Environmental uncertainty, equity nature and inefficient investment -- Based on the study of energy enterprises

Qin Yue¹, Sijie Gao²
¹ School of Management, Dalian Polytechnic University, Dalian, Liaoning, China
² School of Management, Dalian Polytechnic University, Dalian, Liaoning, China
*Sijie Gao: email: Yueqin@xy.dlpu.edu.cn

Abstract. The healthy development of energy enterprises plays an important role in the development of national economy, energy security, sustainable use of energy and environmentally friendly development. Investment, as an important management function of enterprises, cannot be ignored for the operation and development of energy enterprises. The uncertainty of environment is a common problem that energy enterprises have to face. In this case, the investment and decision-making behavior of energy enterprises will also be affected. There is a general problem of non-efficiency of investment. How to do the correct and efficient investment decisions has become a problem to be solved, energy companies. This paper studies the degree of inefficient investment of energy enterprises under environmental uncertainty, and discusses the moderating effect of equity nature on the degree of environmental uncertainty and inefficient investment. The results show that the greater the degree of environmental uncertainty, the more serious the degree of inefficient investment of energy enterprises; the degree of non-state-owned energy enterprises is more serious than that of state-owned energy enterprises; state-owned energy enterprises can adjust the impact of environmental uncertainty on inefficient investment, that is, compared with non-state-owned enterprises, environmental uncertainty has less impact on inefficient investment of state-owned enterprise.

1. Introduction
Energy enterprises are the key organizations to transform and utilize all kinds of energy, which is related to the development of national economy. The healthy development of energy enterprises plays a very important role in how to use energy more efficiently and sustainably. The improvement of energy supply capacity, the optimization of energy structure and the saving of energy resources are all based on the existence of energy enterprises. In recent years, China's energy enterprises have made great progress in the implementation of national policies, energy conservation and emission reduction and improvement of energy efficiency. However, there are still some problems that can not be ignored in the management of energy enterprises. Investment, as one of the three major financial decisions of enterprise financing, investment and profit distribution, plays an important role in business performance and development level at any stage of the development of energy enterprises. Therefore, investment is also an important function of energy enterprises to manage enterprises. Whether from the external environment of resource situation and energy security, or from the internal management environment of energy enterprises, environmental uncertainty is also an unavoidable situation for energy enterprises.

This paper will also explore the inefficient investment of energy enterprises under the environment uncertainty, and in order to study and analyze this problem more clearly, it will also classify the
energy enterprises according to the nature of equity, so as to promote energy enterprises to attach importance to investment and management ability, so as to better achieve the sustainable development of enterprises and resource utilization.

2. Theoretical analysis and research hypothesis

2.1. Environmental uncertainty and inefficient investment

From the environmental point of view, enterprises should consider the internal and external factors when making decisions. For energy enterprises, the external environment refers to the external factors that have an impact on the development and management environment of enterprises, such as the environmental norms and regulations promulgated by the state, the limited energy resources faced, and the changes of social and economic conditions. The internal environment refers to the enterprise itself and the endogenous influencing factors. From the perspective of uncertainty, environmental change is uncontrollable. From the perspective of subjective cognition, the cognitive ability and perspective of the management of energy enterprises are different, and the ability of environmental analysis and prediction is also limited.

The investment behavior and efficiency of the company will be affected by the internal and external environment. Bloom and Reenen research finds that the company managers may take a cautious attitude to reduce investment behavior when facing the risks brought by environmental uncertainty. Under this uncertainty, the management's prediction of investment effect and the development trend of enterprises is very difficult, so it is also very difficult to supervise investment behavior. This is the reason for some managers to use funds for private profit, which leads to inefficient investment providing opportunities.

Due to the existence of principal-agent relationship and information asymmetry, the conflict of interests between enterprises and stakeholders may lead to the emergence of inefficiency. Managers may blindly invest in order to maximize their own interests, resulting in inefficiency. The conflict of interests between creditors and shareholders leads to principal-agent conflict between them. In the case of large debt ratio of enterprises, shareholders tend to invest in projects with high risks borne by creditors, which is prone to over investment, while creditors tend to reduce investment with NPV > 0 in order to avoid risks project, which is easy to lead to underinvestment. Based on the above analysis, hypothesis H1 is proposed.

H1: Environmental uncertainty will aggravate inefficient investment, that is, environmental uncertainty and inefficient investment have a significant positive correlation.

2.2. Environmental uncertainty, equity nature and inefficient investment

ShenHuiHui, Yu Pengsheng to distinguish the nature of the enterprise to explore their under environmental uncertainty embodied in underinvestment or overinvestment, considering they are based on the cost of financing constraints, how to affect the investment efficiency and corporate value, the results showed that the environmental uncertainty, the greater the degree of corporate investment efficiency. Lin, Tan, Sheshinskihe and Lopez also point out that state-owned enterprises have soft budgets because of their social responsibilities.

For energy enterprises, the energy industry has a certain specificity, which is related to the energy security of the country and the pulse of the national economy. In addition to the profitability requirements of enterprises, it also needs to have a certain political, public welfare, engineering and risk. State-owned energy enterprises are more capable of shouldering responsibilities and risks in the face of these challenges, both in terms of enterprise size and policy orientation. However, it is difficult for non-state-owned energy enterprises to compete with state-owned energy enterprises in terms of capital, scale and financing. Therefore, it is more convenient for state-owned energy enterprises to obtain external financing, and their tolerance to environmental uncertainty is better than that of non-state-owned energy enterprises. In other words, state-owned enterprises' investment behavior will be
less affected by environmental uncertainty in the face of changes of internal and external environment. To sum up, hypothesis H3 is proposed.

H2: Compared with non-state-owned enterprises, environmental uncertainty has less impact on the inefficient investment of state-owned enterprises.

3. Research design

3.1. Sample selection and data sources
This paper choose the 2015-2019 from CSMAR database of all a-share listed energy companies as the sample of this empirical research, including involving wind, solar, nuclear, geothermal energy, coal, oil, natural gas, thermal power, water and electricity of traditional energy and new energy company, using Excel to conduct A preliminary sorting data filtering and eliminate processing and calculation, using Stata 15 to data for further processing and analysis. In the preliminary processing of the data, ST and ST* listed companies with abnormal operating and financial conditions are deleted; did not choose the financial insurance industry with special financial data;1% winsorize shrinkage treatment for all continuous variables; remove the missing value after regression. After the above processing, the final sample data contains 213 enterprises and 858 final observed values.

3.2. Definition of variables

3.2.1 Dependent variables.
This paper mainly uses Richardson (2006) model for regression, estimates the residual value of the model, takes the absolute value, to measure the degree of inefficient investment (INIV), the larger the value, the more serious the inefficient investment. If the residual error is above zero, it indicates that there is excessive investment; if the residual error is less than zero, it indicates that there is insufficient investment. Richardson (2006) inefficient investment model:

\[ \text{INVI}_t = \alpha_0 + \alpha_1 \text{Growth}_{t-1} + \alpha_2 \text{Lev}_{t-1} + \alpha_3 \text{Cash}_{t-1} + \alpha_4 \text{Age}_{t-1} + \alpha_5 \text{Size}_{t-1} + \alpha_6 \text{Ret}_{t-1} \\
+ \alpha_7 \text{INV}_{t-1} + \sum \text{Year} + \sum \text{Ind} + \varepsilon_{t,t} \]

Among them, the variable Inv\(_{t,t}\) represents the investment level of the enterprise in the T year, and the explanatory variables in this model are lag data.

3.2.2 Explanatory variables.
Environmental uncertainty is a measure of a enterprise facing the internal and external environment turbulence degree of indexes, this paper mainly adopts ShenHuiHui calculation (2012), by collecting the data of business, calculate the standard deviation of operating income over the past five years, through the data of every industry standard deviation adjustment of intermediate value, obtain the objective data to measure this indicator:

\[ \text{SALE}_{t,t} = \alpha_0 + \alpha_1 \text{YEAR} + \varepsilon \]

In the above model, sale is the operating income and year is the annual variable. The residual is calculated by using the model. The standard deviation of the residual is divided by the average normal operating income of the previous five years, that is, the environmental uncertainty before industry adjustment. On the basis of this value, divide by the median environmental uncertainty of the same industry in each year to get the value of environmental uncertainty in the industry. Excluding the environmental uncertainty in the industry, we can measure the environmental uncertainty more accurately.
3.2.3 Regulating variables.
Measured by the nature of equity ownership (Soe). According to the nature of actual controlling shareholders, Soe=1 for state-owned enterprises and Soe=0 for non-state-owned holding enterprises.

3.2.4 Control variables.
The factors that affect the investment efficiency are complex and diverse. The main control variables in this paper are selected based on the domestic and foreign literature, combined with the business process and situation, and based on the Richardson inefficient investment model and environmental uncertainty model used: growth opportunity, asset liability ratio, company size, cash holding level, stock return, investment level, etc. The listed time, controlled industry dummy variable and year dummy variable of the company. In this paper, by controlling the above variables, we can control these factors to better study the relationship between explained variables and explanatory variables.

The variables in this article are defined in the following table

| Variable types | The variable name | Variable meaning | Measurement method |
|----------------|------------------|-----------------|------------------|
| Explained variable | ININ | Degree of inefficient investment | The absolute value of the residual using the Richardson model |
| Explanatory variables | EU | Degree of environmental uncertainty | Median standard deviation of revenue after industry adjustment |
| Moderator variables | Soe | Nature of equity | Soe = 1 state Soe = 0 non-state |
| Control variables | Growth | Growth opportunities Asset-liability ratio | Revenue growth rate Total liabilities/Assets |
| | Lev | | Net cash flow from operating activities/Total assets at the beginning |
| | Cash | Cash holdings | The company from the number of years on the market, and take the natural pair |
| | Age | Fixed number of year of the listed company | |
| | Size | The company size | The natural log of total assets |
| | Ret | Return on equity | Annual return on equity |
| | Inv | Investment level | Changes in fixed assets, projects under construction, intangible assets, and long-term equity investments/Total assets |
| Industry | Industry dummy variable | | |
| Year | Annual dummy variable | | |
3.3. Model Construction

3.3.1 Regression model of environmental uncertainty and Inefficient Investment.
To test hypothesis 1, environmental uncertainty variables were added to the Richardson model, and $\beta_1$ coefficient was expected to be significantly positive.

\[
ININ_{it} = \beta_0 + \beta_1 EU_{it} + \beta_2 Growth_{it} + \beta_3 Lev_{it} + \beta_4 Cash_{it} + \beta_5 Age_{it} + \beta_6 Size_{it} + \beta_7 Ret_{it} + \beta_8 Inv_{it} + \sum Year + \sum Ind + \varepsilon_{i,t}
\]  

(3)

In model (3), $ININ_{it}$ denotes the degree of inefficient investment of the explained variable, $EU_{it}$ is the main explanatory variable of environmental uncertainty, which is used to test the relationship between environmental uncertainty and inefficient investment.

3.3.2 Regression model of environmental uncertainty, equity nature and inefficient investment.
In order to verify hypothesis 2, the intersection terms of environmental uncertainty and equity nature are added to the model, and expected $\beta_1$. The coefficient of 1 is significantly positive, and the coefficient of cross multiplication is $\beta_7$. The negative was significant.

\[
ININ_{it} = \beta_0 + \beta_1 EU_{it} + \beta_2 Soe_{it} + \beta_3 EU_{it} \times Soe + \beta_4 Growth_{it} + \beta_5 Lev_{it} + \beta_6 Cash_{it} + \beta_7 Age_{it} + \beta_8 Size_{it} + \beta_9 Ret_{it} + \beta_{10} Inv_{it} + \sum Year + \sum Ind + \varepsilon_{i,t}
\]  

(4)

In model (4), $ININ_{it}$ is the degree of inefficient investment of the explained variable. $EU_{it}$ denotes the degree of environmental uncertainty. $Soe_{it}$ denotes the nature of equity, and $EU_{it} \times Soe$ denotes the multiplicative term of environmental uncertainty and equity nature. The model is used to test that compared with non-state-owned energy enterprises, state-owned energy enterprises weaken the impact of environmental uncertainty on inefficient investment.

4. Empirical analysis

4.1. Descriptive Statistics
Through the analysis of Table 2, effective data of 213 enterprises and 858 effective observations were obtained. From the descriptive statistics of the whole sample, it can be seen that the average degree of non-efficient investment is about 1.9% and the standard deviation of 0.02 is relatively small, indicating that non-efficient investment generally exists and has little fluctuation. The extreme range of $EU$, the degree of environmental uncertainty, is very large, indicating that the degree of environmental uncertainty perceived by each enterprise varies greatly. The Growth, Size and Age of each enterprise also show very big differences. The higher Lev average indicates that many enterprises regard debt financing as a very important financing approach.

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|----------|-----|------|-----------|-----|-----|
| INIV     | 858 | 0.018931 | 0.0219413 | 7.44e-06 | 0.2137366 |
| EU       | 858 | 1.475048 | 1.658743 | 0.0096818 | 23.52983 |
| Growth   | 858 | 0.4676044 | 6.305328 | -1 | 363.0683 |
| Lev      | 858 | 0.488369 | 2.116227 | -1.94698 | 3.261896 |
| Cash     | 858 | 0.0448196 | 0.0855761 | -1.377174 | 0.8776646 |
| Age      | 858 | 2.972408 | 3.774221 | 1.098612 | 3.35021 |
| Size     | 858 | 22.53095 | 1.378078 | 14.94164 | 28.50873 |
| Inv      | 858 | 0.0357717 | 0.144916 | -11.52454 | 0.4991988 |
| Ret      | 858 | 1.034421 | 0.0219413 | 7.44e-06 | 0.2137366 |
Correlation analysis

Lev can represent the debt scale of a company, which has a negative correlation with inefficient investment. A higher asset liability ratio and the supervision of creditors can, to a certain extent, prevent enterprises from over investment and reduce inefficient investment. Size can also affect the investment behavior of enterprises. When the scale is large, complex internal structure and cross interest relations, it is easy to guide. When the scale is small, less development opportunities will also make enterprises Miss investment opportunities. Companies with short listing years may have more investment demand, which makes them prone to over investment. However, companies with long listing years have less inefficient investment behaviors compared with those with short years, no matter in terms of experience accumulation or long-term investment habits. Cash, RET and inv are significantly positively correlated at the level of 1%. When there is more cash holdings, it is easy to go out. The higher stock ratio represents the better development prospect of the company and can attract more investment for the enterprise.

Table 3. Correlation analysis.

|       | ININ   | EU     | Growth | Lev | Cash | Age | Size | Inv | Ret  |
|-------|--------|--------|--------|-----|------|-----|------|-----|------|
| ININ  | 1.0000 |        |        |     |      |     |      |     |      |
| EU    | 0.0724 | 0.159  | 1.0000 |     |      |     |      |     |      |
| Growth| -0.0054| -0.126 |        | -0.165 | 0.030 |     |      |     |      |
| Lev   | -0.077 | -0.030 | 0.0235 | 1.0000 | 0.0105 | -0.165 | 0.003 |     |      |
| Cash  | 0.0617 | -0.126 | -0.0105| 0.0455 | 0.105 | 0.003 | 1.0000 |     |      |
| Age   | -0.079 | 0.0104 | 0.0169 | 0.105 | 0.003 | 1.0000 |       |     |      |
| Size  | -0.148 | -0.191 | 0.0170 | 0.059 | 0.241* | 0.023 | 0.257 | 0.0263 |     |
| Inv   | 0.0695 | -0.049 | 0.003  | -0.023 | 0.051 | 0.0455 |       |     |      |
| Ret_1 | 0.0712 | 0.099 | 0.0489 | -   | -   | -   | 0.0130 | 0.059 |      |

Regression analysis

From the regression results of model 1, inin is the explained variable, the main explanatory variable is EU, and its p value is 0.001, The coefficient of EU is positive, indicating that inefficient investment is significantly positively correlated with environmental uncertainty, and it is significantly correlated at the 1% level. That is to say, the more serious the environmental uncertainty, the higher the degree of inefficient investment of enterprises. This result is consistent with the theoretical analysis of previous scholars, and also consistent with the expected hypothesis. Therefore, hypothesis 1 is verified.
In the second model, the environmental uncertainty and the nature of equity are added to the regression analysis. The regression coefficient of EU is significantly positive at the level of 1%, while that of EU and SOE is significantly negative at the level of 5%. The regression coefficient of the cross multiplier is opposite to the regression coefficient before the environmental uncertainty, which indicates that the state-owned energy enterprises weaken the impact of environmental uncertainty on the inefficient investment, which also shows that compared with the non-state-owned energy enterprises, the impact of environmental uncertainty on the inefficient investment of state-owned energy enterprises has been verified.

From the regression result table, we can see that for the control variables, the growth, age and size coefficients are negative, and they are in reverse with inefficient investment, indicating that the higher these indicators are, the lower the investment efficiency of enterprises. The coefficients of other control variables are positive, for example, when there are more cash, it is easy to over invest, and when there is less holding, it is easy to underinvestment; a higher RET represents a better development prospect of the company and can attract more investment for the enterprise. It is necessary to give full play to the role of these aspects, and use the positive driving role to alleviate the problem of inefficiency.

Table 4. Regression results.

| VARIABLES | Model 1 | Model 2 |
|-----------|---------|---------|
| **EU**    | 0.001***| 0.001***|
|           | (3.99)  | (4.49)  |
| **Soe**   | -0.001  |         |
|           | (-0.87) |         |
| **EUSOE** | -0.001**|         |
|           | (-2.45) |         |
| **Growth**| -0.000  | -0.000  |
|           | (-0.98) | (-1.27) |
| **Lev**   | 0.001   | 0.002   |
|           | (0.90)  | (1.23)  |
| **Cash**  | 0.006** | 0.006** |
|           | (2.02)  | (2.00)  |
| **Age**   | -0.002  | -0.001  |
|           | (-1.55) | (-1.27) |
| **Size**  | -0.002***| -0.002***|
|           | (-8.50) | (-7.92) |
| **Inv**   | 0.009***| 0.008***|
|           | (4.78)  | (4.61)  |
| **Ret**   | 0.003***| 0.002***|
|           | (4.61)  | (4.30)  |
| **Industry year** | Have control | Have control |
| **Observations** | 858 | 858 |
| **R-squared** | 0.068 | 0.070 |

*** p<0.01, ** p<0.05, * p<0.1

4.4. Robustness test
This paper mainly uses the method of group regression to carry out the robustness test. The adjustment effect is converted and the group regression is used to carry out the robust test. That is to say, the state-owned energy enterprises and non-state-owned energy enterprises are divided into two groups for regression respectively. The regression results show that the non-efficiency of investment is common
in the two types of enterprises, and they are faced with varying degrees of environmental uncertainty. Other control variables are also consistent with the previous paper.

Table 5. Grouped regression results.

| VARIABLES | State-owned energy enterprise | Non-state-owned energy enterprises |
|-----------|-------------------------------|-----------------------------------|
| EU        | 0.000 (0.50)                 | 0.001*** (4.24)                  |
| Growth    | -0.000 (-0.36)               | -0.000 (-0.94)                  |
| Lev       | 0.003 (1.57)                 | 0.000 (0.18)                    |
| Cash      | 0.009* (1.91)                | 0.001 (1.41)                    |
| Age       | -0.001 (-0.76)               | -0.000 (-0.14)                  |
| Size      | -0.002*** (-6.72)            | -0.002*** (-5.71)               |
| Inv       | 0.004** (2.39)               | 0.073*** (9.39)                 |
| Ret       | 0.002*** (3.06)              | 0.003*** (3.15)                 |
| Industry  | Have control                 | Have control                    |
| year      |                               |                                  |

*** p<0.01, ** p<0.05, * p<0.1

According to the results of group regression, it is found that in the group regression of state-owned energy enterprises, the positive and negative sign direction of their significance is consistent with the explained variables. From the main explanatory variables, the relationship between EU and ININ is not significant, which shows that the impact of environmental uncertainty on inefficient investment is not significant; in the regression group of non-state-owned enterprises, EU has a significant positive correlation with inefficient investment at the level of 1%. This proves that the impact of environmental uncertainty on inefficient investment behavior of state-owned energy enterprises is far less than that of non-state-owned energy enterprises. This result is consistent with the previous test.

5. Conclusion

(1) There is a significant positive correlation between environmental uncertainty and inefficient investment. That is to say, the more serious the changes caused by environmental uncertainty, the more likely energy enterprises will have inefficient investment behavior, which will bring adverse impact on the investment behavior of energy enterprises and even the long-term interests of the whole company. This relationship is likely to be that when the environmental uncertainty increases, it is more difficult for enterprises to obtain information, and the problem of information asymmetry is more serious, resulting in greater decision-making costs and financing costs for enterprises. It is easy to lead to under investment and over investment due to incorrect decision-making. This requires managers and managers of energy enterprises to pay more attention to making investment decisions more rationally in complex environment. The improvement of investment efficiency of energy enterprises is not only the improvement of enterprise management level, but also related to the more reasonable development and utilization of energy resources and sustainable development.

(2) Compared with non-state-owned energy enterprises, environmental uncertainty has less impact on the inefficient investment of state-owned energy enterprises. The state-owned energy enterprises have not only the subsidy guarantee of the relevant system at the national level, but also the preferential policies on the fund acquisition of financial institutions. Therefore, in the face of changes in the external environment, the financing cost of state-owned enterprises will be less than that of non-
state-owned enterprises. However, most of the state-owned energy enterprises, whether in terms of enterprise scale or institutional security, as well as the particularity of the energy industry, have more responsibilities to maintain the security and stability of energy resources, pay attention to environmental sustainability, and stabilize the national economy, so that in the face of uncertain environment, state-owned energy enterprises, compared with non-state-owned energy enterprises, can make the uncertainty fluctuation of the environment have a small impact on the inefficient investment behaviour.

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