The Impact of Climate Disasters on the Cost of Equity Capital: Evidence from China

XIAOJUN CHU[a] AND JING XU[a]

[a] *School of Management Science and Engineering, Nanjing University of Information Science and Technology, Nanjing, China*

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ABSTRACT: Climate change increases the probability and intensity of disaster and brings adverse impacts on social and economic activities. This paper presents the impact of climate risk on the cost of equity capital (COE) and sheds light on the influence mechanisms and moderating factors between climate disaster shocks and the COE in a developing country. We first explain how climate risk represented by drought impacts the COE theoretically. Using the sample data listed in A-share market from 2004 to 2019, we find that drought leads to the rise of the COE due to the deterioration of information environment and the rise of business risk. Specifically, the influence mechanism is tested, and the results show that 1) drought increases firms' real earnings management 2) and drought has a negative impact on the firms' return on asset (ROA). Namely, the influence mechanism of drought on the COE is that drought changes the firms' information environment and business activities. Further analysis shows that the impact of drought on the COE is different in a heterogeneous firm. The drought has a significant impact on the COE in firms with low-ability managers, state-owned enterprises, and politically connected firms, but the impact is not significant in firms with high-ability managers, non-state-owned enterprises, and nonpolitically connected firms. Our research helps people to understand the consequences of climate change from the microeconomic-level firm's perspective.

KEYWORDS: Drought; Climate change; Economic value

1. Introduction

In recent years, the frequency and intensity of extreme weather events are ramping up (Huang et al. 2017; Francis and Vavrus 2012). So far, most extant research finds the impact of climate disaster on economic growth is negative (Hsiang and Jina 2014; Felbermayr and Gröschl 2014; López et al. 2016; Alano and Lee 2016). In particular, climate disasters have a relatively strong macroeconomic impact on developing countries (Loayza et al. 2012; Panwar and Sen 2019; Fomby et al. 2013). As the principal of economic activities, firms' production and operation activities are affected by climate disasters. However, the impact of climate disasters on firms has so far not been well examined. Among climate disasters are amplified by climate change, the disaster most devastating to economic activities is drought (Lesk et al. 2016; Hong et al. 2019; Huynh et al. 2020). Therefore, we use drought to represent climate risk in this paper.

The extant literature on how disaster impacts firms shows that disaster negatively impacts firms' growth (Zhou and Botzen 2021), earnings management (Gao et al. 2019), and supply chain (Ye and Abe 2012). Huynh et al. (2020) discuss the impact of climate disaster on the cost of equity capital (COE) and conclude that there is a significant positive relationship between drought and COE. Kling et al. (2021) explore the effect of climate vulnerability on firms' cost of capital and find that climate vulnerability rises cost of debt but has a limited impact on the cost of equity. We aim to further enrich the research on the impact of climate related disasters on firms' cost of capital by providing empirical evidence from China.

Our empirical results show that drought is positively and significantly associated with the cost of equity of Chinese listed companies. Using a dummy variable, we confirm that the cost of equity is 10–20 basis points (bps) higher for firms headquartered in provinces affected by drought. Furthermore, we motivate a thorough discussion on the possible mechanisms through which drought might impact on the cost of the equity capital. We find that the occurrence of drought results in significant increased earnings management and declined profitability. This shows that the deterioration of the information environment and the business activities of firms are the two paths for drought to affect the cost of the equity capital. We further consider the different impacts of climate disasters on COE of heterogeneous firms. We anticipate that there are some key factors, such as manager ability, ownership structure, and political connections, that affect the impact of drought on the COE. We hold the opinion that the high-ability managers have more ways to hold back the rise of the COE. For state-owned enterprises (SOEs) and politically connected firms (PCFs), their debt financing ability to obtain bank loans is stronger than that of non-state-owned enterprises (NSOEs) and nonpolitically connected firms (NPCFs). At the same time, in China, both state-owned enterprises and politically connected firms may bear more social responsibilities in times of crisis, not just considering economic interests. As a result, the rise of COE of state-owned enterprises and politically connected firms after the drought is higher than that of non-state-owned enterprises and nonpolitically connected firms.

Our contributions to extant literature are as follows: First, we provide empirical evidence of the Chinese market. The literature mentioned above selects different samples to study the relationship between climate risk and COE. Specifically, Huynh et al. (2020) select data from 50 states in the United States, and Kling et al. (2021) cover more countries that are the members of the Climate Vulnerable Forum, such as Ghana, Bangladesh, Kenya, and Vietnam. To the best of our knowledge, the impact of drought on firms' COE has not been

Corresponding author: Xiaojun Chu, lpchxj@nuist.edu.cn

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examined based on a Chinese sample. Second, the dummy variable defined as whether drought occurs is used to measure climate risk in this paper. This differs from two existing articles that select Palmer drought severity index (PDSI) or Notre Dame Global Adaptation Initiative (ND-GAIN) to quantify climate risk. We just focus on whether the climate disaster occurs or not. Our motivation comes from previous financial literature. Brown et al. (2018) indicate that individuals' risk perceptions are changed by the struck of extreme events greatly. Risk premiums increase sharply following a disaster event (H. Chen et al. 2011). Therefore, we expect that the occurrence of drought increases investors' risk awareness and investors demand a higher risk premium. As a result, the COE increases.

The rest of the paper is as follows: section 2 reviews the relevant prior literature and develops hypotheses. Section 3 discusses the data and variables. Section 4 presents the empirical results. Section 5 presents further discussion and robustness test. Section 6 offers concluding remarks.

2. Literature review and hypotheses

a. *Climate risk and the cost of equity capital*

As mentioned by Hong et al. (2019), there is vulnerability in the production process of firms. Extreme weather has a significant negative impact on the production and operation of firms (Auffhammer et al. 2017; Byers et al. 2020). For example, high temperatures and drought cause mechanical and electrical equipment to be forced to stop to keep cool. With global warming, the increase of surface temperature leads to the increase of water vapor evaporation, which makes drought more likely to occur (Dai 2012). Extreme climate change also damages power facilities resulting in a reduction in power supply (Mukherjee and Nateghi 2019). To ensure residential electricity, the government generally limit firms' electricity, which leads to insufficient production. Besides, the high temperature affects the mood of workers in manufacturing firms (Fisher et al. 2012). According to the University of Illinois survey, labor efficiency is the highest when the temperature is at 20°C. With the increase of temperature, the labor efficiency drops sharply. The labor efficiency is only 75% of the highest efficiency when the temperature is 35°C, and only 50% of the highest efficiency when the temperature is 41°C. The working environment with a too-high temperature reduces the overall mood of workers, thus reducing labor productivity (Suzuki-Parker and Kusaka 2016; Xia et al. 2018). This further reduces productivity and increases business risk. Meanwhile, all industrial activities are directly or indirectly related to water (Yang et al. 2013). A sector's output could be affected by either its own production capacity or other industries (Acemoglu et al. 2012). Climate disaster cause disruption of supply chain (Ye and Abe 2012). The impact of drought on firm spreads to other units in the supply chain. Therefore, sectors that are not directly dependent on water may be sensitive to drought risk due to reduced production in other sectors directly affected by drought. Thus, climate risk is significantly negatively correlated with corporate profitability and positively correlated with the volatility of corporate profitability (Huang et al. 2018).

Adverse operating conditions arising from external factors increase firms' business risk. This creates incentives for the firm to engage in earnings manipulation activities. For example, Byard et al. (2007) show that in the aftermath of Hurricanes Katrina and Rita, large petroleum refining firms manage earnings through diminishing accruals. Besides, poor performance caused by climate risk may raise the probability of debt default or reduce the managers' compensation based on the firms' performance (Kim and Park 2005). Therefore, managers have greater motivation for earnings manipulation when firms face high climate risks. If firms engage in more earnings management, the market's information asymmetry are exacerbated (Khuong et al. 2020). Some insiders even take advantage of the opacity of real earnings management activities to participate in market transactions for additional benefits (Abad et al. 2018). These activities undertaken by the company manager will worsen the market environment. Consequently, investors require a higher return because of information asymmetry.

Climate disaster also affects the risk aversion of investors (Brown et al. 2018; Bourdeau-Brien and Kryzanowski 2020). When investors encounter an extreme event (such as drought), their risk perceptions are more sensitive (Brown et al. 2018) and require higher risk premiums. The theoretical models of Barro (2006) and Chen et al. (2012) show that disaster risk can explain the high equity premium observed in historical stock return data. There is the evidence that the losses of drought caused by high temperature have an impact on the subjective expectations of future climate disasters about the investors' universality and seriousness (Brown et al. 2018). These expectations in turn affect their investment decisions.

Therefore, the first hypothesis (H1) is as follows:

H1: The drought positively impacts on the COE due to the deterioration of the information environment and the rise of business risk.

b. *Differentiation effect of heterogeneous firms*

1) Manager ability

Because managers are central in the firms, manager ability has a profound effect on the firm performance (Bertrand and Schoar 2003). There is evidence that higher managerial ability is associated with higher credit ratings (Bonsall et al. 2016). Therefore, the competent managers can generate more cash flows or issue more debt to obtain more resources for their firms, thus increasing the timeliness and stability of resource supply in business activities (Andreou et al. 2017). Especially in the crisis period, they generate greater profitability (Andreou et al. 2017). Meanwhile, the high-ability managers are motivated to align the market with the firm's economic environment (Baik et al. 2011). Therefore, when compared with the low-ability managers, they would be more likely to issue forecasts frequently. Namely, high-ability managers transmit more information to the market than the low-ability managers (Baik et al. 2011). Investors have easier access to business information that managers want them to know. Simultaneously, the high-ability managers usually have more confidence in their investment decision and in reducing the future uncertainty of operation (Kim and Zhang 2016; Yuan et al. 2019). The manager's ability can reduce errors in bad debt provisions and firm-level restatements (Demerjian et al. 2013). Hence, even drought rise the COE, the investors have more confidence in the firms with high-ability managers, which can migrate the increasing effect of the COE.

To sum up, high-ability managers can better resist external shocks. Therefore, when a drought event occurs, high-ability managers can reduce the business risk and keep the information environment relatively transparent. The second hypothesis (H2) is as follows:

H2: The ability of managers plays a moderating role between the drought and the COE. The high-ability managers alleviate the impact of the COE caused by drought.

2) SOEs and NSOEs

SOEs and NSOEs are the unique economic setup in China (Safdar and Yan 2016). There are many differences between them. Specifically, first, SOEs do not necessarily aim at maximizing economic profits (Chen et al. 2014). SOEs have a greater policy burden to keep society stable (Xin et al. 2019). Second, SOEs are frequently intervened by the government in the form of policy decisions or political relations (Chen et al. 2014). This intervention reduces the predictability of business behavior and environment and increases the COE (Xu and Lv 2007). Third, SOEs receive financial assistance from government (Ren and Jack 2014). Banks also provide loans to SOEs at lower interest rates for nonprofit reasons (Brandt and Li 2003). Fourth, when compared with NSOEs, the information environment of SOEs is worse. The literature finds that the audit quality (Gaio and Pinto 2018) and earnings quality (Wang 2006) are worse in SOEs. This means a higher information risk and the investors requires a higher return. Last, due to the favor and support of the government in policy, the bankruptcy risk of SOEs is low (H. Chen et al. 2011). The government often guarantees the normal operation of SOEs through an implicit pledge to stabilize the economy and protect state-owned assets (Zhang and Wang 2020). Although the firm's finances are in trouble, the immediate reaction of investors is to regard the largest shareholder (i.e., the government) as the last resort to compensate for their investment losses (H. Chen et al. 2011).

Because of these differences, the business risk in SOEs is greater. Meanwhile, SOEs may deviate from the goal of maximizing firms' value and utilize the convenience provided by government to keep the information environment opaque. Thus, the information asymmetry increases. In this context, when drought occurs, SOEs lack incentives to control or decrease the COE (Lin et al. 2020). However, NSOEs control the rise of the COE actively in order to reduce the business risk and maintain their competitiveness in the market. They employ the managers based on their development needs (Ren and Jack 2014) and transmit more information to gain the trust of investors.

Based on the above discussion, the third hypothesis (H3) is as follows:

H3: The impact of drought on the COE in SOEs is greater than that in NSOEs.

3) PCFs and NPCFs

The ownership of SOEs implies they have natural political connections (Wu et al. 2012). NSOEs are not directly controlled by government, and the lack of an official connection with the government may place them at a relative disadvantage (Cumming et al. 2016). Therefore, the NSOEs need to build a bridge with the government, which is useful for them to reduce discrimination and seek rents in such a high-government-intervention environment (Li and Zhou 2005). Firms with political background can overcome the disadvantages and seek government-related benefits (Li et al. 2008). For example, it is easier for PCFs to receive bank loans (Khwaja and Mian 2005), subsidies (C. J. P. Chen et al. 2011), and bailouts (Faccio et al. 2006). Li et al. (2008) argue that PCFs indeed face better chances in accessing to loans from state-owned banks. Furthermore, PCFs are more likely to obtain financing by issuing bonds in China (Wang 2015). As a result, PCFs are relatively indifferent to the rising cost of equity financing (Hu et al. 2020).

Politically connected firms may make decisions that are contrary to the principle of firm value maximization (Shleifer and Vishny 1994). For example, when extreme disasters bring about huge economic losses and social upheaval, PCFs have a stronger incentive to participate in postdisaster reconstructions due to political pressure (Rao et al. 2021). These activities keep firms away from market-oriented economic goals (Fan et al. 2007). This is due to the fact that PCFs bear more social responsibility for the government (Xu and Liu 2020). Based on the reciprocity and fairness principle of social exchange, PCFs attempt to meet the expectations of government by shouldering social responsibility (Flammer 2018). When drought occurs, the PCFs are likely to step forward to take more social responsibility because of political goals and ignore the maximization of economic benefits, thus damaging the rights and interests of shareholders.

Existing literature also argues that, when compared with the NPCFs, the PCFs exhibit poor accounting performance (Boubakri et al. 2008). The insiders in PCFs tend to conceal their expropriation activities by using lower-quality accounting information and hindering efficient monitoring (Guedhami and Pittman 2006), which suggests that the PCFs' managers do not care about quality of earnings (Chaney et al. 2011). Consequently, the information opacity increases. Besides, there is some literature showing that analysts experience greater difficulty in predicting the PCFs' earnings than NPCFs' (Chen et al. 2010), implying that in terms of PCFs, the information asymmetry problems are more serious. The adverse effects of meteorological disasters on a firm's operation would motivate managers to undertake earnings manipulations due to the poor performance in bad times. This means the investors have to pay more to deal with such asymmetry, which pushes up the COE.

According to the above analysis, the fourth hypothesis (H4) is as follows:

H4: The impact of drought on the COE in the firms with political connections is greater than those without political connections.

3. Data and variables

a. Sampling

Our sample covers a 16-yr period, 2004–19. The sample data are collected from the China Stock Market Accounting Research (CSMAR) database. The following samples are excluded: 1) firms operating in financial sectors; 2) the special treatment (ST) and particular transfer (PT) domestic-listed Chinese firms; 3) firm-year observations without sufficient data to calculate COE; 4) samples with missing data. To control the influence of extreme values on the regression results, the quantiles with less than 1% and more than 99% of continuous variables are winsorized. The final sample consist of 17 716 firm-year observations.

We obtain the drought data from the Yearbook of Meteorological Disasters in China. Year data for the drought is available from the cities of 31 provinces, municipalities, and autonomous regions in Chinese mainland. According to the Yearbook, we manually collect the year data of drought. We match whether drought occurs with the firm's data according to the location of the firm's headquarters. Based on the situation of whether drought occurs, we construct a dummy drought variable: Drought. The variable Drought takes a value of 1 if drought occurs in the province where the company headquarters is located and 0 otherwise. In section 5, we identify drought based on PDSI values as robustness test.

b. Measures of the COE

The core explanatory variable of this paper is the cost of equity capital. There are two methods to measure the COE: ex ante COE and ex post COE. Existing literature has shown the measurement of the COE in advance is better than that in afterward in the Chinese capital market (Mao et al. 2012). Using price-earnings ratio divided by the short-term earnings growth rate (PEG) and modified PEG (MPEG) models to estimate the COE can better capture the impact of risk factors (Easton 2004). Therefore, in this paper we choose PEG, MPEG, and Ohlson and Juettner-Nauroth (OJN; Ohlson and Juettner-Nauroth 2005) models to estimate the COE. The specific equations are

1) PEG model:

$$R_{\mathrm{PEG}} = \sqrt{\frac{\mathrm{EPS}_{t+2} - \mathrm{EPS}_{t+1}}{P_t}},$$

2) MPEG model:

$$R_{\mathrm{MPEG}} = \sqrt{\frac{\mathrm{EPS}_{t+2} + R_s \times \mathrm{DPS}_{t+1} - \mathrm{EPS}_{t+1}}{P_t}}, \quad \text{and}$$

3) OJN model:

$$R_{\mathrm{OJN}} = A + \sqrt{A^2 + \frac{\mathrm{EPS}_{t+1}}{P_t}\left[\frac{\mathrm{EPS}_{t+2} - \mathrm{EPS}_{t+1}}{\mathrm{EPS}_{t+1}} - (\gamma - 1)\right]},$$

where $A = [\gamma - 1 + (\mathrm{DPS}_{t+1}/P_t)]/2$; EPS is the earnings per share of the firm; P is the stock closing price; R_{OJN}, R_{PEG}, and R_{MPEG} are the measures for cost of equity capital; DPS is dividend per share, and γ is long-term earnings growth rate. In section 5, we also use the COE calculated based on the capital asset pricing model (CAPM) as robustness test.

c. Manager ability

The method to measure the manager ability (MA) is proposed by Demerjian et al. (2012). The data envelopment analysis (DEA) is used to evaluate the firm's efficiency. We distinguish managerial talent and a number of driving factors affecting firms' efficiency to quantify the manager ability. In this paper, we calculate the efficiency optimization of fixed assets investment, acquisition goodwill, research and development investment and other operational input factors x_{jk} and operating income and other output factors y_{ik} to obtain the firm efficiency. And then, we separate firm efficiency into firm-level factors and manager-level factors to obtain the independent measurement index of manager ability. The DEA efficiency of a firm is defined as the ratio of output factors y_{ik} to input factors x_{jk}:

$$\text{DEA efficiency} = \frac{\sum_{i=1}^{s} u_i y_{ik}}{\sum_{j=1}^{m} v_j x_{jk}}, \quad \text{where } k = 1, 2, \ldots, n.$$

According to the DEA method, the input–output efficiency of the firm's resources is calculated and standardized by industry, and we assign the firm's highest efficiency in the industry θ a value 1 and then calculate other firms' relative efficiency. Therefore, the firm's efficiency θ is between 0 and 1. The optimal regression equation about firm efficiency θ is as follows:

$$\max_v(\theta) = \frac{\mathrm{Sales}}{v_1\mathrm{PP\&E} + v_2\mathrm{COGS} + v_3\mathrm{SG\&A} + v_4\mathrm{R\&D} + v_5\mathrm{GoodWill} + v_6\mathrm{OtherIntan}},$$

where variables are property, plant, and equipment (PP&E); cost of goods sold (COGS); selling general and administrative expenses (SG&A); research and development (R&D); and other intangible assets (OtherIntan). COGS and SG&A are measured over year t, whereas the other variables are all measured at the beginning of the year t.

We perform Tobit regression on a firm's efficiency θ by industry, eliminating the firm-level factors in the firm's efficiency. The residual item ε_{it} is our estimate of MA:

$$\theta_{it} = \alpha + \beta_1 \mathrm{SIZE}_{it} + \beta_2 S_{ijt} + \beta_3 \mathrm{AGE}_{it} + \beta_4 \mathrm{BSC}_{it} + \beta_5 \mathrm{FCFD}_{it} + \beta_6 \mathrm{FCI}_{it} + \mathrm{YEAR}_{it} + \varepsilon_{it}.$$

In the equation, firm-level factors include firm size (SIZE), market shares (S_{ij}), listing time (AGE), business segment concentration (BSC), free cash flow (FCFD), foreign currency indicators (FCI), and annual fixed effect (YEAR).

We create a new dummy variable HighMA. In this paper, we use the annual mean of MA to distinguish the manager's ability. The dummy variable HighMA takes a value of 1 if MA is larger than the mean value and is 0 otherwise.

d. *Control variables*

After reviewing the relevant literature, we select some commonly used variables to control the impact of the COE. These include a log value of turnover (lnTurnover), annual return of stock (Ret), a log value of market-to-book ratio (lnMB), system risk (Beta), growth rate of operating revenue (Growth), turnover of total assets (TTA), a log value of total asset (lnAsset), equity multiplier (EM), and return on asset (ROA).

Follow Huynh et al. (2020), we also consider various combinations of year, industry, region, and firm fixed effects in regression models.

4. Main empirical results

a. *Descriptive statistics*

Table 1 shows descriptive statistics for the sample, including the number of observations (N), the mean, standard deviation (SD), the minimum and the maximum for the whole sample. In Table 1, we summarize the statistics for three measures of the COE, including PEG, MPEG, and OJN. The average value of PEG, MPEG, and OJN are 0.11, 0.12, and 0.14, respectively. Among the three measures of the COE, the mean of OJN is highest. The result is comparable to Dhaliwal et al. (2016). Overall, the statistical description in Table 1 shows that the cost of equity for Chinese listed enterprises is between 11% and 14%.

Summary statistics for drought variables and control variables for the sample period 2004–19 are presented in the rest of Table 1. The average of Drought is 0.52, which indicates 52% of firm years suffer a drought. The result is consistent with the fact that China is a country with frequent droughts. According to the statistics of China Meteorological Administration, the frequency of drought events in China is 60% (1961–2010).

In Table 1, we also list the statistical description of relevant control variables. lnTurnover, lnMB, and lnAsset are the logarithm of turnover rate, market-to-book ratio, and asset size, respectively. On average, our sample firms have lnTurnover of 6.15, lnMB of 1.09, lnAsset of 22.17, Beta of 1.11, Growth of 20%, TTA of 0.72, EM of 0.05, and ROA of 7.43%. The Ret is 21%, which indicates China A shares experienced a significant rise during sample period. Take the Shanghai Composite Index as an example, the closing price was 1266 at the end of 2004 and 3050 at the end of 2019.

TABLE 1. A summary of descriptive statistics of variables over the sample period 2004–19. The variables R_{PEG} and R_{MPEG} are the COE estimate based on the Easton (2004) method, and R_{OJN} is the COE estimate based on the Ohlson and Juettner-Nauroth (2005) method. All of the COE are estimated at the end of each year. The variable Drought takes a value of 1 if drought occurs in the province where the company headquarters is located and is 0 otherwise. Ret and lnTurnover are yearly returns and the natural log value of year turnover rates of stock, respectively, and lnMB is the natural log value of market-to-book ratio. Beta is the system risk. Growth is growth rate of operating revenue. TTA is turnover of total assets, and lnAsset is the natural log value of total asset (in billions of dollars) at the end of the fiscal year. EM is equity multiplier, and ROA is return on asset.

Variable	N	Mean	SD	Min	Max
R_{PEG}	17 716	0.110	0.030	0.020	0.280
R_{MPEG}	17 716	0.120	0.040	0.030	0.290
R_{OJN}	17 716	0.140	0.040	0.050	0.330
Drought	17 716	0.520	0.500	0	1
lnTurnover	17 716	6.150	0.820	3.320	7.960
Ret	17 716	0.210	0.880	−0.810	5.080
lnMB	17 716	1.090	0.670	−0.530	2.990
Beta	17 716	1.110	0.280	0.370	2.160
Growth	17 716	0.200	0.340	−0.540	2.500
TTA	17 716	0.720	0.500	0.070	3.240
lnAsset	17 716	22.17	1.340	19.66	26.85
EM	17 716	0.050	0.350	−0.420	2.320
ROA	17 716	7.430	5.980	−11.24	31.49

b. *Regression analyses*

1) CLIMATE DISASTER (DROUGHT) AND COST OF EQUITY CAPITAL

Table 2 reports the empirical regression results of each COE measures on drought with other control variables. In Table 2, columns 1–3 show the regression results that the COE is calculated by OJN model, columns 4–6 are the regression results that the COE is calculated by PEG model, and columns 7–9 are the regression results that the COE is calculated by MPEG model. The year effect, region effect, and industry effect are controlled but only dummy variable Drought is included as explanatory variable in columns 1, 4, and 7. In columns 2, 5, and 8, not only year effect, region effect, and industry effect are controlled, but also other control variables are added to regression model. Year and firm fixed effects are considered in columns 3, 6, and 9.

Consistent with our expectation, the results reported in Table 2 reveal that the coefficients for Drought are positive. These results indicate that drought is related to higher equity financing costs. In terms of economic significance, the estimated coefficient from model 1 shows that drought leads to a rise of 21 bps in a firm's COE. If the COE is measured by PEG and MPEG, similar results are also reported in columns 4 and 7. The economic magnitude of 21 bps is less than that

TABLE 2. The basic regression results of cost of equity on Drought. All variables are as in Table 1. Year, Region, Industry, and Firm denote year, region, industry, and firm fixed effect, respectively. Columns 1–3 are the regression results when the COE is calculated by OJN model, columns 4–6 are the regression results when the COE is calculated by PEG model, and columns 7–9 are the regression results when the COE is calculated by MPEG model. Values of t statistics are reported in parentheses. One, two, and three asterisks denote denote significance at the 10%, 5%, and 1% levels, respectively.

	1	2	3	4	5	6	7	8	9
Variable		R_{OJN}			R_{PEG}			R_{MPEG}	
Drought	0.0021*** (4.08)	0.0022*** (4.15)	0.0011** (1.97)	0.0021*** (4.51)	0.0022*** (4.67)	0.0008 (1.63)	0.0022*** (4.46)	0.0024*** (4.75)	0.0011** (2.08)
lnTurnover		0.0009** (2.37)	−0.0001 (−0.29)		0.0012*** (3.46)	−0.0003 (−0.74)		0.0010*** (2.78)	−0.0002 (−0.56)
Ret		−0.0002 (−0.67)	−0.0001 (−0.36)		0.0001 (0.35)	−0.0001 (−0.15)		0.0000 (0.07)	0.0001 (0.28)
lnMB		−0.0026*** (−4.82)	0.0007 (1.03)		−0.0028*** (−5.75)	0.0014** (2.18)		−0.0039*** (−7.78)	0.0006 (0.84)
Beta		−0.0013 (−1.32)	−0.0031*** (−2.68)		−0.0007 (−0.83)	−0.0023** (−2.27)		−0.0011 (−1.18)	−0.0026** (−2.43)
ROA		0.0002*** (4.03)	0.0001** (2.07)		0.0002*** (5.59)	0.0002*** (4.28)		0.0004*** (9.05)	0.0004*** (6.19)
Growth		0.0065*** (9.24)	0.0027*** (3.50)		0.0080*** (12.52)	0.0032*** (4.54)		0.0072*** (10.65)	0.0031*** (4.22)
TTA		−0.0007 (−1.16)	0.0002 (0.13)		−0.0002 (−0.43)	0.0009 (0.81)		−0.0001 (−0.24)	0.0004 (0.36)
lnAsset		0.0025*** (9.30)	0.0040*** (6.55)		0.0030*** (12.55)	0.0051*** (9.24)		0.0035*** (13.90)	0.0052*** (9.07)
EM		−0.0008 (−1.03)	−0.0005 (−0.20)		−0.0007 (−0.94)	−0.0012 (−0.56)		−0.0002 (−0.23)	−0.0029 (−1.22)
Year	Y	Y	Y	Y	Y	Y	Y	Y	Y
Region	Y	Y	N	Y	Y	N	Y	Y	N
Industry	Y	Y	N	Y	Y	N	Y	Y	N
Firm	N	N	Y	N	N	Y	N	N	Y
Constant	0.1580*** (45.66)	0.1024*** (13.69)	0.0764*** (5.75)	0.1285*** (40.93)	0.0585*** (8.67)	0.0221* (1.85)	0.1428*** (42.83)	0.0638*** (8.94)	0.0334*** (2.66)
Obs	17716	17716	17716	17716	17716	17716	17716	17716	17716
R squared	0.2774	0.2892	0.2757	0.3088	0.3282	0.3108	0.3426	0.3656	0.3576

TABLE 3. The regression results for firms with high-ability managers and low-ability managers. The dummy variable HighMA takes a value of 1 if MA proposed by Demerjian et al. (2012) is larger than the mean value and is 0 otherwise. All other variables are as in Table 1. Year and Firm denote year and firm fixed effect, respectively. Values of t statistics are reported in parentheses. One, two, and three asterisks denote denote significance at the 10%, 5%, and 1% levels, respectively.

	1	2	3	4	5	6
	HighMA = 1			HighMA = 0		
Variable	R_{OJN}	R_{PEG}	R_{MPEG}	R_{OJN}	R_{PEG}	R_{MPEG}
Drought	0.0010 (0.91)	0.0008 (0.76)	0.0010 (0.98)	0.0007* (1.84)	0.0007* (1.90)	0.0010*** (2.69)
lnTurnover	0.0002 (0.22)	−0.0001 (−0.17)	0.0001 (0.11)	0.0000 (0.01)	0.0000 (0.03)	−0.0001 (−0.48)
Ret	0.0003 (0.32)	0.0005 (0.66)	0.0006 (0.77)	0.0001 (0.59)	0.0001 (0.39)	0.0002 (1.04)
lnMB	0.0018 (1.25)	0.0026** (2.00)	0.0013 (0.99)	−0.0000 (−0.05)	0.0005 (1.20)	−0.0001 (−0.25)
Beta	−0.0039* (−1.70)	−0.0030 (−1.49)	−0.0035 (−1.63)	−0.0021*** (−2.81)	−0.0016** (−2.41)	−0.0017** (−2.34)
ROA	0.0002 (1.56)	0.0004*** (3.30)	0.0006*** (4.83)	0.0001* (1.65)	0.0001*** (3.26)	0.0002*** (4.75)
Growth	0.0052*** (3.27)	0.0053*** (3.70)	0.0055*** (3.69)	0.0019*** (3.77)	0.0022*** (4.85)	0.0021*** (4.46)
TTA	−0.0014 (−0.59)	0.0001 (0.07)	−0.0001 (−0.03)	−0.0003 (−0.33)	0.0005 (0.77)	−0.0002 (−0.24)
lnAsset	0.0050*** (4.17)	0.0065*** (6.05)	0.0069*** (6.13)	0.0023*** (5.70)	0.0026*** (7.16)	0.0029*** (7.54)
EM	0.0008 (0.19)	−0.0012 (−0.31)	−0.0024 (−0.58)	−0.0013 (−0.73)	−0.0010 (−0.62)	−0.0024 (−1.48)
Year	Y	Y	Y	Y	Y	Y
Firm	Y	Y	Y	Y	Y	Y
Constant	0.0453* (1.72)	−0.0175 (−0.75)	−0.0129 (−0.52)	0.1171*** (13.44)	0.0780*** (9.96)	0.0892*** (10.87)
Obs	8885	8885	8885	8831	8831	8831
R squared	0.1900	0.2207	0.2594	0.6860	0.7177	0.7619

that of Huynh et al. (2020), which shows the impact of severe drought on COE is 92 bps in the U.S. market. However, the economic magnitude of 21 bps is equivalent to that of other factors on COE reported in the existing literature. For example, in the Chinese stock market, the impact of lifting the short-selling ban on COE is 20 to 30 basis points (Hu et al. 2019), the impact of enterprise internationalization on COE is 10 to 20 basis points (Yang et al. 2022), and the impact of corporate social responsibility disclosure on COE is 20 to 30 basis points (Li and Liu 2018).

We also include both firm and year fixed effects to control for omitted unobservable firm- and year-specific factors in columns 3, 6, and 9. After controlling the year and firm fixed effect, the coefficients of Drought in columns 3 and 9 is still statistically significant at 5% level. Although the regression coefficient of Drought is not significant in column 6, the value of t statistic (1.63) is very close to the critical value (1.65) of t distribution at the 10% significance level. These results suggest that the effect of drought on the cost of equity is unlikely to be driven by the omission of unobservable firm characteristics. In terms of economic significance, the estimated coefficients show that drought leads to a rise of about 10 bps in COE when firm and year fixed effects are controlled. The use of firm and year fixed effects control time-invariant factors, and therefore potentially captures unobservable heterogeneity and omitted factor that are related to both drought and cost of equity. Further, firm fixed effects subsume region and industry fixed effects. As result, the economic magnitude decreases when firm and year fixed effects are controlled. Similar results are also found in Huynh et al. (2020).

We also use the average of these three measures to measure COE and run regression on Drought. For brevity, we do not report this regression result. The unreported result shows that the regression coefficient of Drought is statistically significant at the 5% level if year, firm fixed effect, and other control variables are included. Thus, we conclude that drought has a significant and positive impact on a firm's implied cost of equity.

2) INFLUENCE OF MANAGER ABILITY

In this section, we take manager ability into consideration. In Table 3, columns 1–3 report the regression results for high-ability manager group and columns 4–6 are the regression results for low-ability manager group. We also control year and firm fixed effect, and control variables are included in these six models.[1] The coefficients of Drought in columns 1–3 are not significant but the coefficients of Drought in columns 4–6 are statistically significant. This result shows that, statistically, the COE of enterprises with high-ability managers is not significantly affected by drought, while the COE of enterprises with low-ability managers is significantly increased due to drought. However, the estimated coefficients for the high-ability manager group are slightly larger than that for the low-ability manager group. Therefore, economically, the impact of drought on COE of the former is slightly greater than that of the latter. The results indicate that there is only weak evidence that high-ability managers can alleviate the impact of the COE caused by drought.

3) SOEs AND NSOEs

Considering the impact of ownership nature, we next present the regression result to compare the differences. In Table 4,

[1] Because firm fixed effects subsume region and industry fixed effects, for brevity we only list the regression results of year and firm fixed effect in all subsequent tables (Tables 3–9). If the year, region, and industry fixed effects are included in regression models, the conclusion remains unchanged.

TABLE 4. Regression results for SOEs and NSOEs. All variables are as in Table 1. Values of *t* statistics are reported in parentheses. One, two, and three asterisks denote denote significance at the 10%, 5%, and 1% levels, respectively.

	1	2	3	4	5	6
	SOEs			NSOEs		
Variable	R_{OJN}	R_{PEG}	R_{MPEG}	R_{OJN}	R_{PEG}	R_{MPEG}
Drought	0.0019** (2.08)	0.0014* (1.73)	0.0017** (2.04)	0.0005 (0.69)	0.0002 (0.34)	0.0005 (0.74)
lnTurnover	0.0004 (0.56)	0.0001 (0.19)	0.0002 (0.26)	−0.0004 (−0.77)	−0.0005 (−0.99)	−0.0005 (−0.96)
Ret	0.0005 (0.67)	0.0006 (0.89)	0.0009 (1.37)	−0.0003 (−0.65)	−0.0002 (−0.47)	−0.0001 (−0.28)
lnMB	−0.0018 (−1.55)	−0.0011 (−1.02)	−0.0019* (−1.76)	0.0025** (2.56)	0.0032*** (3.62)	0.0022** (2.38)
Beta	−0.0020 (−1.10)	−0.0014 (−0.83)	−0.0010 (−0.58)	−0.0030** (−2.03)	−0.0025* (−1.88)	−0.0031** (−2.21)
ROA	0.0000 (0.27)	0.0002** (2.28)	0.0004*** (3.66)	0.0002** (2.20)	0.0002*** (3.46)	0.0004*** (4.76)
Growth	0.0022 (1.60)	0.0030** (2.40)	0.0026** (2.05)	0.0028*** (2.95)	0.0030*** (3.52)	0.0032*** (3.54)
TTA	0.0011 (0.68)	0.0018 (1.19)	0.0013 (0.85)	0.0002 (0.10)	0.0006 (0.38)	0.0002 (0.14)
lnAsset	0.0039*** (3.96)	0.0046*** (5.14)	0.0051*** (5.48)	0.0036*** (4.21)	0.0053*** (7.01)	0.0052*** (6.42)
EM	−0.0027 (−0.89)	−0.0025 (−0.89)	−0.0040 (−1.39)	0.0009 (0.20)	0.0010 (0.23)	−0.0018 (−0.41)
Year	Y	Y	Y	Y	Y	Y
Firm	Y	Y	Y	Y	Y	Y
Constant	0.0715*** (3.26)	0.0253 (1.27)	0.0297 (1.44)	0.0901*** (4.95)	0.0230 (1.41)	0.0405** (2.34)
Obs	7461	7461	7461	10 255	10 255	10 255
R squared	0.2570	0.2877	0.3412	0.3007	0.3384	0.3791

columns 1–3 are the regression results of SOEs, while columns 4–6 are the results of NSOEs. Year and firm fixed effects are controlled in all models. The unreported results that year, industry and regional fixed effect are controlled in models are similar to Table 4. In Table 4, the coefficient estimate of SOEs are 0.0019, 0.0014, and 0.0017, respectively, and significant at the 5% or 10% level, while that of NSOEs are 0.0005, 0.0002, and 0.0005, respectively, which are not statistically significant. The result means that when drought occurs, the SOEs are significantly affected, while NSOEs are almost unaffected. This result can be attributed to the fact that SOEs do not necessarily take the interests of market economy as the sole goal. Furthermore, when compared with NSOEs, it is easier for SOEs to obtain financing from banks. In China, the indirect financing that enterprises use to obtain loans from banks is dominant and is far more than the direct financing such as issuing bonds or stocks. When facing the impact of drought, SOEs do not have a good incentive to control and reduce the COE. In contrast, NSOEs pay more attention to direct financing in the capital market because of the fact that NSOEs have relatively poor financing convenience. Therefore, efforts to control the COE is the realistic choice of NSOEs.

4) PCFs and NPCFs

In this section, we compare the impact of drought on the COE in PCFs and NPCFs. In Table 5, columns 1–3 report the

TABLE 5. Regression results for PCFs and NPCFs. All variables are as in Table 1. Year and Firm denote year and firm fixed effect, respectively. Values of *t* statistics are reported in parentheses. One, two, and three asterisks denote denote significance at the 10%, 5%, and 1% levels, respectively.

	1	2	3	4	5	6
	PCFs			NPCFs		
Variable	R_{OJN}	R_{PEG}	R_{MPEG}	R_{OJN}	R_{PEG}	R_{MPEG}
Drought	0.0014* (1.94)	0.0011* (1.65)	0.0014** (2.07)	0.0005 (0.51)	0.0003 (0.28)	0.0005 (0.48)
lnTurnover	0.0003 (0.55)	0.0000 (0.05)	0.0001 (0.23)	−0.0007 (−0.89)	−0.0005 (−0.70)	−0.0006 (−0.85)
Ret	−0.0002 (−0.40)	−0.0001 (−0.26)	0.0001 (0.20)	−0.0000 (−0.03)	−0.0000 (−0.03)	0.0001 (0.23)
lnMB	−0.0007 (−0.70)	0.0001 (0.09)	−0.0007 (−0.81)	0.0030** (2.25)	0.0033*** (2.75)	0.0028** (2.16)
Beta	−0.0027* (−1.79)	−0.0016 (−1.15)	−0.0018 (−1.26)	−0.0041** (−2.18)	−0.0040** (−2.41)	−0.0042** (−2.35)
ROA	0.0001 (1.44)	0.0003*** (3.58)	0.0004*** (4.99)	0.0001 (0.70)	0.0001 (1.40)	0.0003*** (2.68)
Growth	0.0031*** (2.83)	0.0037*** (3.74)	0.0033*** (3.26)	0.0027** (2.17)	0.0021* (1.91)	0.0030** (2.51)
TTA	0.0018 (1.21)	0.0021 (1.54)	0.0022 (1.56)	−0.0026 (−1.08)	−0.0008 (−0.37)	−0.0025 (−1.10)
lnAsset	0.0051*** (6.15)	0.0055*** (7.40)	0.0062*** (7.91)	0.0028** (2.39)	0.0046*** (4.33)	0.0044*** (3.89)
EM	−0.0007 (−0.25)	−0.0023 (−0.88)	−0.0032 (−1.20)	0.0016 (0.32)	0.0028 (0.62)	−0.0004 (−0.07)
Year	Y	Y	Y	Y	Y	Y
Firm	Y	Y	Y	Y	Y	Y
Constant	0.0485*** (2.68)	0.0080 (0.49)	0.0087 (0.51)	0.0615** (2.42)	−0.0028 (−0.13)	0.0060 (0.25)
Obs	11 265	11 265	11 265	5936	5936	5936
R squared	0.2679	0.3003	0.3496	0.2903	0.3265	0.3694

TABLE 6. Test results of influence mechanism, showing regression results for estimating the effect of Drought on earnings management and firm's profitability; absDisACC is based on discretionary accruals from the modified Jones model (Dechow et al. 1995). REM uses the model developed by Dechow et al. (1998) as implemented in Roychowdhury (2006). All other variables are as in Table 1. Year and Firm denote year and firm fixed effect, respectively. Values of t statistics are reported in parentheses. One, two, and three asterisks denote denote significance at the 10%, 5%, and 1% levels, respectively.

Variable	1 absDisACC	2 REM	3 ROA
Drought	−0.0006 (−0.73)	0.0061** (2.31)	−0.1968*** (−2.96)
lnMB	0.0086*** (11.11)	−0.0221*** (−8.28)	2.8244*** (44.52)
ROA	0.0003*** (3.28)	−0.0138*** (−45.30)	
Growth	0.0150*** (13.24)	0.0183*** (4.74)	1.7509*** (18.42)
TTA	0.0042*** (5.66)	0.0105*** (4.15)	1.1707*** (18.38)
lnAsset	0.0014*** (3.83)	0.0011 (0.86)	0.2598*** (8.48)
EM	−0.0021* (−1.73)	−0.0725*** (−17.74)	−4.9057*** (−49.49)
Year	Y	Y	Y
Firm	Y	Y	Y
Constant	0.0083 (0.96)	0.0172 (0.57)	−0.5161 (−0.70)
Obs	16 070	14 351	17 716
R squared	0.0395	0.1644	0.3107

regression results for PCFs and columns 4–6 is the regression results for NPCFs. Year and firm fixed effect are controlled, and control variables are included in all models. The coefficients of Drought in PCFs are 0.0014, 0.0011, and 0.0014, respectively, and significant at least at 10% level. However, the coefficients of Drought in NCFs are not significant. This shows that the PCFs have poor management of COE during the drought. When drought occurs, politically connected firms are relatively indifferent to the rising cost of equity financing because politically connected firms have better financing channels and resources. For example, politically connected firms can more easily get bank loans or issue bonds. Moreover, when the drought occurs, politically connected firms do not necessarily take maximizing the firm's value as the only decision-making goal because such firms need to bear more social responsibility. Therefore, it is not strange that rise of COE in PCFs is consistent with that of SOEs when the drought occurs.

5) INFLUENCE MECHANISM

According to the previous theoretical mechanism analysis, the reason why drought can affect the COE of enterprises is that drought affects the firm's operation and information environment. Therefore, Table 6 examines these two possible mechanisms of action. Columns 1 and 2 test the impact of drought on accrual earnings management (absDisACC) and real earnings management (REM), respectively. The absDisACC and REM are used to measure information environment. Column 3 reports the regression result of ROA on Drought. ROA is used to measure the profitability of an enterprise.

Year and firm fixed effects are controlled in Table 6. The coefficient of Drought in column 1 is not statistically significant, while the coefficient of Drought in column 2 is positive and statistically significant at 5% level. The result suggests that managers prefer to engage in the real earnings management rather than accrual earnings management when the drought occurs. Earnings management is an important measure of the firm's information environment. The higher the degree of earnings management is, the worse the information environment is. Therefore, the result of column 2 means that drought has significantly worsened the firm's information environment and increase information asymmetry. In this context, investors are bound to demand higher returns. As a result, the COE increases. The coefficient of Drought in column 3 is negative and statistically significant at 5% level. This result indicates that the drought has significantly reduced the firm's profitability. In the face of the decline of firm's profitability, investors will increase their concern about the future firm's operation. In other words, investors face increased investment risks. Thus, investor require a higher risk premium.

Combined with the above empirical results, we find that drought increases the actual earnings management and worsens information environment, resulting in the rise of the COE. At the same time, the decline of firm's profitability caused by drought also has an impact on the rise of the COE.

5. Further discussion and robustness test

a. *The effect of drought on cost of debt*

The firm's capital cost includes the cost of equity and the cost of debt (COD). Firm can choose different financing methods. Therefore, we examine the impact of drought on the cost of debt in this section. COD is defined as interest expense divided by total debt. The regression results of COD on dummy variable Drought are listed in Table 7. Table 7 shows that the coefficients of Drought are positive but not statistically significant. This result is different from the previous discussion on the impact of drought on COE. In China, bank loans have been one of the important financing sources, which account for more than 50% of firms' financing (Lu et al. 2015). However, the policy influence of the Chinese government on bank loans is significantly stronger than that of other country. This influence is stronger in times of major disasters. After the disaster, in order to actively support postdisaster reconstruction, the government usually requires commercial banks to provide better financial services, such as reducing

TABLE 7. Results for the regressions of COD on Drought, showing the effect of drought on cost of debt. In this and subsequent tables, column 2 includes some additional control variables in the regression. All variables are as in Table 1. Year and Firm denote year and firm fixed effect, respectively. Values of t statistics are reported in parentheses. One, two, and three asterisks denote denote significance at the 10%, 5%, and 1% levels, respectively.

Variable	1. COD	2. COD
Drought	0.0097 (0.16)	0.0082 (0.14)
ROA		-0.0984^{***} (-16.34)
Growth		0.6535^{***} (8.51)
TTA		0.9488^{***} (8.21)
lnAsset		0.3655^{***} (6.25)
EM		5.2569^{***} (21.37)
Year	Y	Y
Firm	Y	Y
Constant	0.2793 (1.35)	-7.6552^{***} (-6.17)
Obs	17 716	17 716
R squared	0.0578	0.1107

loan interest rates, reducing service charges and other measures to reduce bank loans financing costs. Therefore, it is not surprising that the impact of drought on COD is not significant due to the intervention of the government.

b. Alternative COE measure

Three measures of cost of equity are used in the previous regression analysis. However, it is noted that every measure has its own limitations. In particular, the above three measures all depend on EPS. Therefore, in this section, we use alternative measure of the cost of equity as a robustness test, which does not depend on EPS. The CAPM developed by Sharpe (1964) and Lintner (1965) is the workhorse of finance for estimating the COE. Therefore, this section uses the CAPM method to calculate the cost of equity. The calculation formula is as follows:

$$R_{\mathrm{CAPM}} = R_f + \beta(\mathrm{ER}_m - R_f),$$

where R_{CAPM} represents the cost of equity capital calculated by CAPM model; R_f is risk-free rate measured by the interest rate of 1-yr treasury bonds; β is systematic risk, that is, beta coefficient; and ER_m is the expected market returns. The expected market returns are not directly observable. To solve this problem, we assume that investors have rational expectations. Therefore, the realized returns are used as a proxy for expected returns. Table 8 reports the regression results of R_{CAPM} on Drought. The results show that the coefficients of Drought are positive and statistically significant. The result is consistent with that of Table 2.

TABLE 8. The regression results of COE on Drought; R_{CAPM} is an alternative COE measure and is based on CAPM developed by Sharpe (1964) and Lintner (1965). All other variables are as in Table 1. Year, Region, Industry and Firm denote year, region, industry, and firm fixed effect, respectively. Values of t statistics are reported in parentheses. One, two, and three asterisks denote denote significance at the 10%, 5%, and 1% levels, respectively.

Variable	1. R_{CAPM}	2. R_{CAPM}
Drought	0.0008^{*} (1.89)	0.0009^{**} (2.13)
lnTurnover		-0.0045^{***} (-14.21)
Ret		-0.0023^{***} (-8.67)
lnMB		-0.0009^{*} (-1.74)
Beta		-0.0073^{***} (-8.83)
ROA		0.0001 (1.50)
Growth		0.0005 (0.82)
TTA		0.0000 (0.03)
lnAsset		-0.0035^{***} (-8.02)
EM		0.0016 (0.91)
Year	Y	Y
Firm	Y	Y
Constant	0.1535^{***} (103.58)	0.2623^{***} (27.22)
Obs	17 656	17 656
R squared	0.4080	0.4290

TABLE 9. As an alternative drought measure, shown are the regression results of cost of equity on Drought. The variable COE is the average of the three models, including R_{PEG}, R_{MPEG}, and R_{OJN}. The variable Drought_PDSI takes a value of 1 when PDSI is less than -0.5 and otherwise is 0. The PDSI data are computed using area-weighted averages of $0.5° \times 0.5°$ gridpoint estimates. All other variables are as in Table 1. Year and Firm denote year and firm fixed effect, respectively. Values of t statistics are reported in parentheses. One, two, and three asterisks denote denote significance at the 10%, 5%, and 1% levels, respectively.

Variable	1. COE	2. COE
Drought_PDSI	0.0013^{*} (1.73)	0.0013^{*} (1.76)
lnTurnover		-0.0004 (-0.76)
Ret		0.0001 (0.12)
lnMB		0.0010 (1.05)
Beta		-0.0035^{**} (-2.40)
ROA		0.0004^{***} (4.73)
Growth		0.0048^{***} (4.89)
TTA		0.0008 (0.52)
lnAsset		0.0075^{***} (9.70)
EM		-0.0025 (-0.79)
Year	Y	Y
Firm	Y	Y
Constant	0.1434^{***} (54.51)	-0.0128 (-0.76)
Obs	17 716	17 716
R squared	0.2056	0.2162

c. Alternative drought measure

In this section, we identify drought based on the PDSI values. PDSI values of 0 to -0.5 are considered near normal. PDSI values of less than -0.5 are considered an incipient drought or more severe drought. Therefore, Drought_PDSI takes a value of 1 when PDSI is less than -0.5, and otherwise it is 0. Table 9 reports the regression results of COE on Drought_PDSI. The results show that the coefficients of Drought_PDSI are positive and statistically significant at 10% level. The result is consistent with that of Table 2.

6. Conclusions

Climate change makes climate disasters more frequent and severe. Drought has been a common climate disaster in China.

Firms affected by drought tend to face increased operating costs, supply chain disruption, uncertainty of future cash flows, and other risks. While prior studies showed that the risk of climate change predictably leads to a rise in the risk of global financial assets, there is limited evidence that climate change affects the COE. We show that the occurrence of drought increases a firm's COE by providing empirical evidence from China. The influence mechanism test shows that drought increases the actual earnings management and reduces a firm's profitability. With the deterioration of the information environment and the expected increase of business risks in the future, investors demand a higher risk premium. As a result, the cost of equity capital of enterprises increases.

In this paper, we also find that the impact of drought on COE is different in heterogeneous firms. Specifically, we find that the positive correlation between drought and the COE can be weakened for the firms with high-ability managers, NSOEs or NPCFs.

Our empirical evidence has significant implications for policy makers, firm management, and investors. First, SOEs can optimize the evaluation system for appointed managers. This system can require managers to maximize the profits of SOEs as far as possible on the premise of meeting the requirements of corresponding policies. Second, firms can recruit managers with high ability or develop the ability of managers. Our empirical results document that the impact of drought on the COE is significantly mitigated with a high-ability manager. They know better how to respond to climate disasters. The way they handle the negative impact can increase market confidence and reassure investors. Third, we support the policy view that managers can engage in strategies that manage finance transparently when facing sudden drought. The evidence suggests that actively carrying out earnings management make the information environment worse, bringing adverse impacts to the cost of the equity capital. This is because the investors' risk perception changes when drought occurs. If the information asymmetry reaches a certain degree, investors lose confidence in the firms. Therefore, the COE continues to increase.

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Data availability statement. All drought data created or used during this study are available from China Meteorological Yearbook, and other datasets analyzed during the current study are available in the CSMAR database.

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