

# Top Executives' Overconfidence and Investment Efficiency Based on Data Analysis by Regression Method and CSMAR: Evidence from China

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**Abstract.** This paper studies the impact of management's overconfidence on corporate investment and decision-making. Using the China A-share listed companies and the data from the CSMAR database, applying the regression method to estimate the investment efficiency of the enterprises, this research studies the quantitative relationship between the executive overconfidence and the panel data model and packet regression. This paper finds that management overconfidence is positively associated with an inefficient corporate investment. Strictly controlling the confidence level of enterprise management and strengthening supervision are important measures to ensure the good operation of enterprises, reduce operational risks and achieve sustainable development.

**Keywords:** overconfidence; investment efficiency; management; investment decision; data analysis.

## 1. Introduction

Investment plays a critical role in ensuring companies' sustainable development in market competition and creating new value for shareholders [1]. Investment efficiency is measured as the difference between real and predictable investment to reflect the degree to which a firm departs from its optimum investment strategy [2]. Under the assumption of the perfect capital market, investors believe that the most significant character of managers is the ability to make rational decisions, that is, to obtain the maximum profit by using all the possible resources of the enterprise. However, due to the complexity of the capital market and interference from the external and internal environments, managers often have physiological behaviors contrary to rational decisions. Overconfidence happens when an individual overestimates their abilities, knowledge, and forecasts. Overconfidence may be driven by an individual's successful past experiences or may simply be based on illusionary capabilities that are not supported with any evidence of qualification. "In this most basic form, overconfidence can be summarized as unwarranted faith in one's intuitive reasoning, judgments, and cognitive abilities" [3].

Executive overconfidence, defined as executives' tendency to inflate or overestimate their own abilities [4, 5], is central to a growing, cross-disciplinary research stream focused on how executives affect the behaviors of organizations [6]. In 1986, Roll proposed that overconfidence is typical irrational behavior and that corporate managers tend to exhibit it when they make business decisions. Previous studies have shown that overconfident managers make investment decisions that result in over-investment or under-investment problems, which may cause inefficient investment directly.

Besides, some other factors may affect the efficiency of corporate investment. First, tax policies can weaken the positive correlation between investor sentiment and corporate overinvestment and suppress the negative correlation between investor sentiment and corporate underinvestment. Tax policies will have an important impact on the investment efficiency of the micro real economy. Second, the stickiness of executive compensation has a negative impact on corporate investment

efficiency, which will aggravate corporate over-investment, thereby increasing inefficient investment and reducing investment efficiency. Risk-taking plays an intermediary role in the relationship between executive salary stickiness and corporate investment efficiency. Executive salary stickiness affects corporate investment efficiency by affecting corporate risk-taking. The transmission channel of "executive salary stickiness-risk bearing-corporate investment efficiency" is effective. Third, the higher the degree of soft budget constraint, the lower the investment efficiency of the enterprise; the better the financial environment that the enterprise faces, the higher its investment efficiency; the financial environment significantly weakens the correlation between soft budget constraint and enterprise investment efficiency.

Previous studies investigated the relation between investment efficiency and financial reporting quality [7], corporate social responsibility [8], or management forecast errors [9]. However, a lack of work examines the association between investment efficiency and executives' overconfidence. In this research, we will mainly discuss the impact of investment efficiency on executive overconfidence.

Due to China's unique institutional context, the principal-agent problem is not embodied as conflicts between principals and agents in Western countries with highly dispersed shareholding. Still, as big shareholders' encroaching upon the interests of small and medium shareholders. In Chinese listed companies, almost all top managers, including presidents, managers, general managers, are appointed by controlling shareholders [10]. A company's decision-making power is in the hand of an overconfident manager appointed by controlling shareholders. Besides, many state-owned enterprises have more serious over investments made by overconfident managers than non-state enterprises do. In state-owned enterprises in China, the largest shareholder is a government official who acts as a government agent. In which the enterprise lacks an owner, this system results in lower motivation for supervision of financial decisions than in private corporations. The government often appoints State-owned enterprise managers. This is a non-market technique, which can easily lead to opportunistic behavior by managers, who have a much higher risk of pursuing their private interests [11]. These firms' managers pay more attention to political "success" than to the operating performance of their companies. When certain industries or projects become "hot" in the market, overconfident managers, eager to prove their competence in discovering investment opportunities, tend to expand the scale of investment without considering returns and other factors, and they are more likely to blindly follow other firms' excessive investment behaviors.

The research contribution of this paper is as follows. First, in our study, we found that even if enterprises have good investment decision plans, their investment efficiency is often lower than their preset plans, including returns, duration, risk exposure, and so on. According to CEO Overconfidence and Management Forecasting [12], the operating efficiency of an enterprise's investment decision is usually driven by its Management. The overconfidence of the management can predict the return of the enterprise to some extent. Second, by referring to different indicators of corporate financial statements, we quantify the degree of management's overconfidence and its impact on corporate investment efficiency, which can reflect the correlation between the two. In an economic society, overconfidence is common. People often cannot accurately grasp the correct degree of their decisions. Managers' irrational is a common behavioral tendency among senior executives. Usually, because they like to add their own independent judgment, this paper measures the impact of management's overconfidence on the investment efficiency of the enterprise, which can help the company better control internal risks and reduce operational risks [13]. Third, according to the irrational behavior theory of managers, the research results of this paper can verify the accuracy of the theory again. Enterprises can control the influence of irrational behavior of managers [14] on enterprises through incentives or behavioral restrictions.

The remainder of this study is organized as follows. We develop our hypothesis in Section 2. Section 3 describes the research design. The empirical results are discussed in Section 4. Finally, section 5 concludes the paper.

## 2. Hypotheses

In general, under the assumption of the perfect capital market, investors believe that the most significant character for managers is the ability to make rational decisions, that is, to obtain the maximum profit by using all the possible resources of the enterprise. However, due to the complexity of the capital market and interference from the external and internal environments, managers often have physiological behaviors contrary to rational decisions.

Malmendier and Tate [15] have found that some personal characteristics of managers, such as overconfidence, may lead to distortions in a corporate investment decision. Besides, managers' degree of optimism positively correlates to the investment sensitivity in terms of free cash flow. Another research by Malmendier and Tate [16] has proposed that in 1986, Roll proposed that overconfidence is typical irrational behavior and that corporate managers tend to exhibit it when making business decisions. Previous studies have shown that overconfident managers make investment decisions that result in over-investment or under-investment problems.

According to relative studies, we defined those overconfident managers are the ones who tend to have controlling illusions about technologies they own and the accuracy of their judgment, so when they make decisions, they tend to overestimate the likelihood of success. They believe that their companies will show good profits and have great potential and that outside investors underestimate the actual value of these companies. Wang, Zhang, and Yu [17] found a positive relationship between managerial overconfidence and internal financing. Specifically, Ahmad and Habib [18] found that overconfident managers tend to have controlled illusions about technologies they own and the accuracy of their judgment. As a result, when they make decisions, they tend to overestimate the likelihood of success. They believe that their companies will show good profits and have great potential and that outside investors underestimate the actual value of these companies. Due to asymmetric information and transaction costs, managers tend to choose internal financing and remain cash inside.

Therefore, we propose the following hypotheses for the relationship between top executives' overconfidence and investment efficiency.

*H1: investment efficiency is negatively correlated to top executives' overconfidence.*

In the current market environment, inefficient investment phenomena such as under-investment or over-investment abound. In removing the influence of various external factors, managers' psychological factors on investment decision-making are obvious. So, if the influence of external factors is taken into account, how can the overconfidence of the management and the external governance environment simultaneously affect the non-investment efficiency of the company? Khan and other studies have found that independent third-party audits can restrict management's behavior by auditing corporate financial statements and internal control, affecting the management's choice of investment projects [19]. Boubaker et al. [20] took 125 French listed companies from 2008 to 2015 as a research sample. The empirical results show that the value-added services provided by auditors will affect the investment decisions of the company's management. The auditor's knowledge will inhibit companies that overinvest Investment, at the same time, promote underinvestment enterprises to increase investment. Wang pointed out that the impact of high-quality auditing on corporate investment efficiency will be interfered with by the debt policy implemented by the company. A radical debt policy will put management under pressure to repay the debt and interest due, and creditors can also pass audit reports. To understand the operating conditions of the company to protect its own rights and interests. Therefore, in the case of high debt ratios of enterprises, high-quality audits have enhanced supervision and restraint on management's behavior, which in turn has an impact on management's investment decisions [21]. As the external macro-environment, the legal environment sets a series of behavioral norms for the business activities of enterprises in the market. La Porta was the first scholar who began to pay attention to the governance effect of the external governance environment on corporate management. He believed that the legal environment has a wide-ranging impact on the corporate governance structure and business decision-making, and a good legal environment is the foundation of corporate management [22]. Albuquerque and others believe

that the improvement of the legal system is conducive to restraining the behavior of major shareholders and reducing their inappropriate investment behavior [23]. Therefore, we put forward the hypothesis:

*H2*: In a company with a poor external governance environment, management overconfidence will significantly increase the company's inefficient investment.

### 3. Variables

#### 3.1 Research Design

The data used in this paper comes from the Cathay Security Database (CSMAR). The data studied include Chinese A-share listed companies, excluding financial companies and ST companies. The reason for excluding financial companies is that the financial statements of financial companies are different from other companies. ST company is a company that will be delisted, and its financial statements have no reference value.

$$Inv\_B2 = \beta_0 + \beta_1 OverCON + \beta_2 Size + \beta_3 Age + \beta_4 BM + \beta_5 Roa + \beta_6 Ret + \beta_7 Lev + \beta_8 Growth + \mu \quad (1)$$

Among them, *Inv\_B2* is the explained variable, *OverCON* is the explanatory variable, *Size*, *Age*, *BM*, *Roa*, *Ret*, *Lev*, *Growth* are the control variables,  $\mu$  is the random disturbance term,  $\beta_0$  is the intercept term,  $\beta_1 - \beta_8$  is the parameter.

#### 3.2 Independent variables: investment efficiency

Investment efficiency is a function used to evaluate the risk, return, and total cost of an investment. It is subjected to internal and external constraints.

In this section, we will apply three methods to evaluate the investment efficiency of a particular firm. First, according to the methodologies used by Biddle, Hilary, and Verdi [24], the formula can be expressed by the equation below:

$$Investment_{i,t} = \beta_0 + \beta_1 SalesGroth_{i,t-1} + \varepsilon_{i,t} \quad (2)$$

We assume that *Investment<sub>i,t</sub>* is the overall investment of firm *i* in year *t*, defined as the net increase in tangible and intangible assets and scaled by lagged total assets. *SalesGroth<sub>i,t</sub>* is the percentage change in sales of firm *i*, from year *t-1* to *t*.  $\varepsilon_{i,t}$  is the residual, which will be explained in the following paragraph. We use this formula to estimate the investment for each industry year based on the figures and observations shown in China Stock Market & Accounting Research Database (CSMAR).

Then we use the *INVEFF*, which Lin, Li, Cheng, and Lam [25] proposed to estimate the investment efficiency. *INVEFF* is the difference between the actual investment and the expected optimal investment of the firm, also expressed as the residual  $\varepsilon_{i,t}$  of *Investment<sub>i,t</sub>*. In theory, investment efficiency is higher when the *INVEFF* is smaller, vice versa. It can be measured as:

$$INVEFF = Investment_{i,t} - E(Investment_{i,t}) = \varepsilon_{i,t} \quad (3)$$

#### 3.3 Dependent variables: top executives' overconfidence

Following Chen, Ho and Yeh, CEO overconfidence represents a CEO's belief in the future payoff and his/her attitude toward risk-taking. Overconfident CEOs are likely to overestimate the future gains of investment projects, leading to a disagreement on firms' equity value [26]. As a result, overconfident CEOs tend to overinvest when the firms have ample internal funds and underinvest when the investments require external financing.

Top executives' overconfidence is an implicit variable, which means that it is not easy to quantify the accurate degree of overconfidence. Recent studies have used different approaches to measure top executives' overconfidence. Extant studies have estimated CEOs' overconfidence based on their executive options holding decisions, other methods like media coverage by Malmendier and Tate [27], biases between forecasted earnings and actual earnings by Lin et al. [28], or CEO's relative salaries by Hayward and Hambrick [29]. Next, we will continue constructing two proxies for top executives' overconfidence.

The first proxy is the difference between top executives' forecasted earnings and actual earnings. The earnings are over forecasted once the forecasted value is greater than the actual value, vice versa. Top executives will be defined as overconfidence if the overestimation of the income is more significant than the underestimation in a particular time frame.

The second proxy we use to measure top executives' overconfidence is their relative salary. The higher the relative salary a CEO has than other managers, the more critical his relative position will be, and the more overconfident the CEO tends to be. They use the CEO compensation relative to the second-highest-paid officer to measure CEO self-importance. Extant studies also claim that CEO's relative salary is positively associated with the dominance of power. In psychology studies, people tend to have a more substantial "illusion of control" mentality when their relative position is in a company.

Due to the limitation in Chinese company reporting, salary information for the top manager in China over most of our sample period is not available. We use the ratio of the sum of top three managers' salaries to the sum of all managers' salaries as a proxy for top executives' overconfidence. The greater this ratio is, the higher the top executives' overconfidence will be.

### 3.4 Control Variables

Several factors will be controlled to measure the relationship between top executives' overconfidence and investment efficiency during our benchmark regression and robustness check progress.  $Investment_{i,t}$  is the overall investment of the firm  $i$  in year  $t$ . At the same time,  $INVEF$  is the difference between the actual investment and the expected optimal investment of the firm, also expressed as the residual  $\varepsilon_{i,t}$  of  $investment_{i,t}$ . Overconfidence is when the overestimation of the income, which means that the forecasted value is higher than the actual value, is greater than the underestimation in a particular time frame. Relative salary is the ratio of the sum of the top three managers' salaries to the sum of all managers' salaries.

Then we control the firm's size, which is the natural logarithm of the book value of total assets, the year of companies' establishment, the increased percentage of sales growth, etc.  $Roat$  is the return on assets in year  $t$ . It is calculated by the after-tax net profit divided by total assets.  $BM_t$  is the book-to-market ratio,  $Ret_t$  is the mean of firm-specific weekly returns over the fiscal year  $t$ ,  $Lev_t$  is the assets and liabilities. It can be calculated by the book value of total debt divided by the book value of total assets in year  $t$ . The appendix shows the definitions of all variables used during the analysis process, and we winsorize all continuous variables at 1% at both tails.

## 4. Empirical analyses

### 4.1 Descriptive statistics

The maximum investment efficiency ( $Inv\_B2$ ) is 0.683, which is significantly greater than 75 quantiles 0.080. This proves most companies have high investment efficiency, but few companies have low investment efficiency. The standard deviation in the table is very small, which proves that the influence of extreme value is eliminated in the data because we've processed all the data before we do the regression. The standard deviation of Size is larger than others, which is just normal because the market value of listed companies in China is quite different, consistent with the extant study [30].

Table 1. Descriptive Statistics

| <i>Variables</i> | <i>Mean</i> | <i>Std. dev.</i> | <i>Min</i> | <i>25th</i> | <i>Median</i> | <i>75th</i> | <i>Max</i> |
|------------------|-------------|------------------|------------|-------------|---------------|-------------|------------|
| <i>Inv_B2</i>    | 0.068       | 0.089            | 0.001      | 0.023       | 0.047         | 0.080       | 0.683      |
| <i>OverCON</i>   | 0.423       | 0.122            | 0.206      | 0.335       | 0.405         | 0.494       | 0.791      |
| <i>Size</i>      | 22.092      | 1.304            | 19.478     | 21.173      | 21.920        | 22.842      | 26.047     |
| <i>Age</i>       | 2.773       | 0.362            | 1.609      | 2.565       | 2.833         | 3.045       | 3.434      |
| <i>BM</i>        | 0.623       | 0.244            | 0.116      | 0.435       | 0.626         | 0.814       | 1.121      |
| <i>Roa</i>       | 0.039       | 0.054            | -0.183     | 0.014       | 0.035         | 0.064       | 0.201      |
| <i>Ret</i>       | -0.067      | 0.589            | -1.504     | -0.440      | -0.107        | 0.303       | 1.399      |
| <i>Lev</i>       | 0.469       | 0.205            | 0.062      | 0.311       | 0.472         | 0.624       | 0.941      |
| <i>Growth</i>    | 0.193       | 0.481            | -0.568     | -0.015      | 0.113         | 0.273       | 3.305      |

This table reports the descriptive statistics of the variables. The sample includes 2505 firms excluding financial enterprises and Special treatment companies—year observations of the A-share listed companies in China for 2007–2018 on CSMAR. We estimate the mean, standard deviation, minimum, 25 quantiles, median, 75 quantiles, and maximum for each variable. All continuous variables are winsorized at 1% and 99%. The detailed definitions of the above variables are shown in Table 1.

#### 4.2 Correlation Analysis

Table II reports the correlation coefficient and significance of the below variables. The t-values for the differences in means are based on t-tests (Wilcoxon tests). The lower triangle of the table is the Pearson correlation coefficient, and the upper triangle is the Spearman correlation coefficient. \*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% levels, respectively.

Our t-test results show that the correlation between investment efficiency and firm overconfidence (*OverCON*) is significantly positive at the 1 % level. This shows that if the management is overconfident, the company investment efficiency will be lower. In other words, the company's inefficient investment will be higher. Most of the correlation coefficients are less than 0.5, and the VIF is 1.37, which is less than 5, indicating no multicollinearity between variables [31].

Table 2. Correlation Coefficient Matrix

|                | <i>Inv_B2</i> | <i>OverCON</i> | <i>Size</i> | <i>Age</i> | <i>BM</i> | <i>Roa</i> | <i>Ret</i> | <i>Lev</i> | <i>Growth</i> |
|----------------|---------------|----------------|-------------|------------|-----------|------------|------------|------------|---------------|
| <i>Inv_B2</i>  | 1             | 0.020***       | -0.103***   | -0.039***  | -0.121*** | -0.025***  | 0.092***   | 0.015**    | -0.014*       |
| <i>OverCON</i> | 0.049***      | 1              | -0.227***   | 0.069***   | -0.167*** | 0.066***   | 0.015**    | -0.122***  | -0.008        |
| <i>Size</i>    | -0.102***     | -0.225***      | 1           | 0.187***   | 0.553***  | -0.057***  | -0.058***  | 0.409***   | 0.014**       |
| <i>Age</i>     | -0.008        | 0.081***       | 0.156***    | 1          | 0.053***  | -0.100***  | -0.054***  | 0.095***   | -0.093***     |
| <i>BM</i>      | -0.107***     | -0.160***      | 0.570***    | 0.036***   | 1         | -0.237***  | -0.346***  | 0.353***   | -0.025***     |
| <i>Roa</i>     | -0.024***     | 0.045***       | -0.020***   | -0.089***  | -0.188*** | 1          | 0.026***   | -0.418***  | 0.290***      |
| <i>Ret</i>     | 0.083***      | 0.022***       | -0.061***   | -0.036***  | -0.349*** | 0.035***   | 1          | 0.070***   | -0.003        |
| <i>Lev</i>     | 0.035***      | -0.098***      | 0.398***    | 0.115***   | 0.335***  | -0.385***  | 0.074***   | 1          | 0.033***      |
| <i>Growth</i>  | 0.025***      | 0.041***       | -0.002      | -0.026***  | -0.006    | 0.187***   | 0.045***   | 0.054***   | 1             |

#### 4.3 Univariate analysis

Table III reports the mean values and differences of these variables of low overconfidence enterprise and high overconfidence enterprise, respectively. We also use a t-test to test the significance of the difference. First of all, we divide the management confidence into low overconfidence management and high overconfidence management according to the median. Then we test the other variables according to the two groups to see if they have significant differences. \*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% levels, respectively.

Our t-test results show the differences between low overconfidence firms and high overconfidence firms are significant at 1%. We can find that the investment efficiency means the value of high management overconfidence firm is higher than the low management overconfidence firm, which

means the higher the management overconfidence, the lower the investment efficiency. So, the test preliminarily verified our conclusion.

Table 3. Univariate Analysis

| <i>Variables</i> | <i>Low OverCON (1)</i> | <i>High OverCON (2)</i> | <i>Difference (1)-(2)</i> | <i>t-Value (1)-(2)</i> |
|------------------|------------------------|-------------------------|---------------------------|------------------------|
| <i>Inv_B2</i>    | 0.065                  | 0.072                   | -0.007                    | -5.388***              |
| <i>Size</i>      | 22.350                 | 21.830                  | 0.517                     | 28.494***              |
| <i>Age</i>       | 2.759                  | 2.787                   | -0.028                    | -5.453***              |
| <i>BM</i>        | 0.659                  | 0.588                   | 0.071                     | 20.737***              |
| <i>Roa</i>       | 0.036                  | 0.041                   | -0.005                    | -6.236***              |
| <i>Ret</i>       | -0.079                 | -0.055                  | -0.024                    | -2.904***              |
| <i>Lev</i>       | 0.490                  | 0.448                   | 0.043                     | 14.678***              |
| <i>Growth</i>    | 0.180                  | 0.206                   | -0.026                    | -3.800***              |

#### 4.4 Multivariate results

This paper adopts the panel fixed effect model to explore the relationship between management overconfidence and investment efficiency to conduct an empirical study. Table IV shows the regression results. The first column only controls the fixed effect of year and industry and investigates the influence of overconfidence on investment efficiency alone. The second column adds control variables to investigate the net impact effect.

Table 4. Benchmark Return

|                               | (1)                 | (2)                   |
|-------------------------------|---------------------|-----------------------|
| <b>Dependent variables =</b>  | <i>Inv_B2</i>       | <i>Inv_B2</i>         |
| <i>OverCON</i>                | 0.036***<br>(6.089) | 0.016***<br>(2.747)   |
| <i>Size</i>                   |                     | -0.005***<br>(-7.136) |
| <i>Age</i>                    |                     | -0.001<br>(-0.277)    |
| <i>BM</i>                     |                     | -0.038***<br>(-9.346) |
| <i>Roa</i>                    |                     | -0.041**<br>(-2.464)  |
| <i>Ret</i>                    |                     | 0.016***<br>(8.057)   |
| <i>Lev</i>                    |                     | 0.026***<br>(5.246)   |
| <i>Growth</i>                 |                     | 0.004**<br>(2.135)    |
| <i>_cons</i>                  | 0.052***<br>(9.809) | 0.159***<br>(10.493)  |
| <b>Year Fixed Effect</b>      | Yes                 | Yes                   |
| <b>Industry Fixed Effect</b>  | Yes                 | Yes                   |
| <b>Observations</b>           | 19805               | 19795                 |
| <b>Adjusted R<sup>2</sup></b> | 0.040               | 0.063                 |

It can be seen from the results that enterprise overconfidence has a significant positive impact on enterprise investment efficiency. Without the addition of control variables, the influence coefficient is 0.036, significant at the significance level of 1%. After the addition of control variables, the influence coefficient decreases to 0.016, which is highly significant. In this paper, the absolute value

of the difference between the actual investment and the optimal investment is used to measure investment efficiency. It means that the higher the enterprise's overconfidence, the greater the difference between the actual investment and the optimal investment may be, which means the lower the investment efficiency of the enterprise.

In other words, the higher the degree of overconfidence, the lower the investment efficiency. In the case of overconfidence, the management will take their own factors into subjective consideration when making investments and modify the original decisions. For example, increasing derivative hedging positions to make profits also increases the company's exposure to risky assets and reduces the overall investment efficiency. Among the control variables, the improvement of company Size (*Size*), book-to-market ratio (*BM*), and return on assets (*ROA*) are conducive to the improvement of corporate investment efficiency. In contrast, the increase of individual stock yield (*RET*), asset-liability ratio (*LEV*), and operating income growth rate will reduce corporate investment efficiency. This empirical result reveals the relationship between corporate overconfidence and corporate investment efficiency, providing beneficial enlightenment for enterprises to improve investment efficiency.

Table V measures the impact of management's overconfidence on corporate investment results by comparing whether the enterprise is a state-owned enterprise, whether the audit firm is a Big Four accounting firm or a high proportion of institutional investors' shares.

Table 5. Grouped Regression

|                               | (1)<br>Non-SOE        | (2)<br>SOE            | (3)<br>Non-Big4       | (4)<br>Big4        | (5)<br>Low Ins        | (6)<br>High Ins       |
|-------------------------------|-----------------------|-----------------------|-----------------------|--------------------|-----------------------|-----------------------|
| <b>OverCON</b>                | 0.016**<br>(1.965)    | 0.008<br>(1.036)      | 0.016***<br>(2.610)   | 0.012<br>(0.693)   | 0.018**<br>(2.126)    | 0.011<br>(1.402)      |
| <b>Size</b>                   | -0.007***<br>(-5.545) | -0.003***<br>(-3.919) | -0.006***<br>(-7.200) | -0.001<br>(-0.431) | -0.006***<br>(-4.177) | -0.005***<br>(-5.740) |
| <b>Age</b>                    | 0.002<br>(0.580)      | 0.001<br>(0.311)      | -0.001<br>(-0.572)    | 0.010<br>(1.361)   | 0.002<br>(0.643)      | -0.003<br>(-0.998)    |
| <b>BM</b>                     | -0.044***<br>(-7.281) | -0.031***<br>(-5.967) | -0.039***<br>(-9.407) | -0.002<br>(-0.117) | -0.049***<br>(-7.997) | -0.024***<br>(-4.446) |
| <b>Roa</b>                    | -0.041**<br>(-2.121)  | -0.048**<br>(-2.135)  | -0.037**<br>(-2.205)  | -0.056<br>(-0.670) | -0.038*<br>(-1.645)   | -0.039<br>(-1.560)    |
| <b>Ret</b>                    | 0.018***<br>(6.745)   | 0.016***<br>(5.869)   | 0.018***<br>(8.326)   | 0.003<br>(0.392)   | 0.017***<br>(5.823)   | 0.016***<br>(5.710)   |
| <b>Lev</b>                    | 0.035***<br>(5.589)   | 0.020***<br>(3.238)   | 0.028***<br>(5.453)   | 0.001<br>(0.031)   | 0.035***<br>(4.930)   | 0.016**<br>(2.319)    |
| <b>Growth</b>                 | 0.007***<br>(3.575)   | -0.000<br>(-0.259)    | 0.004*<br>(1.920)     | 0.007<br>(1.034)   | 0.003<br>(0.991)      | 0.004*<br>(1.901)     |
| <b>_cons</b>                  | 0.178***<br>(6.861)   | 0.123***<br>(6.264)   | 0.177***<br>(10.401)  | 0.054<br>(0.976)   | 0.163***<br>(6.116)   | 0.168***<br>(8.372)   |
| <b>Year Fixed Effect</b>      | Yes                   | Yes                   | Yes                   | Yes                | Yes                   | Yes                   |
| <b>Industry Fixed Effect</b>  | Yes                   | Yes                   | Yes                   | Yes                | Yes                   | Yes                   |
| <b>Observations</b>           | 9657                  | 10138                 | 18416                 | 1379               | 9884                  | 9911                  |
| <b>Adjusted R<sup>2</sup></b> | 0.070                 | 0.062                 | 0.065                 | 0.040              | 0.073                 | 0.056                 |

From Table V, the coefficients of overconfidence in columns (1), (3), and (5) are significantly positive and greater than the significant coefficients. Private enterprises, non-Big Four accounting firms as auditors, and enterprises with low institutional shareholding ratios significantly impact the variables. The grouping condition clearly compares the investment efficiency of these three groups of enterprises. Management's overconfidence also influences the investment efficiency of these three groups of enterprises, often showing lower investment efficiency. We can conclude that, under the

circumstance of lax supervision of the company's external environment, the overconfidence of the management of these companies has a more significant impact on the investment efficiency, which often fails to achieve the optimal investment portfolio. We can also explain this with some practical economic phenomena. In reality, state-owned enterprises are often subject to more stringent supervision at the national level than the risk management departments of private enterprises. The management tends to mix their own personal judgment with fewer investment decisions (due to their overconfidence). Moreover, the supervision of the four audit departments on enterprises is obviously stricter than other audit departments, making it more difficult for the management to cover up the reduction of investment efficiency caused by their overconfidence through some means [32]. Therefore, the management will reduce the degree of overconfidence.

To test the stability of the results, we replaced the index to measure the inefficiency of enterprise investment, added the  $t+1$  item, and reported the results in Table VI. In the robustness test, we replace the index of investment efficiency and adopt the investment efficiency of the  $t+1$  item, taking into account the influence of time changes on investment efficiency.

Table 6. Robustness Test

| Dependent variables            | <i>Inv_R2<sub>i,t</sub></i><br>(1) | <i>Inv_G2<sub>i,t</sub></i><br>(2) | <i>Inv_B2<sub>i,t+1</sub></i><br>(3) |
|--------------------------------|------------------------------------|------------------------------------|--------------------------------------|
| <i>OverCON<sub>i,t</sub></i>   | 0.008**<br>(2.150)                 | 0.011**<br>(2.278)                 | 0.014**<br>(2.186)                   |
| <i>Size<sub>i,t</sub></i>      | -0.006***<br>(-13.031)             | -0.006***<br>(-9.686)              | -0.007***<br>(-8.986)                |
| <i>Age<sub>i,t</sub></i>       | -0.007***<br>(-5.553)              | -0.002<br>(-1.250)                 | 0.003*<br>(1.647)                    |
| <i>BM<sub>i,t</sub></i>        | -0.022***<br>(-8.315)              | -0.037***<br>(-10.292)             | -0.014***<br>(-2.968)                |
| <i>Roai,t</i>                  | -0.039***<br>(-3.645)              | -0.023*<br>(-1.657)                | -0.037**<br>(-2.091)                 |
| <i>Ret<sub>i,t</sub></i>       | 0.008***<br>(6.333)                | 0.013***<br>(7.661)                | 0.011***<br>(5.339)                  |
| <i>Lev<sub>i,t</sub></i>       | 0.014***<br>(4.521)                | 0.013***<br>(3.042)                | 0.018***<br>(3.497)                  |
| <i>Growth<sub>i,t</sub></i>    | 0.004***<br>(2.947)                | 0.006***<br>(3.882)                | -0.000<br>(-0.025)                   |
| <i>Constants<sub>i,t</sub></i> | 0.202***<br>(19.421)               | 0.166***<br>(12.880)               | 0.188***<br>(11.346)                 |
| <b>Year Fixed Effect</b>       | Yes                                | Yes                                | Yes                                  |
| <b>Industry Fixed Effect</b>   | Yes                                | Yes                                | Yes                                  |
| <b>Observations</b>            | 17644                              | 19795                              | 16969                                |
| <b>Adjusted R<sup>2</sup></b>  | 0.072                              | 0.075                              | 0.063                                |

It can be seen from the output results that the influence of management overconfidence on the current investment efficiency is greater than the influence on the optimal future portfolio. The adjusted R square also shows that the model is more fit for the present and can better reflect the current situation rather than the future. The new index in the table is to add a  $T+1$  item to alleviate the endogeneity problem. The final result is significant and consistent with the benchmark result, which can confirm that the results of our experimental analysis are robust.

## 5. Conclusion

This paper selects the data of 2505 A-share listed companies in China from 2007- 2018 to examines the relationship between management overconfidence and corporate investment efficiency. The empirical results show that management overconfidence correlated significantly negatively with corporate investment efficiency, which means high overconfidence management decreased corporate investment efficiency. Moreover, high management overconfidence in investment inefficiency is more pronounced in non-state-owned and non-Big 4 auditing firms and firms with low institutional shareholding ratios. In addition, after replacing the index of investment efficiency and using the investment efficiency with  $t + 1$  term, the results are still valid.

The policy implications of this paper are as follows: due to the widespread overconfidence of managers in Chinese firms, firms should formulate a reasonable incentive system to reduce the risk aversion tendency of conservative managers and improve their risk-taking level [33]. At the same time, improve the internal supervision and management assessment mechanism, increase information feedback and self-evaluation. This is not only to meet regulatory requirements but also to identify managers' overconfidence and its degree. Furthermore, establish and improve the firm decision-making risk assessment mechanism, timely find and deal with risks, and standardize overconfidence management.

### APPENDIX

#### 5.1 Variable Definition

| Independent Variables     |                                                                                                                               |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| Investment <sub>i,t</sub> | The overall investment of firm i in year t.                                                                                   |
| INVEF                     | The difference between the actual investment and the expected optimal investment of the firm.                                 |
| Dependent Variables       |                                                                                                                               |
| OVERCON                   | Relative proportion of executive compensation, equals to 1 if the firm is authorised “over confidence” in year t and 0 if not |
| Other Variables           |                                                                                                                               |
| Size <sub>t</sub>         | The natural logarithm of the book value of total assets in year t                                                             |
| Age                       | Year of companies' establishment                                                                                              |
| BM <sub>t</sub>           | The book-to-market ratio, the book value of equity divided by the market value of equity in year t                            |
| Roa <sub>t</sub>          | Return on assets in year t, the after-tax net profit divided by total assets                                                  |
| Ret <sub>t</sub>          | The mean of firm-specific weekly returns over the fiscal year t                                                               |
| Growth <sub>t</sub>       | The increased percentage of sales growth in year t                                                                            |
| Big4                      | Equals to 1 if the firm hires the Big 4 accounting firm in year t and 0 if not                                                |
| analyst                   | The number of analysts                                                                                                        |
| Lev <sub>t</sub>          | Assets and liabilities, the book value of total debt divided by the book value of total assets in year t                      |
| SOE                       | Equals to 1 if the firm is a state-owned enterprise in year t and 0 if not                                                    |
| ins                       | Institutional investor shareholding ratio                                                                                     |

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