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Full Length Article

Female CEOs and corporate investment efficiency: Evidence from China

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Abstract

This study investigates the effect of female chief executive officers (FCEOs) on investment efficiency. Our study suggests that CEO gender plays a significant role in efficient investment decisions by improving governance and disciplining the management. We document that FCEOs are associated with higher investment efficiency. We also find that FCEOs, when making investment decisions, pay more attention to curbing overinvestment than to underinvestment. Furthermore, we find that FCEOs play no role in improving the investment efficiency of state-owned enterprises (SOEs). Our findings suggest that SOEs' investment decisions are independent of factors that shape investment decisions at non-state-owned enterprises and are more reliant on sociopolitical factors.

JEL classification: G3; G31; J16; P31

Keywords: China; Female CEOs; Investment efficiency; Overinvestment; Underinvestment

1. Introduction

The growing number of female CEOs (FCEOs) around the world indicates the significance of female leadership. The performance of FCEOs has been widely studied because of their unique characteristics—for example, risk aversion, conservative decision making, less overconfidence, and efficient monitoring (Barua et al., 2010; Chen et al., 2016; Huang & Kisgen, 2013; Johnson & Powell, 1994; Ullah et al., 2019). These studies note that females in the top echelons of the corporate domain affect corporate decisions and corporate behavior differently from their male counterparts (Adams & Ferreira, 2009; Francis et al., 2014; Peni, 2014). Female leaders are associated with better corporate governance and financial performance than male CEOs (Adams & Ferreira, 2009; Khan & Vieito, 2013; Peni, 2014). Female CEOs are different from males CEOs in their influence on financial reporting (Peni & Vähämaa, 2010), stock price informativeness (Gul et al., 2011), agency conflict (Jurkus et al., 2011), and company acquisitions (Dowling & Aribi, 2013). Khan and Vieito (2013) note that FCEOs are linked to lower risk taking despite the boards' encouragement. The conservative behavior of FCEOs has also been documented from a financial reporting perspective, as FCEOs are associated with conservative accounting practices (Francis et al., 2015). Similarly, prior research concurs with the conservative behavior of FCEOs and document a positive association between FCEOs and corporate cash holding (Zeng & Wang, 2015). The risk-averse behavior of FCEOs results in lower earnings volatility and a greater likelihood of firm survival (Faccio et al., 2016). All these earlier studies show that the gender of the top managers plays a significant role in shaping corporate decisions. Because of the immense importance of the influence of gender differences in corporate decisions, this study explores the effect of FCEOs on investment efficiency.

We study the effect of FCEOs in the Chinese context. Attitudes toward gender in China have changed tremendously

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over time. Local culture and social norms kept women far from achieving their potential. However, with the passage of time, a cultural shift has occurred. Various efforts have been made to exploit female potential. In 1950, a new marriage law was put into effect, which paved the way for Chinese women to participate in the labor market (Chen & Ge, 2018). The Chinese female labor force is currently the largest in the world (Tsou & Yang, 2019). Greater opportunities for Chinese women were not limited to social and cultural activities but, rather, extended to the corporate sphere as well. These efforts yielded growing female participation at the top level in the corporate sector. Women are more likely to become top managers in China than in most other countries. According to the World Development Indicators, the proportion of firms in China with a top female manager was 18 percent in 2016, higher than the average 15.8 percent among member countries of the Organization for Economic Corporation and Development (OECD). An increasing number of corporate CEOs in China are female.[1] The boards of hundreds of companies have female representation. *Shanghai Daily* reported that, between 2004 and 2013,[2] China had the second-highest number of female CEOs, after the US and Canada. The projections also suggest that a third of the CEO appointments until 2040 will be female.[3] Female leaders have become an important phenomenon in the Chinese business environment, and female executives can no longer be overlooked in the corporate world. The increased participation by women in the top echelons of the corporate sector over time offers an interesting opportunity for exploring their role in the efficient utilization of resources.

Investment efficiency (IE) is an important concept that signifies the efficient use of resources. It means that, in the absence of market imperfection, firms carry out projects with a positive net present value (NPV) and reject those with a negative NPV. However, in the presence of market imperfection, firms might make suboptimal investment decisions. Firms continue to invest until the marginal cost equals the marginal benefit from an investment (Modigliani & Miller, 1958). Prior literature also distinguishes two kinds of suboptimal decisions: underinvestment and overinvestment (Biddle et al., 2009; Cutillas Gomariz & Sánchez Ballesta, 2014). In overinvestment, firms invest more than the optimal level, whereas in underinvestment firms invest less than the optimal level. Prior studies (Biddle et al., 2009; Cheng et al., 2013) also show that corporate governance mechanisms can mitigate information risks and agency costs, resulting in inefficient investment. Biddle et al. (2009) find that the quality of financial reporting enhances IE by reducing agency issues between managers and shareholders. Similarly, Cutillas Gomariz and Sánchez Ballesta (2014) report that IE is enhanced not only by financial reporting quality but also by debt maturity. Other studies suggest that lower agency conflict and managerial opportunism are negatively associated with IE (Chen et al., 2017).

This discussion suggests that any governance mechanism that reduces agency risk and disciplines management enhance IE. Furthermore, these studies indicate that when the CEO is female, the firms experience less agency and managerial opportunism. Two important points emerge from this discussion. First, FCEOs are associated with less managerial opportunism and agency risk. Second, less managerial opportunism and fewer agency issues enhance IE. This study links these two perspectives and examines whether FCEOs lead to higher IE. This study seeks to answer the following questions: what is the influence of FCEOs on investment efficiency? What is the effect of FCEOs on overinvestment and underinvestment? What is the impact of a firm's state ownership on the relationship between FCEOs and IE?

Based on a sample of Chinese A-share listed firms for the period 2000−2017, we document that FCEOs are positively associated with IE, which means that FCEOs enhance it. The results suggest that firms led by FCEOs make better investment decisions than firms led by their male counterparts because FCEOs decrease managerial opportunism and agency conflicts, which leads to higher IE. We extended our analysis by examining the impact of FCEOs on two kinds of inefficiency: overinvestment and underinvestment. Our results reveal that FCEOs reduce overinvestment significantly. However, we do not find any significant association between FCEOs and underinvestment. These findings are consistent with those in prior studies that suggest that overinvestment involves greater agency issues than underinvestment (Majeed et al., 2018; Richardson, 2006). This study also explores how state ownership influences the decisions of FCEOs in the efficient allocation of resources. We also examine the effect of state ownership on the nexus of FCEOs and IE. We document no statistically significant association between FCEOs and IE at state-owned enterprises (SOEs). The findings suggest that SOEs' primary objectives are the accomplishment of sociopolitical goals (i.e., employment), which is reflected in their investment behavior as well.

Our study contributes to the literature in many ways. We contribute by documenting that gender differences in the top echelons influence resource allocation. This contribution is important because the efficient allocation of resources is important not only from a corporate point of view but also from a societal perspective. Earlier studies have focused on risk taking, performance, and financial reporting (Faccio et al., 2016; Khan & Vieito, 2013; Strøm et al., 2014). However, the role of female leaders in investment decisions has been ignored. Our findings empirically support that greater female participation in the corporate sphere can result in more efficient investment decisions, which lead to the efficient utilization of resources. This study also deepens our understanding of how gender differences affect the decision-making process in the (male-dominated) corporate world. Our study extends the prior literature on the effects of FCEOs on corporate behavior (e.g., Chen, Dong, et al., 2018; Chen, Leung, et al.,

[1] Female CEOs in China: Future Looks Brighter (https://cbk.bschool.cuhk.edu.hk/female-ceos-in-china-future-looks-brighter/).

[2] http://www.chinadevelopmentbrief.cn/news/in-spite-of-sexism-chinas-female-ceos-flourish/.

[3] https://archive.shine.cn/business/China-ranks-2nd-in-female-CEO-percentage/shdaily.shtml.

2018; Francis et al., 2014; Khan & Vieito, 2013). Second, this study extends the literature on the kinds of inefficient investment and documents that overinvestment is a greater agency problem than underinvestment (Majeed et al., 2018; Richardson, 2006). Third, our findings enrich the literature on SOEs. SOEs are important not only in the Chinese context but in other developed and developing economies, which makes it crucial to understand their behavior. Finally, we also contribute by studying the Chinese institutional setting. Although China is the second-largest economy of the world, it is still a developing economy. Therefore, our findings have implications for developing economies, which suffer the most from the inefficient utilization of resources. Further, women's participation is particularly low in developing economies. Therefore, this study provides inspiration for formulating policy guidelines for enhanced female participation in business.

The rest of the paper is structured as follows. Section 2 provides hypothesis development. Section 3 gives the details of the sample, research design, and variable measurement. Section 4 discusses the results, and Section 5 conducts robustness testing and examines endogeneity issues, and then Section 6 concludes the paper.

2. Literature review and hypothesis development

2.1. Female CEOs and investment efficiency

Investment efficiency is a vital concept and has been given immense importance in recent research (Biddle et al., 2009; Chen et al., 2017; Lai & Liu, 2018). IE can be defined as a firm's propensity to carry out projects with a positive NPV and vice versa. Prior literature identified various factors that contribute to efficient investment by reducing agency conflicts, information asymmetry, and managerial opportunism (Chen et al., 2011; Lai & Liu, 2018). Lower information asymmetry resulting from improved information quality and transparency enhances the monitoring of managerial activities (resulting in lower managerial opportunism) and better investment decisions (Biddle et al., 2009; Chen et al., 2011, p. 2012). In the presence of better monitoring mechanisms, relevant information reaches investors promptly and facilitates optimal investment decisions.

Higher-quality corporate information increases transparency and improves the monitoring of managerial opportunism, thereby reducing agency conflict and leading to higher IE (Biddle et al., 2009; Chen et al., 2011; Cheng et al., 2013). Moreover, financial analysts bring enhanced monitoring by providing investors with timely and transparent information, which prevents managers from making suboptimal investment decisions (Chen et al., 2017; To et al., 2018). Previous studies also suggest that auditors specialized in an industry (Elaoud & Jarboui, 2017) or auditors' with superior knowledge (Bae et al., 2017) improve IE because they enhance transparency, which improves investment decisions. The same argument is made by Chen et al. (2017), who suggest that foreign institutions alleviate agency problems by enhancing transparency and governance, leading to improved efficiency. IE also increases when a fund available to opportunistic managers decreases; that is why firms involved in corporate social responsibility activities have higher efficiency (Attig et al., 2014). Lai and Liu (2018) suggest that better top management team characteristics (e.g., reputation and management quality) reduce agency problems and improve investment decisions, leading to higher IE.

The scarcity of female corporate leaders is at odds with the evidence of multiple empirical studies documenting that female leaders increase economic value for firms. For example, Khan and Vieito (2013) and Peni (2014) suggest that FCEOs are associated with better firm performance than their male counterparts. Khan and Vieito (2013) further argue that FCEOs are associated with lower risk, although they are encouraged by the board to take higher risk. Palvia et al. (2015) and Francis et al. (2014) also concur regarding the risk-averse behavior of FCEOs. Risk-averse behavior by FCEOs is also supported from a financial reporting perspective. Francis et al. (2015) suggest that female leadership is associated with more conservative accounting. Zeng and Wang (2015) further support this notion and document that FCEOs are more conservative than male CEOs and are associated with higher corporate cash holding in Chinese institutional settings.

Earlier studies suggest that female leadership helps attenuate information asymmetry and agency conflicts between principals and agents (Chen, Dong, et al., 2018; Chen, Leung, et al., 2018; Francoeur et al., 2008). For example, FCEOs facilitate implementation of strong corporate governance, which improves firm investment decisions (Frye & Pham, 2018; Nielsen & Huse, 2010). Extant research posits that female directors of the board play a vital role in improving firm-level monitoring (Adams & Ferreira, 2009). Higher board gender diversity improves the monitoring of managerial activities, reduces agency problems, enhances financial performance, and improves innovation performance and high-quality reporting (Chen, Dong, et al., 2018; Chen, Leung, et al., 2018; Jurkus et al., 2011).

Prior literature also documents the effect of FCEOs on firm behavior, suggesting that FCEOs are more conservative and risk-averse than their male counterparts (Khan & Vieito, 2013; Palvia et al., 2015). Gul et al. (2011) report that the risk aversion by FCEOs leads to better investment decisions that enhance shareholder value and increases public disclosure and stock price informativeness. Faccio et al. (2016) document that firms led by FCEOs tend to make financing and investment choices that are less risky. This discussion suggests that female leaders influence corporate decisions because of their risk-averse behavior and lower propensity to engage in managerial opportunism (leading to less agency conflict).

We combine the two discussion points from this discussion. First, the principal sources of inefficient investment are

information asymmetry and agency problems. Because they are both reduced by having a female CEO, we expect that FCEOs make optimal investment decisions. Furthermore, FCEOs strengthen corporate governance, leading to the identification and execution of superior investment projects and thereby to optimal investment decisions. Moreover, lower managerial opportunism (leading to fewer agency problems) associated with FCEOs also improves the quality of investment decisions and decreases underinvestment. Second, because FCEOs are risk averse and more conservative in their behavior, they are less likely to exhibit overconfidence and engage in aggressive decision making. This kind of environment curbs overinvestment of free cash flows and leads to optimal investment decisions. All these arguments suggest that FCEOs avoid suboptimal investment projects and make efficient investment decisions. Based on this discussion, we posit that FCEOs are associated with greater IE and present our hypothesis as follows:

Hypothesis 1. *There is a positive association between female CEOs and investment efficiency.*

2.2. Female CEOs and underinvestment and overinvestment problems

Following Cutillas Gomariz and Sánchez Ballesta (2014), we divide our sample into two types of inefficiency: underinvestment (less than optimal level of investment) and overinvestment (higher than optimal level of investment). Both under- and overinvestment cause value distortion. The effect of one type of inefficiency may be more pronounced than that of the other.

On the one hand, underinvestment can be viewed as a value-distorting activity (inefficiency) that leads to a future loss, and a firm may lose its competitiveness, as it will be hard for it to capture mounting market demand (Majeed et al., 2018). Hence, underinvestment can cause predation risk (risk of losing investment opportunities and market share). Predation risk can lead a firm to lose business and market share to its competitors, leading it to have lower profitability. Consequently, such poor performance by the firm would raise questions about the executives' management and concerns about the firm's survival. To improve firm performance, FCEOs try to make optimal investment decisions. It is important to note that underinvestment might result from a lack of funds (Abdallah & Abdallah, 2019). Prior literature suggests that FCEOs are associated with a lower cost of funds and easier access to bank loans (Luo et al., 2018), both of which can reduce underinvestment.

On the other hand, overinvestment is also a value-destroying strategy, which can arise when excess cash is available to managers, who might use it to serve their own interests due to a lack of effective monitoring and weak governance. Richardson (2006) argues that overinvestment is a common problem that cannot be reduced even with corporate governance mechanisms. Li (2004) finds an adverse effect of investment expenditures on firm future performance. Similarly, Titman et al. (2004) report a negative association between stock returns and investment, which means that investors regard higher investment as a significant problem because it decreases firm efficiency—and this inefficiency might be due to agency costs. Majeed et al. (2018) find a negative association between IE and the cost of equity. They argue that investors in the capital market respond negatively to investment decisions and demand a higher rate of return.

Hence, both kinds of inefficient investment affect firm value. Therefore, FCEOs try to reduce investment to an optimal level. Based on this discussion, we propose the following hypothesis:

Hypothesis 2. *Female CEOs decrease underinvestment/ overinvestment.*

2.3. Female CEOs, state ownership. And investment efficiency

SOEs are an essential part of the corporate environment around the world. The significance of SOEs has been recognized worldwide because many countries have a large number of SOEs, and they play a vital socioeconomic role: 5 percent of the gross domestic product (GDP) in the OECD countries and 10 percent of global GDP come from SOEs (Peng et al., 2016). The Chinese business setting, which has a large number of SOEs, provides a unique opportunity to study SOEs (Wu et al., 2018).

SOEs and non-state-owned enterprises (non-SOEs) are quite different (Majeed et al., 2018) in their objectives, riskiness, financial reporting, performance, and corporate governance practices (Allen et al., 2012). Allen et al. (2005) suggest that China is a transitional economy, where the main source of financing is the banking sector, rather than equity markets. Further, they argue that a large amount of funding from banks goes to SOEs. This study shows that SOEs enjoy more benefits than non-SOEs because the state acts as an insurer and helps SOEs when they are in financial distress (Faccio, 2006). Along with preferential access to finance, SOEs also enjoy a lower cost of debt capital (Shailer & Wang, 2015). These arguments show that SOEs face little capital market pressure, as they have easier and cheaper access to finance than non-SOEs. The government (support) intervention destroys efficient allocation of investment and hence reduces IE at SOEs (Hao & Lu, 2018).

Based on these arguments, we hypothesize that the association between FCEOs and IE is less pronounced at SOEs for two reasons. First, SOEs face limited capital market pressure for high-quality governance; therefore, they may make inefficient investment decisions. Second, SOEs have different objectives from non-SOEs (Du et al., 2018; Faccio, 2006), because they have to achieve sociopolitical goals (i.e., employment), which may result in inefficient investment decisions. Based on this discussion, we present our third hypothesis:

Hypothesis 3. *There is no association between female CEOs and firm investment efficiency at SOEs.*

3. Research design

3.1. Model specification

We offer the following panel regression with fixed-effect (FE) models to test our hypotheses.

$$IE_{i,t}/OI_{i,t}/UI_{i,t} = \beta_0 + \beta_1 FCEO_{i,t} + \beta_2 SOEs_{i,t} + \beta_3 Size_{i,t} + \beta_4 Lev_{i,t} + \beta_5 MB_{i,t} + \beta_6 FRQ_{i,t} + \beta_7 Age_{i,t} + \beta_8 OCF_{i,t} + \beta_9 Top1_{i,t} + \beta_{10} ROA_{i,t} + \beta_{11} Loss_{i,t} + F_i + h_t + \mu_{i,t} \quad (1)$$

$$IE_{i,t} = \beta_0 + \beta_1 FCEO_{i,t} + \beta_2 SOEs_{i,t} + \beta_3 FCEO{*}SOEs_{i,t} + \beta_4 Size_{i,t} + \beta_5 Lev_{i,t} + \beta_6 MB_{i,t} + \beta_7 FRQ_{i,t} + \beta_8 Age_{i,t} + \beta_9 OCF_{i,t} + \beta_{10} Top1_{i,t} + \beta_{10} ROA_{i,t} + \beta_{11} Loss_{i,t} + F_i + h_t + \mu_{i,t} \quad (2)$$

where $IE_{i,t}/OI_{i,t}/UI_{i,t}$ represent investment efficiency, over-investment, and underinvestment, respectively. $FCEO_{it}$ represents a female chief executive, which is a binary variable that takes a value of one if the firm's chief executive is female, and zero otherwise. Following prior literature (Biddle et al., 2009; Cutillas Gomariz & Sánchez Ballesta, 2014; Majeed et al., 2018), we use several control variables in our estimation. We control for $SOEs_{it}$, which is a dummy variable that takes a value of one for SOEs and zero for non-SOEs. We also control for $Size_{it}$(log of total assets), Lev_{it} (debt-to-equity ratio), and MB_{it} (market-to-book value). FRQ_{it} (financial reporting quality) is used as a control variable, following the model proposed by Kothari et al. (2005). We employ the following model to estimate FRQ:

$$\frac{TA_{i,t}}{A_{i,t-1}} = \beta_1\left[\frac{1}{A_{i,t-1}}\right] + \beta_2\left[\frac{\Delta Rev_{i,t} - \Delta AR_{i,t}}{A_{i,t-1}}\right] + \beta_3\left[\frac{PPE_{i,t}}{A_{i,t1}}\right] + \beta_4 ROA_{i,t-1} + \delta_{i+1} \quad (3)$$

where $TA_{i,t}$ is total assets scaled by lagged assets, and $\Delta Rev_{i,t}$ and $\Delta AR_{i,t}$ represent the change in revenue and change in account receivables for firm i and year t, scaled by lagged total assets, respectively. $PPE_{i,t}$ is property, plant, and equipment over lagged total assets, and $ROA_{i,t-1}$ is the return on investment, measured as income before interest and tax over total assets. FRQ is a residual from Eq. (3) multiplied by −1. A higher FRQ represents higher financial reporting quality and vice versa. We control for Age_{it}, OCF_{it} and $Top1_{it}$, which represents a firm's listing age, operating cash flow (scaled by total assets), and shares held by top 1 percent of shareholders, respectively. We also control for $ROA_{i,t}$ and $Loss_{i,t}$, in which ROA equals net income divided by total assets in year t-1, and loss is a dummy variable that equals 1 if the earnings before extraordinary items in years t and t-1 are negative, and zero otherwise. $\mathscr{F}_i$ and h_t represent firm- and year-fixed effects, respectively.

3.2. Variable measurement

3.2.1. Measurement of investment efficiency

Conceptually, IE means investing funds in projects with a positive NPV. Investment is considered efficient if they are at the optimal level for a firm. However, firms that invest above their optimal level (above-expected investment) overinvest, whereas those that do not take on all profitable projects (below-expected investment) underinvest. To measure IE, we use three different proxies, those from Biddle et al. (2009) and Chen et al. (2011) and the average of the two. The first measure is obtained following the model developed by Biddle et al. (2009). They posit that investment is a function of growth opportunities, which is estimated as:

$$Investment_{i,t+1} = \beta_0 + \beta_1 * SalesGrwoth_{i,t} + \varepsilon_{i+t} \quad (4)$$

$Investment_{i,t+1}$is total investment by the firms' industry-year groups (i,t+1) and $SalesGrowth_{i,t}$, a proxy for investment opportunities, is the percentage change in sales in each industry-year group from year t-1 to t. The model is estimated cross-sectionally for each year and industry, and residuals represent the deviation from the expected level. A positive residual means overinvestment (more than the expected level as growth in sales) whereas a negative residual means under-investment (a lower than expected level). Therefore, the test variable, *IE,* the absolute value of residuals multiplied by −1, which is the dependent variable, represents an efficient investment. The second measure of IE is obtained from the model of Chen et al. (2011):

$$Invest_{i,t} = \alpha_0 + \alpha_1 NEG_{i,\,t-1} + \alpha_2 SalesGrowth_{i,t-1} + \alpha_3 NEG{*}SalesGrowth_{i,t-1} + \varepsilon_{i+t} \quad (5)$$

All the variables are the same as discussed in the previous model, except $NEG_{i,t-1}$, which takes a value of one for negative revenue growth and zero otherwise. The residuals are used as proxies for IE. Positive (negative) residuals mean overinvestment (underinvestment). Higher values of residuals reflect higher investment efficiency. The third measure we used in this study is the average of IE values, following Biddle et al. (2009) and Chen et al. (2011).

3.2.2. Control variables

Following Biddle et al. (2009) and Cutillas Gomariz and Sánchez Ballesta (2014), we use various control variables. We use size as a control variable because size affects agency costs (Jensen & Meckling, 1976). In addition, large firms are

less likely to go bankrupt because they have access to external funds and have a better reputation in the market (Diamond, 1994). We also control for state ownership because it can influence investment decisions. As mentioned earlier, SOEs have different goals from non-SOEs, as SOEs have various political and social objectives, such as national security, job creation, and development (Du et al., 2018; Faccio, 2006); thus SOEs received preferential treatment regarding funds, which creates principal-principal agency issues, consequently state ownership affects investment decisions.

Leverage is also used as a control variable because debt financing can reduce agency risk because of the governance roles performed by lenders (Agrawal & Knoeber, 1996). Moreover, debt financing also plays a crucial role in mitigating overinvestment (Jensen, 1986). We further control for FRQ as a measure of information and agency risks. FRQ mitigates agency conflicts between shareholders and management that create moral hazards and adverse selection (Cutillas Gomariz & Sánchez Ballesta, 2014). We use the model in Kothari et al. (2005) to measure FRQ. We also use alternative measures of FRQ, such as those in Dechow and Dichev (2002), and found consistent results. Following Cutillas Gomariz and Sánchez Ballesta (2014), we used operating cash flow (OCF) as a control variable to identify the effect of cash on IE. We control for independent directors, following Fama and Jensen (1983), who argue that the board of directors plays a key role in mitigating management opportunism by reducing agency conflicts. Biddle (2006) and Lai and Liu (2018) argue that firms with inefficient investment have a higher market-to-book ratio; thus, we control for the market-to-book ratio to ensure that our estimation does not omit this variable. We also control for firm age because older and more mature firms tend to have more capital investment than new firms. Finally, to control for the effect of unobservable firm characteristics on investment decisions, we use firm-fixed effects in analyzing our models.

For further confirmation of our results, we include additional control variables, that is, independent directors, board size, and duality (Du et al., 2018; Jiang et al., 2018). *Indir* is the ratio of independent directors (the number of independent directors divided by the number of board members), *BS* is the number of directors on the board, and *Dual* is a dummy variable that takes a value of 1 if the positions of CEO and chairman held by the same person and 0 otherwise. Further, to control for economic conditions/crisis, we use *ROA* (return on assets) and *loss* (Cutillas Gomariz & Sánchez Ballesta, 2014; Lai & Liu, 2017), where ROA equals net income divided by total assets in year *t*-1, and *loss* is a dummy variable that equals 1 if earnings before extraordinary items in years *t* and is negative, and 0 otherwise.

Table 1
Descriptive statistics.

	Mean	Median	Min	Max	Sd.	N
For MCEOs						
Biddle_IE	−0.1383	−0.1199	−0.1249	−0.0094	0.0242	21,268
Chen_IE	−0.1519	−0.1343	−0.1782	−0.0069	0.0229	21,233
IE_Avg	−0.1457	−0.1259	−0.1622	−0.0049	0.1491	20,732
Size	21.7424	21.6156	19.0521	25.3378	1.2332	21,268
Lev	0.4819	0.3217	0.0495	0.5021	0.2178	21,268
OCF	0.0479	0.0468	−0.2235	0.2857	0.0872	21,268
MB	3.4932	2.8176	−0.9758	25.1327	3.4473	21,268
Age	9.1805	9.0000	1.0000	21.0000	5.2385	21,268
Top1	0.3698	0.3466	0.0219	0.8941	0.1593	21,268
FRQ	−0.0817	−0.0535	−0.5993	−0.0009	0.0948	21,268
SOEs	0.5787	1.0000	0.0000	1.0000	0.4937	21,268
ROA	0.0343	0.0323	−0.2376	0.2282	0.0648	21,268
Loss	0.1741	0.0000	0.0000	1.0000	0.3791	21,268
For FCEOs						
Biddle_IE	−0.1396	−0.1275	−0.1511	−0.0039	0.0148	1306
Chen_IE	−0.1428	−0.1398	−0.1691	−0.0047	0.0381	1298
IE_Avg	−0.1409	−0.1338	−0.1596	−0.0056	0.0254	1255
Size	21.6010	21.4935	19.0493	25.4833	1.1443	1306
Lev	0.4527	0.3233	0.0921	0.4495	0.1867	1306
OCF	0.0465	0.0458	−0.1298	0.2592	0.0853	1306
MB	3.6215	2.7961	−0.8875	23.5781	3.2464	1306
Age	9.2828	9.0000	1.0000	21.0000	5.6629	1306
Top1	0.3653	0.3448	0.0745	0.8147	0.1515	1306
FRQ	−0.0907	−0.0541	−0.5993	−0.0009	0.0990	1306
SOEs	0.3816	0.0000	0.0000	1.0000	0.4860	1306
ROA	0.0421	0.0371	−0.2360	0.0000	0.2282	1306
Loss	0.1353	0.0000	0.0000	1.0000	0.3422	1306
Total Sample						
Biddle_IE	−0.1340	−0.1280	−0.1511	−0.0094	0.0231	22,531
Chen_IE	−0.1578	−0.1347	−0.1782	−0.0047	0.0197	22,517
IE_Avg	−0.1395	−0.1311	−0.1622	−0.0056	−0.0209	21,987
Size	21.7351	21.6027	19.0493	25.3378	1.2292	22,574
Lev	0.4871	0.3233	0.0495	0.5021	0.2212	22,574
OCF	0.0483	0.0472	−0.2235	0.2857	0.0892	22,574
MB	3.7962	2.7196	−0.9758	25.1327	3.7453	22,574
Age	9.1858	9.0000	1.0000	22.0000	5.4611	22,574
Top1	0.3695	0.3465	0.0219	0.8941	0.1589	22,574
FRQ	−0.0822	−0.0541	−0.5993	−0.0009	0.0950	22,574
SOEs	0.5684	1.0000	0.0000	1.0000	0.4953	22,574
ROA	0.0347	0.0327	−0.2360	0.2282	0.0647	22,574
Loss	0.1720	0.0000	0.0647	1.0000	0.3774	22,574

The table reports the descriptive statistics of the variables in our analysis, including the mean, median, standard deviation(Sd), minimum and maximum; The data cover the period from 2000 to 2017; FCEOs is the dummy variable, which equals 1 if the firm has female chief executive and 0 otherwise; IE_Biddle2009 is the investment efficiency measured by Biddle et al. (2009); IE_Chen2011 is the investment efficiency measured by Chen et al., (2011); IE_Aveg is the standardized average of the two proxies; Size is the total assets; Lev is the ratio of total debt to total assets; CFO is the operating cash flow; Age is the age of the firm since inception; Top1 is shares held by top 1% shareholders; FRQ is the financial reporting quality measured by Kothari et al. (2005); SOEs is the state owned enterprises.

3.3. Sample description

Our sample includes all Chinese firms issuing A-shares listed on the Shanghai and Shenzhen Stock Markets. The

Table 2
Female CEOs and investment efficiency.

	Panel A			Panel B		
	IE (Biddle et al., 2009)	IE (Chen 2011)	IE (Average)	IE (Biddle et al., 2009)	IE (Chen 2011)	IE (Average)
FCEOs	0.0523[a] (0.004)	0.0347[a] (0.007)	0.0475[a] (0.004)	0.0371[a] (0.004)	0.0252[a] (0.008)	0.0281[a] (0.009)
SOEs	−0.0156[a] (0.001)	−0.0537[a] (0.000)	−0.0638[a] (0.004)	−0.0228[a] (0.000)	−0.0245[a] (0.001)	−0.0244[a] (0.000)
Size	0.1147[b] (0.027)	0.0235[b] (0.034)	0.0457[b] (0.023)	0.0133[b] (0.027)	0.0131[c] (0056)	0.0117[b] (0.014)
Lev	0.0911[a] (0.008)	0.0451[a] (0.002)	0.0643[a] (0.001)	0.0459[a] (0.002)	0.0127[a] (0.001)	0.0283[a] (0.005)
MB	−0.0721[b] (0.014)	−0.0017[b] (0.044)	−0.0325[b] (0.033)	−0.0147[b] (0.0032)	−0.0209[c] (0.074)	−0.0614[b] (0.040)
FRQ	0.0242[b] (0.021)	0.0147[b] (0.041)	0.0361[b] (0.029)	0.0145[b] (0.032)	0.0423[c] (0.051)	0.0138[b] (0.041)
Age	−0.0173 (0.329)	−0.0264 (0.364)	−0.01494 (0.358)	−0.00547 (0.239)	−0.0253 (0.419)	−0.0163 (0.371)
OCF	−0.0129[a] (0.000)	−0.0184[a] (0.003)	−0.1347[a] (0.005)	−0.1288[a] (0.000)	−0.1329[a] (0.002)	−0.1342[a] (0.001)
Top1	0.3204 (0.398)	0.0232 (0.348)	0.0562 (0.361)	0.0341 (0.241)	0.0332 (0.247)	0.0312 (0.238)
ROA	−0.0117[b] (0.039)	−0.0121[b] (0.022)	−0.0186[c] (0.057)	−0.0081[b] (0.035)	−0.0078 (0.028)	−0.0085 (0.067)
Loss	0.0193 (0.221)	0.035[c] (0.087)	0.032 (0.263)	0.040 (0.176)	0.067[c] (0.091)	0.049 (0.437)
Indir				0.0437 (0.665)	0.0246 (0.616)	0.0316 (0.636)
BS				0.0045[c] (0.057)	0.0044[c] (0.054)	0.0037[b] (0.046)
Dual				0.0183[b] (0.017)	0.0237[b] (0.033)	0.0162[b] (0.029)
Firm Fixed Effects	Included	Included	Included	Included	Included	Included
Year Fixed Effects	Included	Included	Included	Included	Included	Included
Constant	0.4765[c] (0.055)	0.4517[b] (0.029)	0.3265[b] (0.023)	0.2426[b] (0.030)	0.1525[b] (0.029)	0.1725[b] (0.034)
R-Square (%)	9.45%	9.72%	9.61%	14.24%	13.98%	14.05%
Observations	19,689	19,357	19,152	19,345	19,289	19,319

This table reports fixed effect regression results examining the impact of female CEOs on investment efficiency for the sample firms spanning 2000−2017 that meet data requirements. The dependent variable is investment efficiency as defined earlier. The p-values reported in the parentheses are calculated with standard errors clustered by industries.

[a] Represents significance level a 1%.

[b] Represent significance level at 5% and.

[c] Represent significance level at 10%.

sample period is 2000−2017. Financial firms, special treatment firms,[4] and particular treatment[5] firms are not included in this study because of their abnormal financial conditions. The data come from the China Stock Market and Accounting Research (CSMAR) database. Industries with fewer than fifteen observations are omitted from the calculation of *IE*. The final sample consists of 14,968 firm-year observations with complete data on 35 industries identified by the second-level industry classification code of the China Securities Regulatory Commission.

3.4. Descriptive statistics and correlation matrix

Table 1 presents the descriptive statistics of the variables for the sample period, 2000−2017. The mean (median) of IE is −0.1340 (−0.1280) for *Biddle_IE,* −0.1578 (−0.1347) for *Chen11_IE*, and −0.1395 (−0.1311) for *IE_Avg*.

The proportion of firms with female executives is 4.97 percent, which is consistent with the percentage of female executives found in previous studies (Vähämaa, 2017; Wu et al., 2018). In the sample, 56.85 percent of firms are SOEs. *OCF* has a mean value of 0.0483; its positive sign reflects the positive cash flow at most firms in their operations.

Appendix Table S1 (in the online supplementary material) reports the Pearson correlation matrix between the variables used in our analysis. All three measures of *IE* have a positive correlation with FCEOs, indicating that firms with female executives are associated with higher investment efficiency, hence promoting IE at Chinese firms. These measures also have positive and significant correlations with one another. Correlations between the variables are not high; therefore, our study has no collinearity problems.

4. Results

4.1. Empirical findings

4.1.1. FCEOs and IE

Table 2 reports the results of the estimation of Eq. (1) using different IE measures. In column 1 in Panels A and B, we use the IE measure in the model defined by Biddle et al. (2009), in column 2, the model proposed by Chen et al. (2011), and, in column 3, the aggregate measure of IE. The coefficients of FCEOs in all three measures are positive and statistically significant ($p < 0.01$), indicating that FCEOs are positively associated with IE, which shows that firms with FCEOs tend to have higher IE. These results support our H1, that efficient investment signals the existence of governance tools that mitigate information asymmetry and agency conflicts between managers and shareholders. This argument and evidence are

[4] According to China's Security Law, a listed firm is labeled as requiring special treatment (ST) if its recent financial profit is negative for two consecutive years or its net asset value per share is lower than the book value at the end of the last fiscal year.

[5] A firm labeled as ST will be relabeled as requiring particular treatment (PT) if it is unable to be revived within two years. We delete ST and PT firms because their investment behavior differs from that of healthy firms.

consistent with prior findings (Frye & Pham, 2018; Jurkus et al., 2011; Wang et al., 2018) that females at the top echelons mitigate agency and information risks, which in turn enhances firm efficiency.

All the control variables have signs and coefficients in accordance with the theory. For example, SOEs have a significant and negative coefficient, showing that they lead to lower IE. The result supports our argument that SOEs have different goals form non-SOEs, which include providing social and political support (e.g., national security, employment, and regional development), rather than maximizing firm value. Our results are consistent with those of Chen (2014). Moreover, we find a positive association between FRQ and IE, indicating that firms with higher FRQ have higher IE (Biddle et al., 2009; Chen et al., 2011). We find a positive association between *Size* and IE, but a negative relationship between ROA and IE. These results are in line with the findings of Lai and Liu (2017). The coefficient of other control variables, such as *MB*, has sign and significance that are consistent with those reported by Wang et al. (2018). In Panel B, we used additional control variables, such as *Indir*, *BS*, and *Dual*. We find a positive relationship between *Dual* and IE. The results are consistent with a previous study (Jin & Yu, 2018). Taken together, the results for the control variables are highly consistent with those in prior studies (Benlemlih & Bitar, 2018; Biddle et al., 2009; Cutillas Gomariz & Sánchez Ballesta, 2014).

4.1.2. FCEOs, overinvestment, and underinvestment

We perform our analysis by dividing the sample into two kinds of inefficiency, overinvestment and underinvestment. Table 3 presents the regression results from testing H2 (overinvestment/underinvestment) using all three IE proxies. The models have higher explanatory power for overinvestment (which is more common in our sample). Columns 1−3 give the results of the regressions using overinvestment as the dependent variable, whereas columns 4−6 use underinvestment as the dependent variable.

In overinvestment, FCEOs contribute to reduction in excess investment. We find that all coefficients are negative and

Table 3
Female CEOs and investment efficiency.

	Panel A			Panel B		
	Over Investment			Under Investment		
	IE (Biddle et al., 2009)	IE (Chen 2011)	IE (Average)	IE (Biddle et al., 2009)	IE (Chen 2011)	IE (Average)
FCEOs	**−0.0437[b]**	**−0.0238[b]**	**−0.0325[b]**	**−0.0249**	**−0.0263**	**−0.0473**
	(0.000)	**(0.003)**	**(0.001)**	**(0.327)**	**(0.475)**	**(0.521)**
SOEs	0.0149[c]	0.0263[c]	0.0431[c]	−0.1176	−0.1307	−0.1219
	(0.001)	(0.000)	(0.003)	(0.133)	(0.174)	(0.145)
Size	−0.0142[b]	−0.0157[b]	−0.0247[b]	0.0043[b]	0.0051[a]	0.0077[b]
	(0.022)	(0.013)	(0.019)	(0.021)	(0.055)	(0.045)
Lev	−0.0239[c]	−0.0475[c]	−0.0251[c]	0.0273[c]	0.0643[c]	0.0471[c]
	(0.000)	(0.002)	(0.001)	(0.000)	(0.003)	(0.001)
MB	0.0452[b]	0.0351[b]	0.0324[b]	−0.571[c]	−0.0241[c]	−0.0235[b]
	(0.011)	(0.015)	(0.021)	(0.009)	(0.007)	(0.012)
FRQ	−0.0065[b]	−0.0047[b]	−0.0051[a]	−0.2436[b]	−0.4231[a]	−0.4565[b]
	(0.032)	(0.042)	(0.052)	(0.042)	(0.054)	(0.064)
Age	0.0075	0.0135	0.0247	−0.0028	−0.0074	−0.0076
	(0.325)	(0.389)	(0.359)	(0.291)	(0.253)	(0.297)
OCF	0.1627[c]	0.1457[c]	0.1524[c]	−0.0478[c]	−0.0247[c]	−0.0831[c]
	(0.001)	(0.005)	(0.003)	(0.003)	(0.001)	(0.000)
Top1	0.0354	0.0432	0.0392	0.2047	0.2152	0.2836
	(0.337)	(0.329)	(0.473)	(0.287)	(0.347)	(0.357)
ROA	0.0318[c]	0.0421[c]	0.0186[b]	−0.0081[b]	−0.0078[a]	−0.0085[a]
	(0.005)	(0.002)	(0.017)	(0.047)	(0.078)	(0.067)
Loss	−0.0093	−0.0358[a]	−0.0324	0.0409	0.1673[a]	0.0289
	(0.351)	(0.095)	(0.463)	(0.426)	(0.070)	(0.397)
Firm Fixed Effect	Included	Included	Included	Included	Included	Included
Year Fixed Effects	Included	Included	Included	Included	Included	Included
Constant	0.4847[a]	0.1872[b]	0.3417[b]	0.2451[b]	0.1864[b]	0.2783[b]
	(0.057)	(0.048)	(0.49)	(0.054)	(0.061)	(0.047)
R-Square (%)	13.79	13.65	13.91	11.29	11.52	11.27
Observations	14,105	13,862	13,784	5584	5495	5368

This table reports fixed effect regression results examining the impact of female CEOs on under/over-investment for the sample firms spanning 2000−2017 that meet data requirements. The dependent variable is investment efficiency as defined earlier. The p-values reported in the parentheses are calculated with standard errors clustered by industries.

[a] Represent significance level at 10%.
[b] Represent significance level at 5%.
[c] Represents significance level a 1%.

Table 4
Female CEOs and investment efficiency.

	IE (Biddle et al.. 2009)	IE (Chen 2011)	IE (Average)
FCEOs	**0.0047[b] (0.014)**	**0.0034[b] (0.019)**	**0.0025[b] (0.011)**
SOEs	**−0.0291[a] (0.007)**	**−0.0384[a] (0.004)**	**−0.0352[a] (0.005)**
FCEOs_SOEs	**−0.0273 (0.472)**	**−0.0198 (0.348)**	**−0.0282 (0.384)**
Size	0.0149[b] (0.031)	0.0146[b] (0.024)	0.0173[b] (0.028)
Lev	0.0259[a] (0.001)	0.0628[a] (0.001)	0.0526[a] (0.003)
MB	−0.0047[b] (0.019)	−0.0045[b] (0.024)	−0.0039[b] (0.022)
FRQ	0.0149[b] (0.024)	0.0164[b] (0.032)	0.0158[b] (0.038)
Age	−0.0068 (0.297)	−0.0047 (0.347)	−0.0055 (0.391)
OCF	0.0226[a] (0.000)	0.0189[a] (0.004)	0.0195[a] (0.002)
Top1	0.0357[c] (0.095)	0.0232 (0.149)	0.0237 (0.247)
ROA	−0.0088[b] (0.017)	−0.0051[b] (0.012)	−0.0069[b] (0.026)
Loss	0.0093 (0.005)	0.0358[c] (0.002)	0.0324 (0.017)
Firm Fixed Effect	Included	Included	Included
Year Fixed Effects	Included	Included	Included
Constant	0.4714[c] (0.061)	0.5532[c] (0.054)	0.4832[b] (0.062)
R-Square (%)	11.87	11.97	11.79
Observations	19,689	19,357	19,152

This table reports fixed effect regression results examining the impact of female CEOs on investment efficiency in SOEs for the sample firms spanning 2000−2017 that meet data requirements. The dependent variable is investment efficiency as defined earlier. The p-values reported in the parentheses are calculated with standard errors clustered by industries.
[a] Represent significance level at 1%.
[b] Represent significance level at 5% and.
[c] Represent significance level at 10%.

statistically significant, indicating that firms with FCEOs tend to reduce the overinvestment problem. These results are consistent with those of Cutillas Gomariz and Sánchez Ballesta (2014) and Majeed et al. (2018), who argue that overinvestment leads managers to expropriate creditors and minority shareholders. The results are also in line with the findings of Titman et al. (2004). Li (2004) reports an adverse effect of investment expenditure on future firm performance, which may be due to agency issues. Titman et al. (2004) also find a negative association between stock returns and investment, which means investors consider higher investment a serious problem because it decreases IE. However, in underinvestment, FCEOs have no significant impact on improving IE. Among the control variables, *SOE, MB, OCF*, and *ROA* are positively and significantly associated with overinvestment, consistent with expectations and prior research. *FRQ* is negatively correlated with deviation from expected investment.

4.1.3. FCEOs, IE, and SOEs

We predict that FCEOs have no effect on IE at SOEs. Table 4 presents the results for the effect of FCEOs on IE at SOEs. The interaction term *FCEOs * SOE* reports the results of the association between FCEOs and IE at SOEs. The results for SOEs are insignificant, supporting H3. These results support our argument that SOEs are less risky because the government acts as an insurer and bails them out when they are in financial distress (Faccio, 2006). Therefore, investors do not consider investment inefficiency and value-destroying activities serious issues at SOEs compared to non-SOEs. Further, the results are in line with prior studies, which suggest that SOEs are different from non-SOEs. Because of the difference in their objectives, default risk, access to finance, and sociopolitical goals, the investment decisions are not determined by the same factors at SOEs as at non-SOEs, so the effect of IE on the cost of equity is more evident at non-SOEs than SOEs (Chen et al., 2011; Kato & Long, 2006).

5. Robustness tests

5.1. FCEOs and investment efficiency: using alternative measures of investment efficiency

We used two alternative measures of IE, following Chen et al. (2013) and Richardson (2006). The first alternative measure is obtained following the model developed by Chen et al. (2013). They use sales growth and Tobin's Q to estimate the optimal level of investment. They observe that "this approach does not rely on the assumption that cash balance and leverage are exogenous factors predicting the propensity to underinvestment and overinvestment."

$$Investment_{i,t} = \beta_0 + \beta_1 SalesGrwoth_{i,t-1} + \beta_2 Q_{i,t} + \varepsilon_{i,t} \quad (6)$$

where $Investment_{i,t}$ is the total investment in firm i in year t, which is the net increase in tangible and intangible assets scaled by total assets, and $\beta_1 SalesGrowth_{i,t-1}$ is the rate of change in sales from year t-2 to t-1, whereas $Q_{i,t}$ is the lagged Tobin's Q, measured as the sum of the market value of shareholder equity and the book value of liabilities divided by total assets.

The second alternative measure of IE is obtained from the model of Richardson (2006). Many studies (e.g., Biddle et al., 2009; Chen et al., 2011, 2017) use this model to measure IE. Specifically, the model used in our study is as follows:

$$\begin{aligned} Investment_{i,t} = {} & \beta_0 + \beta_1 TQ_{i,t-1} + \beta_2 Lev_{i,t-1} + \beta_3 Cash_{i,t-1} \\ & + \beta_4 Listage_{i,t-1} + \beta_5 Size_{i,t-1} \\ & + \beta_6 Return_{i,t-1} + \beta_7 Investment_{i,t-1} \\ & + IndustryFE + YearFE + \varepsilon_{i,t} \end{aligned} \quad (7)$$

where $Investment_{i,t}$ is the firms' capital investment in year t. All the dependent variables are lagged by one year. $TQ_{i,t-1}$ is Tobin's Q, $\beta_2\ Lev_{i,t-1}$ is the leverage ratio measured by the ratio of debt to total assets at the end of year t-1, and $Cash_{i,t-1}$ is the cash holding of the firm scaled by total assets. $Listage_{i,t-1}$ is the age of the firm since its founding, $Size_{i,t-1}$ in the natural log of total assets, $Return_{i,t-1}$ is the annual market-adjusted return, and $Investment_{i,t-1}$ is capital investment in year t-1.

The results as reported in Appendix Tables S2, S3, and S4 (in the online supplementary material) are similar to those reported earlier. FCEOs are positively associated with IE in the full sample. The results for over- and underinvestment are similar to those reported earlier. We also found a negative

Table 5
FCEO and investment efficiency.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
	Stage 1	Stage 2															
	FCEOs	Investment Efficiency				Over-Investment				Under-Investment				FCEOs[c]SOEs			
		Biddle	Chen11	Chen13	Rich	Biddle	Chen11	Chen13	Rich	Biddle	Chen11	Chen13	Rich	Biddle	Chen11	Chen13	Rich
Ind_FCEOs	0.541[a]																
	(0.0320)																
FCEO(IV)		0.0837[a]	0.0812[a]	0.0634[b]	0.0521[a]	−0.112[a]	−0.103[a]	−0.0846[b]	−0.0766[a]	−0.0087	−0.0055	0.0010	−0.0348	0.0865[a]	0.0823[a]	0.0531[c]	0.0444[a]
		(0.0289)	(0.0297)	(0.0283)	(0.0176)	(0.0335)	(0.0324)	(0.0331)	(0.0254)	(0.0065)	(0.0107)	(0.00753)	(0.0280)	(0.0272)	(0.0266)	(0.0272)	(0.0133)
FCEO(IV)[c]SOEs														−0.0051	−0.0022	0.0197	0.0171
														(0.0286)	(0.0291)	(0.0291)	(0.0108)
SOEs	−0.0087[c]	0.0012	0.0013	0.0015	−8.53e-05	0.0005	−0.0003	−0.0008	−0.0012	0.0003	7.88e-05	0.0007	0.0007	0.0015	0.0014	0.0004	−0.0034
	(0.0051)	(0.0024)	(0.0025)	(0.0024)	(0.0018)	(0.0036)	(0.0035)	(0.0032)	(0.0022)	(0.0008)	(0.0011)	(0.0010)	(0.0026)	(0.0025)	(0.0025)	(0.0025)	(0.0022)
Size	−0.0040	0.0103[a]	0.0113[a]	0.0138[a]	0.0083[a]	−0.0185[a]	−0.0150[a]	−0.0162[a]	−0.0126[a]	0.0040[a]	0.0039[a]	0.0014[c]	−0.0061[a]	0.0103[a]	0.0113[a]	0.0138[a]	0.0082[a]
	(0.0034)	(0.0019)	(0.0020)	(0.0020)	(0.0015)	(0.0036)	(0.0032)	(0.0034)	(0.0024)	(0.0006)	(0.0008)	(0.0008)	(0.0021)	(0.0012)	(0.0013)	(0.0013)	(0.0011)
Lev	0.0191	0.0151[c]	0.0139[c]	0.0112	−0.0052	−0.0386[a]	−0.0265[b]	−0.0314[a]	0.0030	−0.0025	0.0003	0.0015	0.0117	0.0151[a]	0.0139[b]	0.0111[b]	−0.0042
	(0.0141)	(0.0077)	(0.0080)	(0.0084)	(0.0064)	(0.0116)	(0.0110)	(0.0115)	(0.0088)	(0.0025)	(0.0036)	(0.0032)	(0.0085)	(0.0053)	(0.0054)	(0.0055)	(0.0048)
MB	−0.0002	0.0007[a]	0.0015[a]	0.0008[a]	0.0610[a]	−0.783	−1.054	−0.862	−0.0875[a]	7.41e-05[c]	0.0006[a]	0.0002[a]	−0.258	0.0006	0.0014	0.0009	0.0632[b]
	(0.0025)	(0.0001)	(0.0001)	(0.0001)	(0.0080)	(0.746)	(0.668)	(0.707)	(0.0122)	(4.43e-05)	(9.83e-05)	(4.47e-05)	(0.194)	(0.0011)	(0.0011)	(0.0011)	(0.0303)
FRQ	0.0011	0.0007	−0.0015[b]	0.0003	−0.0007	0.0033[b]	0.0017[c]	−0.0009	0.0012	−0.0006[b]	−0.0039[a]	−0.0002	−0.0010[c]	0.0007	−0.0014[a]	0.0002	−0.0007[c]
	(0.0013)	(0.0007)	(0.0006)	(0.0006)	(0.0005)	(0.0014)	(0.0009)	(0.0011)	(0.0008)	(0.0003)	(0.0009)	(0.0002)	(0.0006)	(0.0005)	(0.0005)	(0.0005)	(0.0004)
AGE	0.0010	−0.0049[a]	−0.0052[a]	−0.0053[a]	−0.0057[a]	0.0072[a]	0.0069[a]	0.0065[a]	0.0065[a]	−0.0005[a]	−0.0005[b]	−0.0002	0.0015[a]	−0.0049[a]	−0.0052[a]	−0.0053[a]	−0.0055[a]
	(0.0009)	(0.0004)	(0.0004)	(0.0004)	(0.0003)	(0.0006)	(0.0006)	(0.0006)	(0.0004)	(0.0002)	(0.0002)	(0.0002)	(0.0005)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
OCF	8.38e-05	−0.0038	−0.0158	−0.0180[c]	−0.0210[b]	0.0813[a]	0.0734[a]	0.0781[a]	0.0409[a]	0.0102[a]	0.0123[a]	0.0097[a]	0.0129[a]	−0.0038	−0.0158[b]	−0.0180[a]	−0.0172[a]
	(0.0124)	(0.0078)	(0.0130)	(0.0101)	(0.0093)	(0.0158)	(0.0144)	(0.0148)	(0.0125)	(0.0018)	(0.0039)	(0.0017)	(0.0036)	(0.0044)	(0.0064)	(0.0064)	(0.0056)
Top1	8.34e-05	0.0004[a]	0.0005[a]	0.0003[b]	0.0004[a]	−0.0005[a]	−0.0005[a]	−0.0003	−0.0003[b]	−1.54e-05	−1.93e-05	−2.34e-05	−0.0002	0.0004[a]	0.0005[a]	0.0003[a]	0.0003[a]
	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(4.10e-05)	(5.43e-05)	(4.84e-05)	(0.0001)	(8.60e-05)	(8.82e-05)	(9.00e-05)	(7.70e-05)
ROA	0.0658[b]	0.252[a]	0.281[a]	0.252[a]	0.215[a]	−0.404[a]	−0.343[a]	−0.359[a]	−0.302[a]	−0.0102[b]	−0.0041	−0.0216[a]	−0.0063	0.252[a]	0.281[a]	0.252[a]	0.216[a]
	(0.0264)	(0.0183)	(0.0203)	(0.0195)	(0.0139)	(0.0293)	(0.0260)	(0.0275)	(0.0210)	(0.0049)	(0.0078)	(0.0054)	(0.0133)	(0.0099)	(0.0103)	(0.0103)	(0.0089)
Loss	0.0072[c]	0.0003	−0.0017	0.0008	0.0030[b]	0.0023	0.0024	0.0003	0.0019	0.0045[a]	0.0042[a]	0.00243[a]	−0.0024	0.00027	−0.0017	0.0007	0.0029[b]
	(0.0039)	(0.0016)	(0.0017)	(0.0017)	(0.0013)	(0.0027)	(0.0026)	(0.0024)	(0.0018)	(0.0006)	(0.0008)	(0.0007)	(0.0019)	(0.0014)	(0.0015)	(0.0015)	(0.0013)
Ind.FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year. FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.148[b]	−0.148[a]	−0.165[a]	−0.200[a]	−0.0692[b]	0.310[a]	0.224[a]	0.249[a]	0.159[a]	−0.0993[a]	−0.106[a]	−0.0445[a]	0.0847[b]	−0.148[a]	−0.165[a]	−0.200[a]	−0.0649[a]
	(0.0734)	(0.0404)	(0.0418)	(0.0417)	(0.0298)	(0.0745)	(0.0661)	(0.0705)	(0.0483)	(0.0125)	(0.0171)	(0.0152)	(0.0423)	(0.0277)	(0.0285)	(0.0288)	(0.0250)
Observations	17,334	16,172	15,860	17,334	17,524	11,347	11,174	11,525	11,238	4798	4684	6160	6286	16,152	15,836	18,212	17,525
R-square	0.036	0.142	0.155	0.147	0.165	0.198	0.177	0.175	0.193	0.076	0.085	0.043	0.053	0.142	0.155	0.147	0.176

This table reports the 2SLS results examining the impact of female CEOs on investment efficiency, under/over-investment for the sample firms spanning 2000−2017 that meet data requirements. The p-values reported in the parentheses are calculated with standard errors clustered by industries.

[a] Represents significance level a 1%.

[b] Represent significance level at 5% and.

[c] Represent significance level at 10%.

Table 6
Female CEOs and investment efficiency.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Investment Efficiency				Over Investment				Under Investment			
	Biddle	Chen11	Chen13	Rich	Biddle	Chen11	Chen13	Rich	Biddle	Chen11	Chen13	Rich
FCEOs	0.0291[a]	0.0222[b]	0.0215[a]	0.0024[a]	−0.0215[a]	−0.0358[b]	−0.0385[b]	−0.0178[c]	0.0007	−0.0003	0.00031	−0.0024
	(0.0060)	(0.0088)	(0.0080)	(0.0005)	(0.0052)	(0.0179)	(0.0179)	(0.0093)	(0.0015)	(0.0033)	(0.0017)	(0.0023)
SOEs	0.0039[c]	0.0002	−0.0017	−0.0010	−0.0020	−0.0058	−0.00749[b]	0.0015	0.0005	0.0018[c]	0.0003	0.0020[c]
	(0.0022)	(0.0017)	(0.0016)	(0.0014)	(0.0022)	(0.0037)	(0.00359)	(0.0024)	(0.0007)	(0.0010)	(0.0007)	(0.0011)
Size	−0.0057[a]	0.0092[a]	0.0102[a]	0.0037[b]	−0.0015	−0.0036	−0.0045	−0.0016	0.0012[a]	0.0021[a]	0.0021[a]	0.0031[a]
	(0.0010)	(0.0027)	(0.0028)	(0.0015)	(0.0009)	(0.0040)	(0.0049)	(0.0012)	(0.0003)	(0.0004)	(0.0005)	(0.0008)
Lev	0.0191[c]	−0.0772[a]	−0.0664[a]	−0.0294[a]	0.0286[a]	−0.0814[b]	−0.0252	−0.0123	−0.0071[a]	−0.0059[a]	−0.0095[a]	0.0077[c]
	(0.0099)	(0.0132)	(0.0117)	(0.0073)	(0.0066)	(0.0333)	(0.0237)	(0.00766)	(0.0015)	(0.0022)	(0.0021)	(0.0040)
MB	0.465	0.0353	0.0287	0.166[b]	−1.595[b]	−0.0978	−3.946	0.0184	−0.0067[a]	−0.0088[a]	−0.0070	0.125
	(0.404)	(0.0383)	(0.0278)	(0.0773)	(0.637)	(3.702)	(4.305)	(0.0299)	(0.0014)	(0.0020)	(0.0045)	(0.149)
FRQ	−0.0028[b]	−0.0020	−0.0025	0.0089[a]	−0.0012	−0.0052	0.0069	−0.0008	−0.0016[a]	−0.00571[a]	−0.0024[a]	0.0007
	(0.0013)	(0.0018)	(0.0016)	(0.0026)	(0.0010)	(0.0113)	(0.0096)	(0.00085)	(0.0005)	(0.0005)	(0.0008)	(0.0010)
Age	−0.0003	0.0003	0.0001	0.0041	−0.0004[c]	0.0052[b]	0.0050[b]	0.0023[a]	−0.0001[a]	−0.0003[a]	−1.67e-05	−0.0025[a]
	(0.0002)	(0.0004)	(0.0004)	(0.0067)	(0.0002)	(0.0022)	(0.0022)	(0.0005)	(5.32e-05)	(8.03e-05)	(0.0002)	(0.0004)
OCF	0.0323[a]	0.0152	0.0060	0.0862[a]	−0.0130	0.253[c]	0.352[a]	−0.00493	0.0119[a]	0.0130[a]	0.0300[a]	0.0033
	(0.0103)	(0.0241)	(0.0119)	(0.0298)	(0.0142)	(0.139)	(0.127)	(0.00969)	(0.0020)	(0.0038)	(0.0081)	(0.0118)
Top1	9.10e-06	4.46e-05	−0.0004	−0.0005	−2.59e-05	0.0012	−0.0008	0.0001[b]	−1.23e-05	−3.49e-05	0.0002[a]	0.0001
	(6.19e-05)	(0.0007)	(0.0007)	(0.0003)	(6.38e-05)	(0.0008)	(0.00114)	(6.83e-05)	(1.70e-05)	(2.50e-05)	(6.96e-05)	(0.0001)
ROA	0.125[a]	−0.545[a]	−0.358[a]	−0.280[a]	0.236[a]	−0.370[c]	−0.131	−0.216[a]	−0.0059	0.0115	−0.0323[b]	0.0009
	(0.0200)	(0.127)	(0.110)	(0.0305)	(0.0284)	(0.208)	(0.147)	(0.0247)	(0.0050)	(0.0070)	(0.0136)	(0.0178)
Loss	−0.001	0.0163	−0.0046	−0.0212[b]	−0.0044	−0.0522[c]	−0.0103	0.0024	0.0036[a]	0.0025[a]	0.00137	−3.03e-05
	(0.0023)	(0.0180)	(0.0152)	(0.0090)	(0.0028)	(0.0290)	(0.0215)	(0.0020)	(0.0006)	(0.0008)	(0.0015)	(0.0017)
Ind.Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.157[a]	−0.194[a]	−0.194[a]	−0.0959[a]	0.0508[b]	−0.00415	0.0393	−0.0364	−0.0376[a]	−0.0702[a]	−0.0715[a]	−0.0374[a]
	(0.0216)	(0.0362)	(0.0364)	(0.0180)	(0.0198)	(0.0701)	(0.0761)	(0.0266)	(0.0058)	(0.0074)	(0.00916)	(0.0138)
Diagnostic tests												
Ar(1)	−5.49[a]	−8.17[a]	−7.86[a]	−13.60[a]	−7.37[a]	−3.74[a]	−4.44[a]	−3.38[a]	−4.37[a]	−6.17[a]	−2.96[a]	−2.45[a]
Ar(2)	0.12	−0.22	−0.45	−1.18	−0.35	−0.92	−1.63	−0.22	1.61	1.61	−0.81	−0.63
J-statistics	99.02	44.84	43.88	34.14	101.74	26.75	22.45	44.55	92.25	73.70	66.35	24.17
Observations	18,479	17,734	18,189	19,284	13,364	11,570	13,152	13,591	5115	6164	5037	5693

This table reports GMM results examining the impact of female CEOs on investment efficiency, under/over-investment for the sample firms spanning 2000−2017 that meet data requirements. The p-values reported in the parentheses are calculated with standard errors clustered by industries.
AR(1) and AR(2) are tests of first and second order serial correlation in first-difference residuals under the null of no serial correlation. J-statistic is the Sargan-Hansen test of over-identifying restrictions, asymptotically distributed as chi-squared under the null of instruments are valid.
[a] Represents significance level a 1%.
[b] Represent significance level at 5% and.
[c] Represent significance level at 10%.

association between FCEOs and overinvestment, whereas we found no association between FCEOs and underinvestment. Moreover, unlike non-SOEs, FCEOs are not significantly associated with IE at SOEs.

5.2. Endogeneity issues

In the previous sections, we investigate whether FCEOs have a positive impact on corporate IE. However, this relationship may suffer from endogeneity issues. We adopt three approaches to address endogeneity issues. First, we use the lag of the independent variable (FCEOs). Using lagged independent variables is a suitable tool to deal with endogeneity issues in corporate governance studies (Bennouri et al., 2018; Ullah et al., 2019; Wintoki et al., 2012). The results presented in Appendix Tables S5 (in the online supplementary material) remain consistent with those reported earlier. Second, we employ the two-stage least squares (2SLS) approach to overcome endogeneity issues. In the first-stage analysis, we use CEO age and education and then regress it with our main dependent variables. Finally, to confirm our results, we use the two-step generalized method of moments (GMM) technique adopted by Arellano and Bover (1995) and Blundell and Bond (1998). The GMM analysis offers valid instruments that address unobserved heterogeneity and simultaneity, which is vital for eliminating any endogeneity issues (Wintoki et al., 2012). The results of 2SLS and GMM, reported in Tables 5 and 6 show, that after controlling for endogeneity issues, our findings remain identical to those reported earlier. Specifically, we document a positive effect of FCEOs on IE. Furthermore, FCEOs decrease over-investment, rather than underinvestment, and the association between FCEOs and IE is weaker at SOEs.

Table 7
This table reports fixed effect regression results examining the impact of female CEOs on investment efficiency in high and low growth) for the sample firms spanning 2000−2017 that meet data requirements.

VARIABLES	IE_Biddle		IE_Chen11		IE_Chen13		IE_Rich	
	HG_Ind	LG_Ind	HG_Ind	LG_Ind	HG_Ind	LG_Ind	HG_Ind	LG_Ind
Female_CEOs	0.0059	0.0173[a]	0.0052	0.0164[a]	0.0035	0.0177[b]	0.0018	0.0156[a]
	(0.0043)	(0.0064)	(0.0041)	(0.0063)	(0.0042)	(0.0068)	(0.0030)	(0.0052)
SOEs	0.0089[a]	0.0069[a]	−0.0084[a]	0.00723[a]	−0.0057[a]	0.0058[a]	−0.0051[a]	−0.0053[a]
	(0.0018)	(0.0016)	(0.0018)	(0.0016)	(0.0018)	(0.0017)	(0.0014)	(0.0013)
Size	−0.0017[b]	0.0009	0.0014[c]	0.00129[c]	0.0038[a]	−0.0014*	0.0026[a]	3.37e-05
	(0.0008)	(0.0007)	(0.0008)	(0.0007)	(0.0009)	(0.0008)	(0.0007)	(0.0006)
Lev	−0.0279[a]	−0.0239[a]	0.0226[a]	−0.0248[a]	0.0216[a]	−0.0172[a]	0.0044	0.0097[b]
	(0.0050)	(0.0051)	(0.0053)	(0.0052)	(0.0055)	(0.0054)	(0.0044)	(0.0043)
MtoB	0.0114	−0.0002[b]	−0.0062	−0.0002	−0.0065	4.36e-05	0.0288[a]	0.0885[a]
	(0.0208)	(0.0001)	(0.0143)	(0.0001)	(0.0056)	(0.0001)	(0.0056)	(0.0185)
FRQ	−0.0004	−0.0018[b]	0.00256[a]	−0.00174[b]	0.0041[a]	−0.0033[a]	0.0003	0.0006
	(0.0015)	(0.0007)	(0.0007)	(0.0008)	(0.0009)	(0.0007)	(0.0004)	(0.0007)
Age	0.0008[a]	0.0011[a]	−0.0008[a]	0.0011[a]	−0.0009[a]	0.0009[a]	−0.0025[a]	−0.0026[a]
	(0.0002)	(0.0001)	(0.0002)	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0001)
OCF	−0.0330[a]	−0.0117	0.0327[a]	−0.0138[c]	0.0441[a]	−0.0163*	0.0180[b]	0.0015
	(0.0091)	(0.0077)	(0.0093)	(0.0070)	(0.0103)	(0.0088)	(0.0073)	(0.0054)
Top1	0.0001[c]	−3.91e-05	−7.95e-05	−4.45e-05	−0.0002[b]	−8.19e-06	−7.81e-05	4.93e-05
	(6.06e-05)	(5.44e-05)	(5.84e-05)	(5.42e-05)	(6.09e-05)	(5.70e-05)	(4.77e-05)	(4.58e-05)
ROA	−0.2900[a]	−0.1950[a]	0.2590[a]	−0.1890[a]	0.2400[a]	−0.1730[a]	0.2040[a]	0.1700[a]
	(0.0234)	(0.0225)	(0.0200)	(0.0236)	(0.0211)	(0.0233)	(0.0166)	(0.0174)
Loss	0.0037	9.44e-06	−0.0018	0.0013	−0.0014	−0.0014	−0.0017	0.0017
	(0.0022)	(0.0019)	(0.0021)	(0.0019)	(0.0022)	(0.00205)	(0.00178)	(0.0015)
Ind.Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year.Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	−0.0136	−0.0802[a]	0.0267	−0.0899[a]	−0.0253	−0.0300[c]	0.0341[b]	0.0901[a]
	(0.0173)	(0.0150)	(0.0165)	(0.0151)	(0.0170)	(0.0160)	(0.0135)	(0.0125)
Observations	6418	12,061	6418	11,316	5767	12,425	6119	13,165
R-squared	0.078	0.110	0.072	0.102	0.066	0.109	0.074	0.176

The dependent variable is investment efficiency as defined earlier. The p-values reported in the parentheses are calculated with standard errors clustered by industries.
[a] Represent significance level at 1%.
[b] Represent significance level at 5% and.
[c] Represent significance level at 10%.

5.3. Additional testing: FCEOs, high-growth industries, and investment efficiency

High-growth industries differ from other industries in many ways, particularly in terms of investment decisions. They are characterized by higher research and development expenditures, greater market acceptance, sustainable profitability over the long term, and stiff market competition. Furthermore, these industries also defy the traditional investment models. Therefore, we examine the effect of FCEOs in high-growth and low-growth industries separately, which enables us to understand how gender differences at the top level respond to market/industry conditions. We determine which industries are high growth using IBIS World for China. They include alternative-fuel car manufacturing, solar power generation, internet services, smartphone manufacturing, optical fiber and cable manufacturing, couriers, oil and gas drilling support services, home appliance stores, energy-efficiency consultants, and online shopping. Table 7 reports the results for the effect of FCEOs in high- and low-growth industries. Our findings indicate that FCEOs do not have a significant impact on IE at high-growth firms. The many industry-specific factors in growth industries contribute to the insignificant effect of FCEOs on IE.

6. Conclusion

The importance of good corporate governance, especially in terms of gender diversity on the board, has been discussed in the previous literature (Luo et al., 2018; Ullah et al., 2019). Thus, focusing on the underlying factors that affect corporate governance decisions is essential. This study aims to determine whether and how female executives affect corporate governance practices, which in turn promote the firm's IE. To do so, we used a large sample of all Chinese companies issuing A-shares listed on the stock exchanges from 2000 to 2017.

We divide our sample into two kinds of inefficiency, overinvestment and underinvestment. At firms that overinvest, we test the relationship between FCEOs and overinvestment for agency conflicts. At firms with underinvestment, we examine the association between FCEOs and underinvestment

based on information risk. Further, we investigate the association between FCEOs and IE at SOEs. This study provides some fresh insights into the importance of female executives in corporate investment decisions.

We find robust evidence that FCEOs are positively associated with IE, which means that FCEOs promote IE. Our findings are consistent with the hypothesis that "FCEOs reduce overinvestment." These results are consistent with evidence that female executives curb investment at firms with overinvestment because they limit excess free cash flow, which can be used by managers to undertake projects with a negative NPV. The monitoring role of FCEOs helps limit this opportunistic behavior by managers, hence preventing firms from overinvesting. We found no association between FCEOs and underinvestment. Overall, our findings are consistent with the notion that FCEOs play a role in mitigating information risks, which ultimately encourages IE.

This study contributes to the literature on the determinants of IE and the role played by FCEOs in corporate investment decisions. To the best of our knowledge, no other study has explored the effect of FCEOs on IE. Furthermore, our results show that FCEOs play a significant role in reducing information asymmetry and agency conflicts between shareholders and managers. Our findings contribute to the literature on the role of corporate governance in investment decisions and extend the literature by suggesting that FCEOs monitor managers by reducing agency problems. Our findings also have significant implications for managers, shareholders, and researchers because they help explain the importance of female executives in investment decisions. Overall, our results strongly suggest that FCEOs can directly benefit investors in the form of more efficient investment. One interpretation of our study is that eliminating females from top management teams can lead to less beneficial investment decisions.

Conflict of interest

Author states that there is no conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bir.2020.09.010.

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