of key variables and descriptive statistics. Level variables including investment I, cash flow CF, and the change in external financing EXT are scaled by one-period lagged total assets. There is a decrease in number of observations from 19,864 of level variables to 14,577 due to scaling. Firms’ size SIZE is the natural logarithm of total assets (in million RMB Yuan) that are GDP deflator-adjusted to base year 1998. The average investment is equal to 8% of total assets of the end of last year and firms’ investment varies from a high of 0.56 of total assets of the end of the last year to a low of −0.13. The average cash flow is equal to 3% of total assets of the end of the last year, which is less than the mean of investment. The amount of average external financing is 6% of total assets of the end of the last year, which shows weak evidence that external financing including net debt issuance and net equity issuance is an importance source of investment. The mean of the cash dividend payment dummy variable DIVD is 0.84 and it indicates 84% of firm-year observations pay cash dividends. The mean 0.31 of GOVT indicates 31% of firm-year observations with government equity. The means of the HP index and the WW index are −13.69 and −1.02, respectively. The HP and the WW indices range from a maximum of −11.56 to a minimum of −16.88 and from −0.29 to −1.30, respectively. These indicate that the sample distribution of the HP index is to the left side of the counterpart of the WW index.

Figure 1 is comprised of parts (a) and (b) and they show how the mean heterogeneity of investment I and cash flow CF evolve through time, respectively. We scale the investment I and cash flow CF by one-period lagged total assets and hence the year on the horizontal axis starts with 1999. The number of firms in the sample becomes highly volatile across the years. The minimum number of firms is 36 in 1999. It slowly increases to 179 firms in 2007 and subsequently rapidly move up to the maximum 1872 in 2014. After that, it dives to around 500 firms in 2017. The means of investment I and cash flow CF show similar time-series variation and hence seem to be serially correlated. The yearly means become more volatile in the first segment from years 1999 to 2005 than those from 2006 to the end. The widths of the 95% confidence interval for the means of investment I and cash flow CF both get narrow as the firms’ numbers increases. The dotted line in Figure 1b represents zero and three negative means of yearly cash flow (1999, 2000, 2016) occur. The mean of investment starts to slowly rise from 2012 on to the peak in 2016 and then rapidly fall. On the contrary, the mean of cash flow starts to fall from 2012 on to the trough in 2016 and then rapidly increase. That is, the time-series variation of the mean of investment from year 2012 onwards turns out to be the very reverse of the means of cash flow.
Table 1 presents the definitions of key variables and their minimum (Min), maximum (Max), mean, median, standard deviation (Std), and the number of observations (Obs.). The variables are winsorized annually at their 1st and 99th percentiles. The data is from the China Stock Market and the Accounting Research Database. The sample consists of 2415 nonfinancial listed firms with 19,864 firm-year observations in total over the period of 1998 to 2020.

| Variable | Description                                                                 | Mean  | Median | Std   | Min   | Max   | Obs. |
|----------|-----------------------------------------------------------------------------|-------|--------|-------|-------|-------|------|
| I        | Cash flow plus change in external financing minus change in cash holdings minus cash dividends minus interest payments, scaled by lagged total assets. | 0.08  | 0.06   | 0.11  | −0.13 | 0.56  | 14,577 |
| CF       | Operating cash flows minus change in working capital, scaled by lagged total assets. | 0.03  | 0.05   | 0.17  | −0.69 | 0.45  | 14,577 |
| Tobin's Q | A proxy for marginal Q, the market value of a firm’s common stock, plus the book value of preferred stock, long-term debt, inventories, and current liabilities minus current assets and then divided by the book value of the firm’s total assets [15,27]. | 1.96  | 1.55   | 1.22  | 0.88  | 8.03  | 19,864 |
| RETN     | Annual stock return.                                                        | 0.31  | 0.10   | 0.77  | −0.71 | 3.39  | 19,864 |
| SIZE     | Logarithm of total assets (GDP deflator-adjusted to base year 1998)          | 21.96 | 21.75  | 1.34  | 19.53 | 25.99 | 19,864 |
| DIVD     | A dummy variable that takes the value of 1 if a firm pays a cash dividend and otherwise 0. | 0.84  | 1      | 0.44  | 0     | 1     | 19,864 |
| GOVT     | A dummy variable that is defined as 1 if a firm owns government equity and 0 otherwise. | 0.31  | 0      | 0.46  | 0     | 1     | 19,759 |
| HP       | suggested by Hadlock and Pierce [28] and equal to −0.737 × log (Assets) + 0.043 × log (Assets)^2 + 0.04 × firm’s age. | −13.69| −13.59 | 0.84  | −16.88| −11.55| 19,864 |
| WW       | Suggested by Whited and Wu [29] and is given by −0.091 × CF/Assets − 0.062 × Dividend Payer Dummy + 0.021 × long-term debt/Assets − 0.044 × log (Assets) + 0.102 × industry median sales growth ratio − 0.035 × sales growth ratio. | −1.02 | −1.00  | 0.07  | −1.30 | −0.29 | 19,761 |
| EXT      | Net debt and equity issuance, scaled by lagged total assets.                | 0.06  | 0.02   | 0.21  | −3.82 | 5.59  | 14,577 |
Figure 1. Mean Heterogeneity across Years. (a,b) plots the annual cross-sectional means of firms’ investment and cash flow, respectively. The investment and cash flow are scaled by one-period lagged total assets and winsorized annually at the bottom and the top 1% of their distributions.

3.2.2. Simple Linear Regressions

To obtain the most intuitive understanding of how investment relates to cash flow, we conduct simple linear regressions over yearly cross-sectional data. To save space, we report the scatter plots and regression lines only for years 2000, 2010, and 2020. Figure 2 plots the scatters and regression lines for 2000, 2010, and 2020, respectively.

Figure 2a plots firms’ investment against cash flow for year 2000. The sensitivity of investment to cash flow is 0.1368, and the corresponding p-value and R² are 0.2870 and 0.0332, respectively. Figure 2b depicts the relationship between firms’ investment and cash flow for year 2010. The estimate of sensitivity coefficient on cash flow is 0.1257 (the p-value of 0.0000 and the R² of 0.0558). Figure 2c captures the link between investment and cash flow for year 2020. The estimate of coefficient, the p-value, and R² are 0.0418, 0.1740, and 0.0335, respectively. The estimates of the sensitivities of investment to cash flow gradually decrease from 0.1368 for year 2000, 0.1257 for 2010, to 0.0418 for 2020. It shows the regression lines become slightly flatter over time. Significant positive estimates suggest the presence of a world with financial frictions. Figure 2 gives us a visual that internal funding is becoming less important in supporting a firm’s investment-induced sustainability.

Figure 2. Simple Linear Regressions of Investment on Cash Flow. Figure 2 consists of three annual cross-sectional simple linear regressions. Investment is on the vertical axis and the horizontal axis indicates cash flow. Graph (a) on the left is a scatter plot of investment versus cash flow with fitted regression line added in 2000. The middle (b) plots the scatters and the line in 2010. The scatter plot with a fitted regression line added in 2020 is displayed in graph (c) on the right.
4. Empirical Results

4.1. Trends in the Sensitivity of Investment to Cash Flow

4.1.1. The Link between Investment and Cash Flow

Table 2 is comprised of panels A and B. Panel A reports the regression results of Equation (6) over the full sample. In order to explore time-series variation in the sensitivity of investment to cash flow, we run regressions of Equation (6) over rolling five-year subperiods. Specifically, the first regression is over the subperiod 1998–2002, the second one over the subperiod 1999–2003, and so on. Panel B of Table 2 presents empirical results over the nineteen five-year subperiods. The nineteen subperiods are consecutively denoted by \( P_1 \) to \( P_{19} \).

Table 2. Sensitivity of Investment to Cash Flow: the Within Estimator.

| Period    | CF          | \( Q_{t-1} \)          | N    | R²     | F-Stat      |
|-----------|-------------|-------------------------|------|--------|-------------|
| \( P_0 \) | 1998–2020   | 0.0481 *** (0.0091)     | 14,577 | 0.0264 | 164.5660 *** |
| \( P_1 \) | 1998–2002   | 0.1244 (0.0993)         | 155  | 0.1847 | 5.0975 **   |
| \( P_2 \) | 1999–2003   | 0.1881 ** (0.0864)      | 157  | 0.2946 | 10.6473 *** |
| \( P_3 \) | 2000–2004   | 0.2438 *** (0.0878)     | 175  | 0.2047 | 8.1062 ***  |
| \( P_4 \) | 2001–2005   | 0.3145 *** (0.0853)     | 188  | 0.2558 | 11.6857 *** |
| \( P_5 \) | 2002–2006   | 0.1966 ** (0.0807)      | 218  | 0.1333 | 6.2263 ***  |
| \( P_6 \) | 2003–2007   | 0.2259 *** (0.0686)     | 359  | 0.1396 | 10.4621 *** |
| \( P_7 \) | 2004–2008   | 0.1332 *** (0.0381)     | 1189 | 0.0699 | 10.1513 *** |
| \( P_8 \) | 2005–2009   | 0.0833 *** (0.0274)     | 2105 | 0.0293 | 15.5565 *** |
| \( P_9 \) | 2006–2010   | 0.0876 *** (0.0171)     | 3155 | 0.0449 | 44.4910 *** |
| \( P_{10} \)| 2007–2011  | 0.0698 *** (0.0145)     | 4192 | 0.0353 | 51.4064 *** |
| \( P_{11} \)| 2008–2012  | 0.0693 *** (0.0138)     | 4816 | 0.0339 | 54.7137 *** |
| \( P_{12} \)| 2009–2013  | 0.0586 *** (0.0137)     | 5644 | 0.0174 | 32.1491 *** |
| \( P_{13} \)| 2010–2014  | 0.0675 *** (0.0141)     | 6395 | 0.0229 | 49.8200 *** |
| \( P_{14} \)| 2011–2015  | 0.0523 *** (0.0149)     | 6938 | 0.0287 | 70.7785 *** |
| \( P_{15} \)| 2012–2016  | –0.0016 (0.0160)        | 6256 | 0.0267 | 56.4808 *** |
| \( P_{16} \)| 2013–2017  | –0.0143 (0.0186)        | 4943 | 0.0303 | 44.7612 *** |
| \( P_{17} \)| 2014–2018  | –0.0324 (0.0243)        | 3567 | 0.0388 | 32.4224 *** |
Table 2. Cont.

| Period | CF | Q_{t-1} | N    | R^2   | F-Stat   |
|--------|----|---------|------|-------|----------|
| P_{18} | 2015–2019 | -0.0080 | 0.0392 *** | 2342 | 0.0713 | 45.6628 *** |
|        |     | (0.0299) | (0.0068) |       |          |
| P_{19} | 2016–2020 | 0.0502 * | 0.0376 *** | 2069 | 0.0361 | 20.7012 *** |
|        |     | (0.0276) | (0.0083) |       |          |

Table 2 reports estimates of the sensitivities of investment to cash flow, standard errors, sample sizes (N), R^2, and F statistics over the full sample and the rolling five-year subperiods (rolling nineteen five-year subperiods in total and denoted by P_{1} through P_{19}, respectively). The dependent variables are investment I scaled by one-period lagged total assets K_{t-1}. The explanatory variables include cash flow CF divided by one-period lagged total assets and one-period lagged Marginal Q_{t-1}. All variables are defined in Table 1. All regressions specify firm and industry-year fixed effects. Standard errors are heteroskedasticity consistent and clustered at the firm level and are shown between brackets. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

As is evident in Panel A of Table 2, a unit of cash flow is associated with an extra 0.0481 of investment at the 1% significance level. A significant positive estimate suggests the existence of frictions in the Chinese financial markets and the first prediction is supported statistically. The estimate of coefficient on Q_{t-1} is 0.0200 and the coefficient is significant at the 1% level. It shows future investment opportunity has a positive impact on firms’ investment. Theoretical review in Section 2 demonstrates internally generated cash flow and future investment opportunity are both the determinants of firms’ investment, but future investment opportunity is fundamental to investment. The standardized regression coefficients of cash flow and investment opportunity are 0.0743 and 0.2218, respectively. It shows that, as expected by theory, investment opportunities play a more important role than internally generated funds in explaining the investment behavior of firms in China. These empirical results further verify previous literature [3,14].

The empirical results from rolling nineteen regressions over five-year subperiods are presented in Panel B of Table 2. We look closely at the nineteen estimates of sensitivity coefficients on cash flow CF. Fourteen of the nineteen estimates of sensitivities are positive and significant at the conventional levels. They range from a high of 0.3145 over the subperiod of 2001 to 2005 to a low of 0.0502 over 2016 to 2020. The results show that the results over the full sample of Panel A are further supported. The other five of the nineteen estimates of sensitivity coefficients on cash flow include one estimate 0.1244 over the first five-year subsample 1998 to 2002 and four estimates −0.0016, −0.0143, −0.0324, and −0.0080 over four continuously rolling subperiods from 2012 to 2019. The estimate over the first five-year subsample is not significant even at the 10% level. The four estimates over four continuously rolling samples are negative but they are not statistically significant. It indicates that the sensitivity of investment to cash flow is completely disappearing over the four continuously rolling subperiods. Extant literature also finds some evidence on completely disappearing sensitivity of investment to cash flow. For example, Larkin et al. finds that the completely disappearing sensitivity emerges for some countries excluding the U.S. over the two years prior to 2011 [4]. The negative investment-cash flow sensitivities here for four consecutive subsample periods appears to reflect the opposite trend of investment and cash flow means from 2012 onward in Figure 2. Turning to the estimates of coefficients on marginal Q_{t-1}, we find that fifteen of the nineteen estimates on Q_{t-1} are positive and vary from a high of 0.2823 over the subperiod 1999 to 2003 and to a low of 0.0097 over 2009 to 2013. The corresponding coefficients are significant either at the 1% level or 5% level. It is worth pointing out that the estimates over the subperiod 2012 to 2019 are not only positive but also statistically significant at the 1% level. It shows investment is driven mainly by investment opportunity over the period of time. Standardized regression coefficients further indicate that, for the rolling regressions, future investment opportunity is still a more important explanatory variable in explaining firms’ investment than internally generated funds. For example, standardized regression coefficients on cash flow CF and marginal Q_{t-1} are 0.0776 and 0.4170 over the subperiod 2016 to 2020, respectively.
4.1.2. Time-Series Variation of the Sensitivity of Investment to Cash Flow

We employ Figure 3 to clearly view the time-series variation of the sensitivity of investment to cash flow.

![Figure 3. Time-Series Variation of the Sensitivity of Investment to Cash Flow.](image)

Two curves are depicted in Figure 3. One is the steel blue solid curve with solid circles and the other is the black dotted curve with circles. The former represents the estimates of sensitivity using the within estimator while the latter denotes the estimates from the instrument variable (IV) estimator (IV will be discussed in Section 4.2). On the vertical axis of Figure 3 are the sensitivity coefficients, which are within and IV estimates of the coefficient of $\beta_{15}$ in Equation (6) over the rolling nineteen subperiods. The steel blue solid curve with solid circles, which depicts the time-series variation of the sensitivity of investment to cash flow, has three segments. The first segment is comprised of the first four subperiods and the curve is steeply upright-sloping, which indicates that firms have become more and more dependent on internally generated cash flow. The second segment covers subsequent rolling thirteen subperiods and the sensitivity heads downhill. It demonstrates that over a long time period, firms have come to rely less and less on cash flow. The last two subperiods are the third segment in which the sensitivity starts going slightly up. We take the three segments as a whole and we have a visual sense that the sensitivity is decreasing during the full sample period. Our findings of a decreasing sensitivity of investment to cash flow over time are consistent with existing literature [4,11,12].

The plot that the sensitivity of investment to cash flow is fading away over time is only visual. The visual view needs to further be statistically supported. For that purpose, we design two recursive statistical tests. The first one is to explore the statistical difference between the high of sensitivity coefficient over the subperiod 2001–2005 and the low of sensitivity over 2014 to 2018. If the test indicates the difference is statistically significant, then we perform the second test to investigate statistical difference between the first subperiod 1998 to 2002 and the last subperiod 2016 to 2020. If the first test shows the difference is not statistically significant, we do not need to further conduct the second one. At this point, we conclude that the declining trend in sensitivity is not statistically significant. We define two dummy variables for the two recursive tests. For the first test, the dummy takes a value of 0 for the subperiod 2001 to 2005 and value of 1 over 2014 to 2018. Likewise, for the second test, the dummy variable takes 0 for the first subperiod 1998 to 2002 and 1 over 2016 to 2020. Table 3 reports the empirical results of the two tests. The first test indicates that the estimate of sensitivity coefficient on cash flow is 0.3924, the standard error is 0.0686, and the coefficient is significant at the 1% level. The coefficient on interaction of the first dummy and cash flow is $-0.4323$, the interaction standard error is 0.0729, and the coefficient on the interaction is significant at the 1% level. The negative and significant
coefficient on the interaction suggests a prerequisite for the second test is satisfied. For the second recursive test, the estimate of the coefficient on cash flow is 0.2284 (a \( t \)-value of 4.9799 and significant at the 1% level), and the estimate of coefficient on the interaction is \(-0.1856\) (a \( t \)-value of \(-3.7781\) and significant at the 1% level). Most noteworthy for us are again the estimate and significance of the coefficient on the interaction. The negative and significant coefficient on the interaction in the second test demonstrates that the above visual sense of decreasing sensitivity is statistically corroborated. The aforementioned empirical results and the corresponding trend graph of investment-cash flow sensitivity show that the second prediction is supported by the data. The firms’ investment has become less and less dependent on internally generated funds as time goes on. That is, internal funding is becoming less important in supporting a firm’s investment-induced sustainability.

### Table 3. Tests for Trends in the Sensitivity.

| Test 1                          | Test 2                          |
|--------------------------------|---------------------------------|
| \( CF \)                       | 0.3924 ***                      |
| \( (0.0686) \)                  | 0.2284 **                       |
| \( DUM \times CF \)            | \(-0.4323 *** \)                |
| \( (0.0729) \)                  | \(-0.1856 ** \)                 |
| \( Qt_{-1} \)                  | 0.0258 ***                      |
| \( (0.0051) \)                  | 0.0404 ***                      |
| \( N \)                        | 3755                            |
| \( R^2 \)                      | 0.0854                          |
| \( F \)-stats                  | 34.812                          |

Table 3 reports tests for trends in sensitivity. The dependent variables in the two tests are investment \( I_t \) scaled by one-period lagged total assets \( K_{t-1} \). The dummy variable \( DUM \) in test 1 is defined as 0 over the subperiod 2001 to 2005 and 1 over the subperiod 2014 to 2018. The dummy \( DUM \) in test 2 takes 0 over the first subperiod 1998 to 2002 and 1 over the last period 2016 to 2020. All regressions specify firm and industry-year fixed effects. Standard errors are heteroskedasticity consistent and clustered at the firm level and are shown between brackets. *** and ** denote significance at the 1% and 5% level, respectively.

#### 4.2. Measurement Error in Tobin’s Q

As is described previously, we use Tobin’s Q as a proxy for marginal Q. Tobin’s Q might be an imperfect proxy because of measurement error in Tobin’s Q. If marginal Q is replaced with the error-laden Tobin’s Q, the cash flow effects on investment discussed previously could be explained by investment opportunity.

We next address how to effectively remedy the measurement error in Tobin’s Q. The most common remedy is to find additional observables that can serve as instruments. One approach in the earlier literature is to employ lagged market to book ratio as an instrument variable (IV). An IV estimator using lagged market to book ratio as IV is valid only if serial correlation in measurement error is small or short-lived [30]. An alternative approach in the recent literature is high-order moment estimators originally proposed by Erickson and Whited [8]. Although high-order moment estimators perform well in the presence of serial correlation, it can be applied only to samples that are arguably independently and identically distributed [9]. We follow Lewellen and Lewellen [14] and employ lagged returns as instrument variable for Tobin’s Q and then leave the high-order moment estimator as a robustness check. The reasons for using lagged earnings as an instrument are as follows. Tobin’s Q is calculated following the logic of market-to-book ratio, a simple comparison of market value with book value of a given firm. Hence, the measurement error in Tobin’s Q is more likely to come from book value in the denominator, which is based on the balance sheet, than from market value in the numerator. Even if the true value of a firm is measured with error, the fundamental value of the firm is the most primary determinant of market prices in the long run. On the contrary, returns do not depend on the book value and hence seem less likely to be correlated with the error in the regression of Tobin’s Q on marginal Q.

The IV regression of investment on cash flow and Tobin’s Q can be estimated using a two-stage least squares estimator on unbalanced panel data. Specifically, we perform a
first-stage regression of Tobin’s Q on cash flow, one-period lagged returns, and two-period lagged returns. We run a second-stage regression of investment on cash flow and the fitted values from the first-stage regression. Therefore, we obtain a consistent estimate of the coefficient on cash flow. Table 4 presents the empirical results of the IV regression.

Table 4. Sensitivity of Investment on Cash Flow: the IV Estimator.

| CF          | Q_{t-1} | N   | R^2 | 1st Stage F-Stat | Sargan |
|-------------|---------|-----|-----|------------------|--------|
| **Panel A: sensitivity over full sample** |
| 0.0478 ***  | 0.0308 *** | 11,293 | 0.0245 | 909.999 | 3.1128 |
| (0.0062)    | (0.0031)       |        |    |                  |        |
| **Panel B: sensitivity over rolling five-year subperiods** |
| P1          | 0.0563 | 0.1492 | 49  | 0.3441 | 3.0845 | 0.6221 |
| (0.0816)    | (0.1109)         |    |    |        |        |
| P2          | 0.2441 *** | 0.0832 *** | 56  | 0.3960 | 4.6595 | 0.2241 |
| (0.0925)    | (0.0273)         |    |    |        |        |
| P3          | 0.3284 *** | 0.1844 *** | 64  | 0.3527 | 5.3729 | 1.0845 |
| (0.0922)    | (0.0273)         |    |    |        |        |
| P4          | 0.3151 ** | 0.4668 | 69  | 0.1087 | 4.5906 | 1.2014 |
| (0.1508)    | (0.4200)         |    |    |        |        |
| P5          | 0.1821 | 0.5883 * | 85  | 0.0170 | 7.6519 | 1.0067 |
| (0.1848)    | (0.3168)         |    |    |        |        |
| P6          | 0.2538 *** | 0.0193 | 128 | 0.2309 | 9.1548 | 2.1123 |
| (0.0682)    | (0.1765)         |    |    |        |        |
| P7          | 0.1440 ** | 0.1470 * | 261 | 0.1654 | 1.5685 | 2.2201 |
| (0.0591)    | (0.0812)         |    |    |        |        |
| P8          | 0.1527 *** | 0.0664 ** | 1032 | 0.0943 | 12.9738 | 1.3458 |
| (0.0373)    | (0.0304)         |    |    |        |        |
| P9          | 0.0902 *** | 0.0468 *** | 1884 | 0.0484 | 45.5368 | 1.9825 |
| (0.0163)    | (0.0127)         |    |    |        |        |
| P10         | 0.1006 *** | 0.0249 *** | 2767 | 0.0398 | 164.8856 | 2.0139 |
| (0.0123)    | (0.0062)         |    |    |        |        |
| P11         | 0.0841 *** | 0.0058 | 3100 | 0.0338 | 161.4680 | 2.0004 |
| (0.0111)    | (0.0065)         |    |    |        |        |
| P12         | 0.0345 *** | 0.0101 * | 3592 | 0.0038 | 279.3491 | 1.9984 |
| (0.0116)    | (0.0056)         |    |    |        |        |
| P13         | 0.0518 *** | 0.0209 *** | 4218 | 0.0311 | 540.8360 | 1.3568 |
| (0.0119)    | (0.0053)         |    |    |        |        |
| P14         | 0.0348 *** | 0.0138 ** | 4759 | 0.0242 | 503.6711 | 2.3969 |
| (0.0118)    | (0.0058)         |    |    |        |        |
| P15         | -0.0127 | 0.0163 ** | 4082 | 0.0252 | 276.8952 | 2.3520 |
| (0.0135)    | (0.0065)         |    |    |        |        |
| P16         | -0.0407 ** | 0.0216 *** | 2845 | 0.0431 | 180.9930 | 2.6691 |
| (0.0187)    | (0.0078)         |    |    |        |        |
| P17         | -0.0274 | 0.0330 *** | 1516 | 0.0653 | 211.3541 | 2.0120 |
| (0.0243)    | (0.0088)         |    |    |        |        |
| P18         | 0.0612 ** | 0.0437 *** | 1132 | 0.0381 | 91.1494 | 1.9687 |
| (0.0262)    | (0.0151)         |    |    |        |        |
| P19         | 0.0089 | 0.0433 *** | 1084 | 0.0068 | 78.3622 | 1.3651 |
| (0.0212)    | (0.0138)         |    |    |        |        |

Table 4 reports IV estimates of the sensitivities, standard errors, sample sizes (N), R^2s, F statistics at the first stage, and Sargan statistics over the full sample and the rolling five-year subperiods. The dependent variables are investment I_t scaled by one-period lagged total assets K_{t-1}. The explanatory variables include cash flow CF_t divided by one-period lagged total assets and one-period lagged Marginal Q_{t-1}. The instruments are one-period and two-period lags of returns RETN_{t-1} and RETN_{t-2}. All regressions specify firm and industry-year fixed effects. Standard errors are heteroskedasticity consistent and clustered at the firm level and are shown between brackets. *** and ** denote significance at the 1%, 5%, and 10% level, respectively.
Table 4 consists of panels A and B. Panel A reports results over the full sample while Panel B presents results over the rolling subperiods. The results in Panel A show that after controlling for the measurement error in Tobin’s Q, firms invest an extra 0.0478 (t-statistics of 7.710) for each additional unit of cash flow, which is the same sign and similar magnitude as that (0.0481) in Table 2. The results mean that measurement error in Tobin’s Q does not fully explain the cash flow effects on investment. We observe the diagnostic statistics of the IV estimator to examine the IV validity in our settings. The first-stage F-statistic from the regression of Tobin’s Q on cash flow and RETN_{t-1} and RETN_{t-2} is 909.999, which is drastically greater than 10. It indicates the instruments are not weak and could explain much of the variation in Tobin’s Q_{t-1}. The Sargan statistic is 3.1128 and the corresponding p-value is 0.9223. It indicates that we cannot refuse the null hypothesis that RETN_{t-1} or RETN_{t-2}, or both are exogenous. We next move on to Panel B. We find F-statistics at the first stage range from a low of 1.5685 to a high of 540.8360, and these F-statistics become larger as the number of sample observations increases. All Sargan statistics show the null hypotheses of exogeneity are not rejected at the conventional significance levels. Almost all signs and magnitudes of IV estimates are very similar as those in Table 2. We add the IV estimates of the sensitivity of investment to cash flow to Figure 3 and find the sensitivity display a very similar trend to OLS estimates. In addition, Machokoto et al. find, during the last global financial crisis when credit constraints were more significant and binding, the sensitivity of investment to cash flow disappears even for constrained firms [13]. In contrast to the findings of Machokoto et al. [13], the results over three continuously rolling subperiods 2004 to 2008, 2005 to 2009, and 2006 to 2010 in Tables 3 and 5 show the sensitivity does not disappear but still maintains a declining trend during the crisis in China. We argue that it is highly probable that a Four Trillion Stimulus policy, which was launched by China’s central government in 2008, has a relaxation effect of financial constraints at the firm level (The discussions on the financial crisis, the Four Trillion Stimulus policy, and its effects in China are beyond our scope. On the crisis, the policy and the effects in China, see Ouyang and Peng [31]). We follow Erickson and Whited [8] and use high-order moment estimators including the third order moment through the seventh moment to further perform a robustness check. The results show very similar trend to those in Tables 3 and 5.

Table 5. Sensitivity of Investment to Cash Flow and External Financing.

| Equation (9.1) | Ext | Q_{t-1} | N  | R² | CF | Ext | Q_{t-1} | N  | R² |
|---------------|-----|---------|----|----|----|-----|---------|----|----|
| Panel A       |     |         | 14,577 |    |    |     |         | 14,577 |    |    |
| Sensitivity and external financing over full sample   |     |         |       |    |    |     |         |       |    |    |
|              | 0.2154 *** | 0.0079 *** | 0.2271 | 0.1709 *** | 0.2657 *** | 0.0102 *** | 0.2271 | 0.1709 *** | 0.2657 *** | 0.0102 *** |
|              | (0.0170)   | (0.0020)   | (0.0146) | (0.0020) | (0.0250) | (0.0021) | (0.0146) | (0.0020) | (0.0250) | (0.0021) |

| Equation (9) | Ext | Q_{t-1} | N  | R² |
|--------------|-----|---------|----|----|
| Panel B      |     |         | 157 |    |    |
| Sensitivity and external financing over rolling five-year subperiods |     |         |    |    |
|              | P_1 | 0.2367 *** | 0.2433 *** | 0.1836 *** | 157 | 0.2840 |
|              |     | (0.0825) | (0.0984) | (0.0677) |    |    |
|              | P_2 | 0.3014 *** | 0.2692 *** | 0.2398 *** | 157 | 0.3854 |
|              |     | (0.0796) | (0.0990) | (0.0638) |    |    |
|              | P_3 | 0.3425 *** | 0.3617 | 0.0491 | 175 | 0.5434 |
|              |     | (0.0524) | (0.7631) | (0.0474) |    |    |
|              | P_4 | 0.3967 *** | 0.4110 *** | 0.1403 * | 188 | 0.6035 |
|              |     | (0.0546) | (0.0666) | (0.0717) |    |    |
|              | P_5 | 0.3049 | 0.3514 *** | 0.0380 | 218 | 0.5725 |
|              |     | (0.4830) | (0.0601) | (0.0776) |    |    |
Table 5. Cont.

| Ext       | Q_{t-1} | N      | R^2     | CF       | Ext       | Q_{t-1} | N      | R^2     |
|-----------|---------|--------|---------|----------|-----------|---------|--------|---------|
| P_6       | 0.2980 *** | 0.3204 *** | −0.0479 * | 0.0349 | (0.0461) | (0.0260) | 359    | 0.5871 |
| P_7       | 0.2701 *** | 0.3615 *** | 0.0014  | 0.0262 | (0.0265) | (0.0075) | 1189   | 0.4497 |
| P_8       | 0.1988 *** | 0.3281 *** | 0.0132 *** | (0.0135) | (0.0141) | (0.0034) | 2105   | 0.3622 |
| P_9       | 0.1839 *** | 0.2729 *  | 0.0157 *** | (0.0098) | (0.1436) | (0.0024) | 3155   | 0.3533 |
| P_10      | 0.1665 *** | 0.3737 *** | 0.0143 *** | (0.0083) | (0.0074) | (0.0018) | 4192   | 0.2930 |
| P_11      | 0.1592 *** | 0.3992 *** | 0.0100 *** | (0.0079) | (0.0063) | (0.0019) | 4816   | 0.2640 |
| P_12      | 0.1497 *** | 0.3888 *** | 0.0036 *** | (0.0077) | (0.0060) | (0.0019) | 5644   | 0.2265 |
| P_13      | 0.1652 *** | 0.4175 *** | 0.0059 *** | (0.0081) | (0.0064) | (0.0019) | 6395   | 0.2308 |
| P_14      | 0.1996 *  | 0.3480 *** | 0.0083 *** | (0.1051) | (0.0080) | (0.0021) | 6938   | 0.2998 |
| P_15      | 0.1450 *** | 0.4815 *** | 0.0086 *** | (0.0091) | (0.0071) | (0.0020) | 6256   | 0.2911 |
| P_16      | 0.1317 *** | 0.3691 *** | 0.0112  | (0.0109) | (0.0083) | (0.0026) | 4943   | 0.2872 |
| P_17      | 0.1204 *** | 0.4497 *** | 0.0117 *** | (0.0142) | (0.0097) | (0.0032) | 3567   | 0.3180 |
| P_18      | 0.1340 *** | 0.4605 *** | 0.0136 *** | (0.0157) | (0.0111) | (0.0036) | 2342   | 0.3650 |
| P_19      | 0.1069 *** | 0.4785 *** | 0.0134 *** | (0.0159) | (0.0199) | (0.0051) | 2069   | 0.3657 |

Table 5 reports the empirical results from the regressions of investment \( I_t \) on cash flow \( CF_t \), external financing \( EXT_t \), and \( Q_{t-1} \) over the full sample and the rolling nineteen five-year subperiods. Variables \( I_t \), \( CF_t \), and \( EXT_t \) are scaled by one-period lagged total assets \( K_{t-1} \). All regressions specify firm and industry-year fixed effects. Standard errors are heteroskedasticity consistent and clustered at the firm level and are shown between brackets. \(*\), \(**\), and \(***\) denote significance at the 1%, 5%, and 10% level, respectively.

4.3. An Inference

So far, we have established that the sensitivity of investment to cash flow decreases at the firm level over time. If the decline in the sensitivity is caused by the relaxing financial constraints, it would be highly probable that firms have easier access to external financing over time. The relaxations of financial constraints allow firms to rely more on externally generated funds. We hence make an inference that while the sensitivity of investment to cash flow drops down, the sensitivity of investment to external financing increases over time. If the inference is not statistically supported, there are reasons to doubt the aforementioned empirical designs and results. Of course, while this inference is supported by the data, it is not necessarily caused by a decline in investment-cash flow sensitivity. The validation of the inference plays a role here similar to that of a placebo test. We test the inference using Equation (9) as follows:

\[
I_{i,t}/K_{i,t-1} = \beta_1(CF_{i,t}/K_{i,t-1}) + \beta_2 EXT_{i,t}/K_{i,t-1} + \beta_3Q_{i,t-1} + \alpha_i + \mu_{ind,t} + \epsilon_{i,t} \quad (9)
\]

where \( EXT \) represents the change in book equity plus total debts. The remaining variables are defined previously.

Table 5 includes the results from Equation (9). As a comparison, we also report the results for cash flow that does not enter Equation (9). We define it as Equation (9.1). The results from Equation (9) show the estimates of the coefficients on \( CF \) and \( EXT \) are 0.1709 and 0.2657 over the full sample, respectively. The coefficients on \( CF \) and \( EXT \) are both
significant at the 1% level. It shows that the sensitivity of investment to external funds is greater than that of investment to cash flow. The estimate of the coefficient on EXT in Equation (9.1) is 0.2154, the coefficient is significant at the 1% level, and $R^2$ is 0.2271. In contrast, the estimate of the sensitivity of investment to cash flow of Equation (6) is 0.0481 over the full sample, the coefficient is significant at the 1% level, and the $R^2$ is 0.0264. The results show that the variation in investment is primarily explained by external funds rather than cash flow. We turn to the results over the rolling nineteen subperiods in Panel B and we find almost all the estimates of the coefficients on CF and EXT are positive, and the coefficients on CF and EXT are significant at the conventional levels. The estimates of the coefficients on EXT are much larger than those on CF except for 0.2692 less than 0.3014 over the subperiod 1999 to 2003. The results over subperiods primarily corroborate those over the full sample.

The inference consists of two recursive propositions. The first proposition is, after controlling for EXT and Tobin’s Q, the sensitivity of investment to cash flow fades over time. If the proposition is not rejected, we further test the second one that investment relies more and more on external funds over time. Table 6 reports the results from the two recursive tests. Test 1 is the results from the regression of the estimates of the coefficients on CF in Equation (9) on the time trend. We find that the estimate of the coefficient on the trend is $-0.0112$, the standard error is 0.0022, and the hypothesis of coefficient equal to zero is significant at the 1% level. The results indicate that we cannot reject the first proposition. We next perform another regression of the estimates of the coefficients on EXT of Equation (9) on the time trend. Test 2 shows the estimate of the coefficient on the trend is 0.0091, the robust standard error is 0.0023, and the hypothesis of the trend coefficient equal to zero is significant at the 1% level. The results show the proposition that increasing dependence of firms’ investment on externally generated funds are statistically supported. In light of the results from the two recursive tests, we draw a conclusion that the inference that the sensitivity of investment to external funds increases over time is statistically supported. Although increasing reliance of investment on external funding is not necessarily caused by a decrease in investment cash flow sensitivity, our confidence in the previous empirical findings is further reinforced by the fact that the inference of increasing reliance of investment on external funding is confirmed by the data. The aforementioned findings suggest that compared to internal funding, external funding is becoming increasingly important in supporting firms’ investment-induced sustainability.

Table 6. Tests for the Sensitivity of Investment to External financing.

|                | Test 1       | Test 2       |
|----------------|--------------|--------------|
| Trend          | $-0.0112$ ***| 0.0091 ***   |
|                | (0.0021)     | (0.0023)     |
| N              | 19           | 19           |
| $R^2$          | 0.6174       | 0.4630       |
| F-stats        | 27.12        | 14.66        |

Table 6 reports tests for the sensitivity of investment to external financing. The dependent variable in the test 1 is estimates of the coefficient on cash flow and the dependent in the test 2 is estimates of the coefficients on external financing. The intercepts are not reported. Robust standard errors are shown between brackets. *** denote significance at the 1% level.

5. Asymmetric Changes in the Sensitivity of Investment to Cash Flow

Although investment-cash flow sensitivity decreases over time, firms’ financial positions can exhibit heterogeneity. While some firms have looser external financing constraints, others face tighter external financing constraints. Thus, there are gaps in the sensitivity of investment to cash flow between firms with tighter and looser financing constraints. We examine in this section whether the gaps in the sensitivity of investment to cash flow broaden or narrows over time. To that end, we employ five classification schemes. Specifically, we divided the sample by company size, whether a company pays cash dividends, whether a company has government equity, the WW index, and the HP index and then
perform regressions of investment to cash flow over the subperiods. Tables 7 and 8 report the empirical results.

Table 7. Asymmetric Changes in the Sensitivity: the Single Index.

|                  | SIZE       | DIVD       | GOVT       |
|------------------|------------|------------|------------|
|                  | ≤ q30      | ≥ q70      |            |
| Panel A: sensitivity over full sample |            |            |            |
| P0                | 0.0969 *** | 0.0892 *** | −0.0124 ***|
|                   | (0.0230)   | (0.0141)   | (0.0206)   |
| P1                | 0.4062 *** | 0.2287     | 0.0101     |
|                   | (0.1200)   | (0.2137)   | (0.1014)   |
| P2                | 0.3921 *** | 0.2446     | 0.0904     |
|                   | (0.1061)   | (0.1621)   | (0.1857)   |
| P3                | 0.3773 *** | 0.5472 *   | 0.1335     |
|                   | (0.0793)   | (0.2880)   | (0.1781)   |
| P4                | 0.4084 *** | 0.5785 **  | 0.0996     |
|                   | (0.0865)   | (0.2314)   | (0.2088)   |
| P5                | 0.2467 *** | 0.3967 *   | −0.3321 *  |
|                   | (0.0800)   | (0.2187)   | (0.1786)   |
| P6                | 0.4201 *** | 0.5701 *** | −0.1638 *  |
|                   | (0.0786)   | (0.1581)   | (0.1221)   |
| P7                | 0.3510 *   | 0.2807 **  | 0.0331     |
|                   | (0.1971)   | (0.1143)   | (0.0787)   |
| P8                | 0.0994     | 0.2593 *** | 0.0458     |
|                   | (0.0692)   | (0.0322)   | (0.0494)   |
| P9                | 0.1203 *** | 0.1343 *** | 0.0529     |
|                   | (0.0431)   | (0.0300)   | (0.0351)   |
| P10               | 0.1225 *** | 0.1000 *** | 0.0323     |
|                   | (0.0381)   | (0.0226)   | (0.0293)   |
| P11               | 0.1370 *** | 0.0931 *** | 0.0421     |
|                   | (0.0367)   | (0.0200)   | (0.0287)   |
| P12               | 0.1406 *** | 0.0666 *** | 0.0371     |
|                   | (0.0318)   | (0.0191)   | (0.0311)   |
| P13               | 0.1520 *** | 0.0707 *** | −0.0206 ***|
|                   | (0.0331)   | (0.0174)   | (0.0342)   |
| P14               | 0.1325 *** | 0.0500 *** | −0.0720 ** |
|                   | (0.0375)   | (0.0176)   | (0.0338)   |
| P15               | 0.0474     | 0.0294     | −0.0709 *  |
|                   | (0.0397)   | (0.0253)   | (0.0392)   |
| P16               | 0.0016     | 0.0208     | −0.0951 ** |
|                   | (0.0493)   | (0.0344)   | (0.0466)   |
| P17               | −0.0627    | 0.0294     | −0.1004 *  |
|                   | (0.0627)   | (0.0449)   | (0.0579)   |
| P18               | −0.0506    | 0.0079 *** | −0.0432 ***|
|                   | (0.0880)   | (0.0037)   | (0.0778)   |
| P19               | 0.1061 *   | 0.0700 *   | 0.0471     |
|                   | (0.0603)   | (0.0357)   | (0.0887)   |

Table 7 only presents asymmetric changes in the sensitivity in terms of the single index: size, dividends dummy, and government dummy. Columns ≤ q30 and ≥ q70 denote the bottom and top three deciles of the distribution of the natural logarithm of firms’ total assets, which are GDP deflator-adjusted to the base year 1998, respectively. DIVD is 1 if a firm pays cash dividends and 0 otherwise in a given year. GOVT is defined as 1 if a firm owns government equity and 0 otherwise in a given year. The two dummy variables are interacted with cash flow. All regressions specify firm and industry-year fixed effects. Standard errors are heteroskedasticity consistent and clustered at the firm level and are shown between brackets. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
Table 8. Asymmetric Change in the Sensitivity: the Composite Index.

| WW index | HP index |
|----------|----------|
| ≤q30     | ≥q70     | ≤q30     | ≥q70     |
| Panel A: Sensitivity over full sample |
| P0       | 0.0183 *** 0.1308 *** 0.0729 *** 0.1125 *** |
|          | (0.0077) (0.0175) (0.0223) (0.0125) |
|          | Panel B: Sensitivity over rolling five-year subperiods |
| P1       | 0.0107 ** 0.3292 *** 0.3485 * 0.6606 *** |
|          | (0.0051) (0.0234) (0.0195) (0.2202) |
| P2       | 0.0166 ** 0.3612 * 0.3626 ** 0.6667 *** |
|          | (0.0078) (0.1694) (0.1265) (0.1905) |
| P3       | 0.0308 * 0.2748 ** 0.3660 *** 0.6658 *** |
|          | (0.0171) (0.1166) (0.0810) (0.1040) |
| P4       | −0.0420 0.2911 ** 0.3983 *** 0.5248 *** |
|          | (0.0550) (0.1343) (0.0841) (0.1125) |
| P5       | 0.0220 ** 0.2069 * 0.0343 0.3845 *** |
|          | (0.0083) (0.1360) (0.1579) (0.1368) |
| P6       | 0.0365 ** 0.4224 ** 0.0306 0.5207 *** |
|          | (0.0180) (0.1737) (0.1408) (0.1090) |
| P7       | −0.2285 0.2268 * 0.0902 0.1918 *** |
|          | (0.1876) (0.1157) (0.1381) (0.0604) |
| P8       | −0.0403 0.1805 *** 0.0615 * 0.1408 *** |
|          | (0.0449) (0.0464) (0.0419) (0.0280) |
| P9       | 0.0010 ** 0.1745 *** 0.0778 *** 0.1311 *** |
|          | (0.0004) (0.0323) (0.0292) (0.0206) |
| P10      | 0.0482 * 0.1485 *** 0.1102 *** 0.1219 *** |
|          | (0.0246) (0.0257) (0.0219) (0.0174) |
| P11      | 0.0783 *** 0.1250 *** 0.1161 *** 0.1208 *** |
|          | (0.0228) (0.0241) (0.0204) (0.0156) |
| P12      | 0.0475 ** 0.1044 *** 0.1125 *** 0.0888 *** |
|          | (0.0231) (0.0240) (0.0194) (0.0143) |
| P13      | 0.0138 ** 0.0963 *** 0.0906 *** 0.0911 *** |
|          | (0.0050) (0.0227) (0.0200) (0.0139) |
| P14      | 0.0019 * 0.0309 *** 0.0864 *** 0.0696 *** |
|          | (0.0009) (0.0023) (0.0210) (0.0137) |
| P15      | 0.0034 0.0204 0.0262 0.0690 *** |
|          | (0.0292) (0.0281) (0.0228) (0.0145) |
| P16      | 0.0132 ** 0.0201 * −0.0034 0.0420 ** |
|          | (0.0046) (0.0106) (0.0301) (0.0176) |
| P17      | −0.0022 0.0255 ** −0.0134 0.0179 *** |
|          | (0.0562) (0.0102) (0.0413) (0.0046) |
| P18      | −0.1781 0.0976 −0.0169 0.0197 *** |
|          | (0.1863) (0.0684) (0.0617) (0.0038) |
| P19      | 0.0530 *** 0.0549 ** 0.1396 ** 0.1197 *** |
|          | (0.0084) (0.0224) (0.0594) (0.0238) |

Table 8 reports asymmetric changes in the sensitivity in terms of the composite index: the WW index and the HP index. The WW index is given by \(-0.091 \times CF/Assets − 0.062 \times Dividend Payer Dummy + 0.021 \times long-term debt/Assets − 0.044 \times \log (Assets) + 0.102 \times industry median sales growth ratio − 0.035 \times sales growth ratio\). The HP index is equal to \(-0.737 \times \log (Assets) + 0.043 \times \log (Assets)^2 + 0.04 \times firm’s age\). Columns \(\leq q30\) and \(\geq q70\) denote the bottom and top three deciles of the distribution of the WW and HP scores in a given year, respectively. All regressions specify firm and industry-year fixed effects. Standard errors are heteroskedasticity consistent and clustered at the firm level and are shown between brackets. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

5.1. Results from Classification by the Single Index

A firm is classified as tighter (looser) external financing constraints if the natural logarithm of its assets, which are GDP deflator-adjusted to the base year 1998, is the bottom (top) three deciles of the distribution each year. Columns \(\leq q30\) and \(\geq q70\) in Table 7 present the empirical results of the subsamples of the bottom and the top three deciles, respectively.
Panel A of Table 7 shows that, as opposed to 0.0892 of the top three deciles, the estimate of sensitivity coefficient on cash flow is 0.0969 of the bottom three deciles. The two sensitivity coefficients are both statistically significant at the 1% level. The results demonstrate firms that are classified as tighter financing constraints face more financial frictions, have less channels to external funds, and have to rely more on internally generated cash flow. We further move on to the results of rolling subperiods in Panel B and find the findings are further corroborated by fifteen of the nineteen estimates of sensitivity. Our findings are consistent with financial constraint hypothesis [1,32] and are not consistent with agency conflict theory [33,34].

The column of DIVD in Table 7 presents the results from classification by whether a firm pays cash dividend. We define the dummy as 0 if a firm did not pay cash dividend and 1 otherwise in a given year. The empirical results from both the full sample and rolling subperiods consistently suggest the DIVD does not effectively capture whether a firm faces tighter or looser financial constraints in China. The results are not consistent with either the financial constraint hypothesis [14,32] or agency conflict theory [33,34]. We speculate on the reason why cash dividends are not a useful index indicating external financing constraints. We refer back to the relevant regulatory policies on cash dividends for listed companies in China. In May 2006, China Securities Regulatory Commission (CSRC) issued the Measures for the Administration of Securities Issuance by Listed Companies, which stipulate that the cumulative profits distributed in cash by listed companies in the last three years shall not be less than 20% of the average annual distributable profits realized in the last three years. In October 2008, the CSRC also issued the Decision on Amending Regulations on Cash Dividends for Listed Companies, which required listed companies to increase the above-mentioned cash dividend ratio from the original 20% to 30%. It is easy to see that these two policies not only make mandatory dividend distribution requirements for cash dividends of listed companies in China, but also stipulate the dividend distribution ratio. Therefore, the variation of cash dividends paid by China’s listed companies would be small, and thus the coefficient on cash dividends would be statistically insignificant. We use a dummy DIVD as a proxy for external financing constraints, and its mean in Table 1 is 0.84. It is a figure that reflects the fact that firms have distributed cash dividends in the vast majority of years as required by regulations.

Existing research shows that firms with government equity face fewer financial constraints and have easier access to external funding than privately owned firms [35,36]. To capture this financing asymmetry, we define a dummy variable GOVT based on whether the firm owns government equity. GOVT is defined as 1 if a firm owns government equity and 0 otherwise each year. The column GOVT in Table 7 reports the empirical results. For the full sample in Panel A, the estimate of the coefficient on GOVT is $-0.0327$ and the null hypothesis that there is not a difference in external financing access is significant at the 1% level. We move on to the rolling five-year regressions and find that all the nineteen estimates of coefficients on GOVT are negative and fifteen of the nineteen null hypotheses are significant at the conventional significance levels. The results are consistent with those over the full sample. IV-based estimates of the classifications using one-period and two-period lagged returns as instruments for Tobin’s Q are very similar to those reported in Table 7. To save space, the IV-based estimates of classification regressions by the single and the composite indices are presented in Appendix B. In sum, listed firms with government equity rely less on internal funds than those with private. Whether a firm owns government equity or not is a second factor that results in a gap in the sensitivity of investment to cash flow in China.

5.2. Results from Classification by the Composite Index

The WW index is constructed according to Whited and Wu [29]. It uses more dimensions including a firm’s size, cash flow, cash dividends payment, liabilities, sales, and industry sales to measure a firm’s financial constraints than the HP index by Hadlock and Pierce [28], which relies heavily on firm size and age. By construction, the WW and HP
indices are both composite indices. Higher scores of the two indices suggest a firm faces tighter financing constraints. To save space, Table 8 reports the empirical results for the HP and the WW classifications.

We split the full sample into two groups according to the bottom \((<q_{30})\) and top \((>q_{70})\) three deciles of the distribution each year. Taking into account that the WW index is more composite, we take the WW index for an example. The estimates of sensitivity coefficients over the bottom and top groups are 0.0183 and 0.1308 over the full sample period in Panel A of Table 8, respectively. They are both significant at the 1% level. The results indicate according to the scheme by the WW index, the sensitivity of tighter financing constrained firms is quite a few times larger than that of the looser financing constrained counterparts.

We move on to the results in Panel B and find that thirteen of the nineteen sensitivity estimates for the top three-decile subperiods are greater than those of the bottom three-decile subperiods and the corresponding coefficients on cash flow are significant at the conventional levels. Although five of the remaining six estimates are unexpectedly negative, they are not significant at the conventional levels. The empirical results over the rolling five-year subperiods further corroborate the aforementioned findings over the full sample in Panel A. We turn to the HP index and find the results of the HP index remain qualitatively unchanged. The effect of cash flow predicted by the financial constraint explanation is present. The WW and the HP indices are useful to capture a firm’s financial constraints and the classifications by the two indices show gaps in the sensitivity of investment to cash flow in China.

We summarize the asymmetric changes in sensitivity coefficients between firms with tighter and looser external financing constraints in a visual way. As is previously defined, gap in sensitivity is the difference in investment-cash flow sensitivity between firms with tighter and looser external financing. The WW gap and the HP gap are the sensitivity differences between the top and bottom three deciles of the distributions of the WW scores and the HP scores, respectively. The size gap is the difference in sensitivity between the bottom and the top three deciles of the distribution of the natural logarithm of total assets GDP deflator-adjusted to the base year 1998. The government equity gap is the difference in sensitivity between firms without and with government equity. The cash dividend gap is the difference in sensitivity between the non-payment of cash dividends and the payment. Figure 4 plots the five sensitivity gaps including size gap, cash dividends gap, government equity gap, the HP gap, and the WW gap against the rolling nineteen subperiods.

Of the five gap lines, the WW gap line and the government equity gap line are both the most salient. The former is marked by the steel blue line with solid circles and is above the zero line. The latter is marked by the steel blue line with solid triangles and is below the line zero. We select both to describe the time-series pattern of the sensitivity gap. Each gap line can be split into two segments; the first segment is over the first seven subperiods and a second segment includes the last twelve subperiods. The two gaps in sensitivity on the first segment are larger than gaps on the second segment and, moreover, they are subject to larger fluctuation than gaps on the second segment. Each gap line as a whole shows a slightly downward trend and the gaps are narrowing to zero over time. The two lines of the size and the HP gaps display similar patterns to those of the WW and government equity gaps. In addition, we use one-period and two-period lagged returns as instruments for Tobin’s Q to investigate the asymmetric change in sensitivity of investment to cash flow and find the results are qualitatively unchanged.
is more composite, we take the WW index for an example. The estimates of sensitivity the difference in sensitivity between the non-payment of cash dividends and the payment of cash.

Figure 4. Time-Series Variation of the Sensitivity of Investment to Cash Flow. Figure 4 presents a plot of five sensitivity gaps against rolling nineteen-five-year subperiods. The gap is defined as the difference in the sensitivity of investment to cash flow between firms with tight versus loose financing constraints. The WW gap denotes the sensitivity difference between the top and bottom three deciles of the WW scores’ distribution. The HP gap is the sensitivity difference between the top and bottom three deciles of the HP scores’ distribution. The government equity gap is the sensitivity difference between classifications without and with government equity. The cash dividend gap is the difference in sensitivity between the non-payment of cash dividends and the payment of cash dividends. The size gap is defined as the sensitivity difference between the bottom and top three deciles of the distribution of firms’ total assets.

Based on the results from asymmetric changes in the sensitivity of investment to cash flow and the corresponding trend graphs, we find that although the gaps in the sensitivity of investment to cash flow between firms with tighter and looser external financing constraints exist, the prediction that gaps in the sensitivity of investment to cash flow broadens over time is not supported by the data. In contrast, the empirical evidence suggests that the gaps in the sensitivity of investment to cash flow between the two types of firms shrinks over time. The law similar to the Matthew effect that the tighter the external financing constraint the harder it is for a company to obtain external financing and the looser the external financing constraints the easier to obtain external financing does not appear. It suggests that the gap-reducing effect caused by the universal social evolution, institutional change, and technological progress is larger than this gap-widening effect brought about by the willingness of external suppliers of funds to finance firms with fewer financing constraints.

6. Conclusions

The long-term survival and development of enterprises, as one of the most basic social organizations for the allocation of various types of resources, depends on efficient investment and on adequate financing for that investment. That is, access to financing affects corporate sustainability.

We examine two issues related to the dependence of companies’ investment on internally generated funding. One is whether a declining trend in the sensitivity of investment to cash flow is exhibited in China; the other is to define the gaps in the sensitivity of investment to cash flow based on asymmetric changes in investment-cash flow sensitivity and further explore the trends in the gaps. We collected financial data from Chinese listed companies over the period 1998–2020. After collating the data, we finally obtained a sample including 2415 listed companies with a total of 19,864 firm-year observations. We find that, as in other countries, China’s firms exhibit not only a decreasing trend in investment cash flow sensitivity in the long run, but also evidence of a complete disappearance of sensitivity over a time horizon; there are gaps in the sensitivity of investment to cash flow caused by asymmetric changes in the sensitivity; the gaps are effectively explained by
firm size, government equity, and the HP and WW indices, but not by cash dividends; and the gaps in the sensitivity of investment to cash flow are narrowing in the long term. Our marginal contribution to the extant literature lies not only in China’s evidence of a continuous decline in investment-cash flow sensitivity, but also in the following two points: first, we define gaps in the sensitivity of investment to cash flow based on asymmetric changes in investment-cash flow sensitivity and then explore the trends of these gaps; second, based on China’s accounting standards for interest expense in the statement of cash flows, we modify the cash flow identity presented in the U.S. scenario literature. According to the modified identity, we propose the broadest measure of China’s firm investment to reflect the recent changes in investment measures.

The decreasing investment-cash flow sensitivity indicates that while internally generated funding has been a significant support for the companies’ investment, it is becoming less so in the long term. The long-term trend of the decreasing gaps in the sensitivity of investment to cash flow suggests that the easing of external financing constraints is not only universal for firms, but also does not exhibit a pattern similar to the Matthew effect. In other words, it does not exhibit a pattern in which firms with tighter financing constraints have less access to external financing and firms with looser financing constraints have easier access to external financing. The empirical findings have two implications. First, for corporate finance, the diminishing sensitivity of investment to cash flow suggests that the role of the sensitivity as a proxy for financing constraints is diminishing and that gaps in the sensitivity can be used as a measure of financial market integration. Second, for firm sustainability, compared to external financing, access to internal financing in supporting investment-induced sustainability is decreasing. The findings also provide insight into how to develop corporate sustainability policies for different types of companies based on gaps in the reliance of investment to cash flow and their changing trends.

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Appendix A

Table A1. GMM Estimation of the Sensitivity of Investment to Cash Flow.

| Period   | CF  | Q_{t-1} | N  | R²   | F-Stat   |
|----------|-----|---------|----|------|----------|
| Panel A: sensitivity over full sample | 0.0475 *** (0.0142) | 0.0330 *** (0.0124) | 14,577 | 0.1264 | 77.4257 *** |
| Panel B: sensitivity over rolling five-year subperiods | | | | |
| P1       | 0.1221 (0.0823) | 0.2007 ** (0.1115) | 155 | 0.0847 | 6.0975 ** |
| P2       | 0.1781 ** (0.0884) | 0.2732 *** (0.0912) | 157 | 0.2246 | 21.6254 *** |
| P3       | 0.2228 *** (0.0773) | 0.1014 (0.0667) | 175 | 0.2365 | 9.1444 *** |
| P4       | 0.3075 *** (0.0952) | 0.2073 *** (0.0779) | 188 | 0.2224 | 10.4457 *** |
| P5       | 0.1868 ** (0.0900) | 0.2027 ** (0.1013) | 218 | 0.1104 | 7.4471 *** |
| P6       | 0.2003 *** (0.0786) | −0.0113 (0.0391) | 359 | 0.1286 | 9.4621 *** |
| P7       | 0.1434 *** (0.0453) | 0.0223 (0.0203) | 1189 | 0.0977 | 24.1513 *** |
| P8       | 0.0976 *** (0.0342) | 0.0147 (0.0249) | 2105 | 0.0635 | 18.5575 *** |
| P9       | 0.0887 *** (0.0342) | 0.0175 *** (0.0060) | 3155 | 0.0889 | 23.4114 *** |
| P10      | 0.0766 *** (0.0214) | 0.0160 *** (0.0044) | 4192 | 0.0475 | 20.4064 *** |
| P11      | 0.0703 *** (0.0248) | 0.0143 *** (0.0034) | 4816 | 0.0968 | 36.7114 *** |
| P12      | 0.0659 *** (0.0144) | 0.0103 *** (0.0047) | 5644 | 0.0207 | 28.1582 *** |
| P13      | 0.0613 *** (0.0101) | 0.0155 *** (0.0043) | 6395 | 0.0630 | 16.8220 *** |
| P14      | 0.0533 *** (0.0107) | 0.0127 *** (0.0043) | 6938 | 0.0521 | 28.4414 *** |
| P15      | −0.0018 (0.0417) | 0.0225 *** (0.0034) | 6256 | 0.0721 | 25.2206 *** |
| P16      | −0.0103 (0.0106) | 0.0170 *** (0.0075) | 4943 | 0.0531 | 23.5512 *** |
| P17      | −0.0211 (0.0343) | 0.0198 *** (0.0069) | 3567 | 0.0541 | 30.2274 *** |
| P18      | −0.0056 (0.0307) | 0.0305 *** (0.0053) | 2342 | 0.0885 | 33.6288 *** |
| P19      | 0.0310 * (0.0329) | 0.0411 *** (0.0099) | 2069 | 0.0479 | 25.402 *** |

Table A1 reports estimates of sensitivities, standard errors, sample sizes (N), R²s, and F statistics from the GMM7 (using the third up to the seventh moments) (Erick and Whited, 2000) over the full sample and the rolling five-year subperiods. The dependent variables are investment \( I_t \) scaled by one-period lagged total assets \( K_{t-1} \). The explanatory variables include cash flow \( CF_t \) divided by one-period lagged total assets and one-period lagged Marginal \( Q_{t-1} \). All regressions specify firm and industry-year fixed effects. Standard errors are heteroskedasticity consistent and clustered at the firm level and are shown between brackets. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
### Appendix B

**Table A2. Asymmetric Changes in the Sensitivity Using IV Estimator: the Single Index.**

| SIZE | ≤ q30 | ≥ q70 | DIVD | GOVT |
|------|-------|-------|------|------|
| Panel A: sensitivity over full sample |
| P0   | 0.0914 *** | 0.0892 *** | −0.0039 | −0.0339 *** |
|      | (0.0349)   | (0.0141)   | (0.0102) | (0.0112) |
| P1   | 0.4102 *** | 0.2301 | 0.0112 | −0.1490 |
|      | (0.1005)   | (0.2211)   | (0.1095) | (0.1733) |
| P2   | 0.3932 **  | 0.2450 *  | 0.0910 | −0.1447 * |
|      | (0.1787)   | (0.1361)   | (0.1032) | (0.8053) |
| P3   | 0.3800 *** | 0.4498 | 0.1348 ** | −0.1901 |
|      | (0.1705)   | (0.3658)   | (0.0612) | (0.1306) |
| P4   | 0.4090 *   | 0.5790 ** | 0.0104 | −0.2109 ** |
|      | (0.2272)   | (0.2632)   | (0.2011) | (0.9098) |
| P5   | 0.2504 *** | 0.3812 *  | −0.3259 | −0.3551 ** |
|      | (0.0915)   | (0.2006)   | (0.1949) | (0.1489) |
| P6   | 0.4211 *** | 0.5698 *** | −0.1542 | −0.2189 * |
|      | (0.1054)   | (0.1581)   | (0.1225) | (0.1216) |
| P7   | 0.3499 *   | 0.2816 *** | 0.0441 | −0.0910 |
|      | (0.1842)   | (0.1002)   | (0.0659) | (0.0767) |
| P8   | 0.1001     | 0.2601 *** | 0.0447 | −0.0622 ** |
|      | (0.0821)   | (0.0544)   | (0.0407) | (0.0280) |
| P9   | 0.1205 *** | 0.1351 *** | 0.0502 * | −0.0697 *** |
|      | (0.0396)   | (0.0481)   | (0.0264) | (0.0199) |
| P10  | 0.1227     | 0.1004 *** | 0.0331 | −0.0330 ** |
|      | (0.1409)   | (0.0335)   | (0.0301) | (0.0150) |
| P11  | 0.1359 *** | 0.0942**  | 0.0418 | −0.0424** |
|      | (0.0358)   | (0.0428)   | (0.0290) | (0.0192) |
| P12  | 0.1403***  | 0.0662 *** | 0.0381 | −0.0441 *** |
|      | (0.0298)   | (0.0221)   | (0.0321) | (0.0201) |
| P13  | 0.1518 *** | 0.0710 *** | 0.0109 | −0.0539 *** |
|      | (0.0369)   | (0.0204)   | (0.0356) | (0.0089) |
| P14  | 0.1319 *** | 0.0498 *** | −0.0658 ** | −0.0858 ** |
|      | (0.0356)   | (0.0156)   | (0.0340) | (0.0290) |
| P15  | 0.0468     | 0.0288 | −0.0668 * | −0.0661 *** |
|      | (0.0402)   | (0.0301)   | (0.0417) | (0.0084) |
| P16  | 0.0018     | 0.0210 | −0.0968 ** | −0.0318 *** |
|      | (0.0501)   | (0.0306)   | (0.0466) | (0.0049) |
| P17  | −0.0609    | 0.0289 | −0.1101 * | −0.0454 *** |
|      | (0.0598)   | (0.0324)   | (0.0579) | (0.0087) |
| P18  | −0.0498    | 0.0084 *** | −0.0658 | −0.0312 ** |
|      | (0.0755)   | (0.0021)   | (0.0778) | (0.0101) |
| P19  | 0.1074     | 0.0705 *  | 0.0480 | −0.0310 ** |
|      | (0.0925)   | (0.0371)   | (0.0759) | (0.0135) |

Table A2 only presents asymmetric changes in the sensitivity using IV estimator in terms of single indices: size, dividends dummy, and government dummy. Columns ≤ q30 and ≥ q70 denote the bottom and top three deciles of the distribution of the natural logarithm of firms' total assets, which are GDP deflator-adjusted to the base year 1998, respectively. DIVD is 1 if a firm pays cash dividends and 0 otherwise in a given year. GOVT is defined as 1 if a firm owns government equity and 0 otherwise in a given year. The two dummy variables are interacted with cash flow. All regressions specify firm and industry-year fixed effects. Standard errors are heteroskedasticity consistent and clustered at the firm level and are shown between brackets. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
References

1. Fazzari, S.; Hubbard, R.; Petersen, B. Financial constraints and corporate investment. *Brook. Pap. Econ. Act.* 1988, 1, 141–195. [CrossRef]

2. Hoshi, T.; Kashyap, A.; Scharfstein, D. Corporate structure, liquidity, and investment: Evidence from Japanese industrial groups. *Q. J. Econ.* 1991, 106, 33–60. [CrossRef]

3. McLean, D.R.; Zhang, T.; Zhao, M. Why does the law matter? Investor protection and its effects on investment, finance, and growth. *J. Financ.* 2012, 67, 313–350. [CrossRef]

4. Larkin, Y.; Ng, L.; Zhou, J. The fading of investment-cash flow sensitivity and global development. *J. Corp. Financ.* 2018, 50, 294–322. [CrossRef]

5. Kaplan, S.; Zingales, L. Do investment-cash flow sensitivities provide useful measures of financing constraints. *Q. J. Econ.* 1997, 112, 169–215. [CrossRef]

6. Cleary, S. The relationship between firm investment and financial status. *J. Financ.* 1999, 54, 673–692. [CrossRef]

7. Almeida, H.; Campello, M.; Galvao, A. Measurement error in investment equation. *J. Corp. Financ.* 2010, 76, 742–755. [CrossRef]

8. Erickson, T.; Whited, T.M. Two-step GMM estimation of the errors-in-variables model using high-order moments. *Econ. Theory* 2002, 18, 776–799. [CrossRef]

9. Erickson, T.; Whited, T.M. Treating measurement error in Tobin’s Q. *Rev. Financ. Stud.* 2012, 25, 1286–1329. [CrossRef]

10. Wei, L.; Wenjun, W.; Sulkowski, A.J.; Wu, J. The relationships between environmental management, firm value and other firm attributes: Evidence from Chinese manufacturing industry. *Int. J. Environ. Sustain. Dev.* 2011, 10, 78–95.

11. Chen, H.; Chen, S. Investment-cash flow sensitivity cannot be a good measure of financial constraints: Evidence from the Time Series. *J. Financ. Econ.* 2012, 103, 393–410. [CrossRef]

12. Moshirian, F.; Nanda, V.; Zhang, A.; Zhang, B. What drives investment cash flow sensitivity around the world? An asset tangibility perspective. *J. Bank Financ.* 2017, 77, 1–17. [CrossRef]

13. Machokoto, M.; Tanveer, U.; Ishaq, S.; Areneke, G. Decreasing investment—Cash flow sensitivity: Further UK evidence. *Finance Res. Lett.* 2021, 38, 1–7. [CrossRef]

14. Lewellen, J.; Lewellen, K. Investment and cash flow: New evidence. *J. Financ. Quant. Anal.* 2016, 51, 1135–1164. [CrossRef]

15. Sun, J.; Yamori, N. Regional disparities and investment-cash flow sensitivity: Evidence from Chinese listed firms. *Pac. Econ. Rev.* 2009, 14, 657–667. [CrossRef]

16. Wang, Z.; Wang, Q.; Xu, M. Short Debt Maturity and Corporate Investment: New Evidence from Chinese Listed Firms. *Asset. Pric. Stud.* 2020, 51, 776–799. [CrossRef]

17. Yang, X.; Han, L.; Li, W.; Tian, L. Monetary policy, cash holding and corporate investment: Evidence from China. *China Econ. Rev.* 2017, 46, 110–122. [CrossRef]

18. Shiu, H.; Chang, Y.; Yang, Y. The cash holdings and corporate investment surrounding financial crisis: The cases of China and Taiwan. *China Econ. Rev.* 2018, 51, 175–207. [CrossRef]

19. Khan, M.A.; Qin, X.; Jebran, K.; Rashid, A. The sensitivity of firms’ investment to uncertainty and cash flow: Evidence from listed state-owned enterprises and non-state-owned enterprises in China. *Sage Open.* 2020, 10, 1–17. [CrossRef]

20. Miao, B.; Teoh, S.H.; Zhu, Z. Limited attention, statement of cash flow disclosure, and the valuation of accruals. *Rev. Account. Stud.* 2016, 21, 473–515. [CrossRef]

21. Bresnahan, T.F. Measuring the spillovers from technical advance: Mainframe computers in financial services. *Am. Econ. Rev.* 1986, 76, 742–755.

22. Giombini, G.; Teobaldelli, D.; Schneider, F. Interaction effect of tax evasion and legal system inefficiency on firms’ financial constraints. *Int. Rev. Econ. Financ.* 2018, 55, 1–20. [CrossRef]

23. Ang, J.S. On the theory of finance for privately held firms. *J. Financ.* 1992, 1, 185–203.

24. Hirshleifer, D.; Lim, S.S.; Teoh, S.H. Limited investor attention and stock market misreactions to accounting information. *Rev. Asset. Pric. Stud.* 2011, 1, 35–73. [CrossRef]

25. Miao, B.; Teoh, S.H.; Zhu, Z. Limited attention, statement of cash flow disclosure, and the valuation of accruals. *Rev. Account. Stud.* 2016, 21, 473–515. [CrossRef]

26. Compello, M.; Lin, C.; Ma, Y.; Zou, H. The real and financial implications of corporate hedging. *J. Financ.* 2011, 66, 1615–1647. [CrossRef]

27. Firth, M.; Chen, L.; Wong, S. Leverage and investment under A state-owned bank lending environment: Evidence from China. *J. Corp. Financ.* 2008, 14, 642–653. [CrossRef]

28. Hadlock, C.J.; Pierce, J.R. New evidence on measuring financial constraints: Moving beyond the KZ index. *Rev. Financ. Stud.* 2010, 23, 1909–1940. [CrossRef]

29. Whited, T.; Wu, G. Financial constraints risk. *Rev. Financ. Stud.* 2006, 19, 531–559. [CrossRef]

30. Almeida, H.; Compello, M.; Galvao, A. Measurement error in investment equation. *Rev. Financ. Stud.* 2010, 23, 3279–3328. [CrossRef]

31. Ouyang, M.; Peng, Y. The treatment-effect estimation: A case study of the 2008 economic stimulus package of China. *J. Econom.* 2015, 188, 545–557. [CrossRef]
32. Beatty, A.; Liao, S.; Weber, J. The effect of private information and monitoring on the role of accounting quality in investment decisions. *Contemp. Account. Res.* **2010**, *27*, 783–827. [CrossRef]

33. Jensen, M. Agency costs of free cash flow, corporate finance and takeovers. *Am. Econ. Rev.* **1986**, *76*, 323–329. [CrossRef]

34. Stulz, R. Managerial discretion and optimal financing policies. *J. Financ. Econ.* **1990**, *26*, 3–27. [CrossRef]

35. Lin, K.J.; Lu, X.; Zhang, J.; Zheng, Y. State-owned enterprises in China: A review of 40 years of research and practice. *China J. Account. Res.* **2020**, *13*, 31–55. [CrossRef]

36. Liu, Q.; Pan, X.; Tian, G. To what extent did the economic stimulus package influence bank lending and corporate investment decision? Evidence from China. *J. Bank. Financ.* **2018**, *86*, 177–193. [CrossRef]