

# Research on the Factors Affecting the Performance of Mineral Enterprises

—Based on Qualitative Comparison Analysis Method

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**Abstract:**-Based on the qualitative comparative analysis (qca) method, this paper studies the conditional configuration of Chinese energy companies to achieve high performance and avoid low performance from the aspects of independent R&D investment, human capital, enterprise scale and regional institutional environment. The findings can provide reference for Chinese energy companies and have practical significance.

**Keywords:** *QCA, China energy enterprise performance, regional institutional environment*

## 1. INTRODUCTION

The influencing factors of company performance are usually given to two categories, one is external factors and the other is internal factors. For internal factors, R&D is the driving force for technological progress and the foundation of technological innovation. Independent research and development refer to the process in which enterprises mainly use their own R&D resources and strength to carry out innovative production. It is an important way for technological progress and innovation. The R&D investment of enterprises has a significant positive impact on productivity improvement [1][2][3]. The R&D investment is conducive to the improvement of corporate performance and corporate value [4]. Human capital reflects the proportion of a company's R&D personnel. Generally speaking, the higher the proportion of R&D personnel, the stronger the independent R&D capability of the company, and the easier it is to achieve high performance [5]. Enterprise scale is an important factor affecting innovation [6][7]. The larger the scale, the more innovation resources accumulated by enterprises, the stronger the risk response capability, and the more favorable it is to develop new products. It is also easier to achieve high performance. The existing literature is mainly based on Chinese industrial enterprises [8]. In China's energy enterprises, these issues about the level of human capital and enterprise scale and whether the increase of independent R&D investment could improve the performance of enterprises need to explore further.

For external factors of the enterprise, the existing research mainly focuses on the research of multinational companies. They only study the national institutional environment's impact on corporate performance from different perspectives.

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[10][11][12] But they ignored the importance of the regional institutional environment. Although the companies of the Western economy, universities and research institutions are located in a stable national institutional environment, the institutional environment of each region is almost homogeneous. The national market economy is not mature enough for emerging economies such as China[13], the property rights system is still not perfect, the legal system needs to be improved, and the efficiency of the implementation of the various regions is different, the system differences between the provinces are obvious, which has led to the existence of the operation modes of the provinces. Big difference[14][15]. Therefore, it is necessary to study the impact of China's regional institutional environment on the performance of energy companies. The institutional environment includes factors closely related to business operations such as law, government, and market[16]. The intellectual property protection system is the basic institutional to ensure the stability of energy enterprise performance. The increase in the protection level of intellectual property rights can effectively combat infringements, help attract foreign investment, promote the legal dissemination of technology, enhance the competitive advantage of enterprises, promote innovative research and development of enterprises, protect and promote the research and development of enterprises, and ensure the performance of enterprises.[18][19][20][21]. The existing literature mainly examines the impact of a country's intellectual property protection level on corporate innovation activities [20][22]. However, the roles of regional intellectual property protection differences and other institutional factors at the regional level in corporate R&D innovation activities have not been thoroughly studied. Therefore, this paper regards regional intellectual property protection as the first aspect of the regional institutional environment and studies its impact on the performance of energy companies. Openness refers to a country or regional economy's degree of opening up to the outside world, which is manifested in the degree of openness of the market. Foreign investors in more open regions may be highly integrated into the international trading system and adopt internationally competitive technologies, the invested companies can take the lead in contacting the world's leading technologies and developing their own technological capabilities to gain competitive advantage and improve

corporate performance [28]. However, due to the differences between the open policy, coupled with the geographical location and environmental differences of the provinces, the openness of the provinces in China vary greatly. Therefore, this paper takes the regional openness as the second aspect of the regional institutional environment and studies its impact on corporate performance. Regional marketization refers to which a region has market-oriented institutions [13]. The reform of China's transition from a planned economy to a market economy has been going on for more than 30 years. Although great progress has been made, there are still some problems, especially the marketization process is very uneven in regional development. Areas with relatively mature market mechanisms can promote technology transfer by foreign companies and enhance competitive advantage [32], and promote greater value for companies. Therefore, this paper regards the regional marketization degree as the third aspect of the regional institutional environment and studies its impact on the performance of energy companies.

## II. RESEARCH HYPOTHESIS AND ANALYSIS FRAMEWORK

### *A. Independent R&D, Human Capital, Firm Size and Energy Enterprise Performance*

The scale of enterprises has a great impact on independent R&D investment, and it is an important factor affecting innovation [6][7]. Generally speaking, the larger the enterprise, the more innovative resources it has accumulated, the stronger the risk response capability, the more favorable it is to develop new products, the more capital to invest in new products and enhance its independent research and development capabilities. Human capital refers to the proportion of R&D personnel in the total number of companies. Under normal circumstances, enterprises with high R&D investment will increase their human capital accordingly to improve their independent R&D capabilities [5]. Independent R&D greatly affects the company's innovation performance and competitive advantage [8]. The R&D investment of an enterprise has both a direct impact and an indirect impact on corporate performance. Lu Guoqing found that increasing the investment in innovation is still the basic path to improve the performance of small and medium-sized listed companies, and the internal driving force for the continued growth of the company [2]. Zhou Haisheng & Lu Dan found that the R&D investment of non-state-owned listed companies has a significant effect on the business performance of the next year, which used the data of listed companies that disclosed R&D investment in 2003-2007 [4]. Indirect impacts are manifested in increasing the productivity and performance. This impact will vary from region to region. Hu found that R&D has a significant positive impact on firm productivity when examining the relationship between R&D spending and productivity of Chinese companies [1]. The impact of independent R&D and the introduction of foreign technology on productivity has shown obvious regional differences. Independent R&D has only a significant positive effect on productivity in the eastern and central regions, while foreign technology introduction has only a significant positive effect on productivity in the western region. Increase R&D investment by upgrading existing capital or generating new capital to form new

knowledge, new technologies and new experiences [33]. On the one hand, in the process of continuous R&D, the entire enterprise's knowledge reserve and technical capabilities continue to mature and become a part of the intangible assets of enterprises, which enhances the competitiveness of enterprises. On the other hand, increasing independent R&D investment will help enterprises to introduce advanced production equipment, hire more high-quality R & D personnel, improve the skill level of workers' process design, and enhance the innovation ability of the whole enterprise, thereby improving its performance. Although the above scholars did not conduct research on Chinese energy listed companies, with the significant impact of R&D investment on the performance of various enterprises, we propose the following assumptions:

H1: Enterprise scale, independent research and development and human capital all have a positive impact on energy enterprise performance, which means increasing independent R&D investment, improving human capital, and expanding enterprise scale will improve the performance of energy companies.

B. Regional institutional differences and energy enterprise performance

a. Regional Intellectual Property Protection Level and Energy Enterprise Performance

Although many high-tech technologies can now be bought with money, the price of some core technologies is quite high, which requires our enterprises to exert their own independent research and development initiative to reduce their own weakness. Intellectual property is the link and bridge connecting innovation and market [8]. On the one hand, strong intellectual property protection encourages local companies to innovate and strengthen the innovation capabilities of local companies in developing countries, thereby improving the performance of the entire enterprise [34]. When Fang studying how the level of intellectual property protection in the region affects China's innovation in the process of privatization of state-owned enterprises, he concluded that regional intellectual property protection strengthens the innovation power of enterprises and that private companies are more sensitive to intellectual property protection than state-owned enterprises [21]. Wu Chaopeng, when studying how to develop high-tech industries in countries with weak intellectual property protection, concluded that intellectual property protection would enhance the impact of corporate patent output on future financial performance [18]. On the other hand, a good local intellectual property protection system can also attract foreign investors to invest in China, and increase the available funds of the company, which is used for technology research and development and to expand its business scope. It is likely to significantly improve corporate performance. The impact of intellectual property rights on corporate performance is mainly through the following ways: First, it can crack down on infringements and protect the stability of energy companies' performance. Multinational companies tend to enter areas with strong intellectual property rights to reduce the possibility of imitation and protect their technological advantages [19]. Local intellectual property rights, by restricting the behavior of non-rights persons, attacking and punishing infringement activities such as imitation and

counterfeiting, enhance the predictability of corporate income, protect the achievements of energy enterprises, ensure the legitimate rights and interests of energy enterprises, and ensure the stable performance of enterprises. Second, it is conducive to the dissemination of knowledge and technology, steadily enhancing the performance of energy companies [19]. Stronger intellectual property protection may encourage foreign companies to transfer some non-core technologies to the host country, which increases the likelihood of spillover effects on local companies, thereby increasing the performance of local companies. Conversely, a weak intellectual property system may hinder the transfer of technology by foreign companies and limit the opportunities for local companies to learn technology. Based on this, the study proposes the following assumptions:

H2: The impact of regional intellectual property protection on the performance of energy companies is positive. That is, the higher the level of regional intellectual property protection, the higher the performance of energy companies.

b. Regional openness level and energy enterprise performance

The regional openness refers to the degree of trade openness in a region, that is, the proportion of import and export trade to the GDP of each province [31]. Although international open policies are developed by the state, specific implementation often developed by the local government [35]. Chinese open situation is "unbalanced in space and structure". Some regions are open earlier than others to allow foreign investment, making the degree of openness in various regions of the country significantly different. Differences in regional openness can affect foreign investment, which in turn affects the productivity of local businesses. The high international openness of the region will make local businesses more efficient and increase the level of competition among local businesses [26]. Gambardella found that regional openness has a direct and indirect positive impact on firm performance when studying regional openness and firm performance [36]. The impact of the level of openness on the performance of energy companies is mainly through financing, alliance cooperation and other means. The higher the level of regional openness, the more foreign-invested enterprises will enter. However, there will be social trust in every region, that is, local people are likely to reject, or it is difficult to accept foreign companies, which will inevitably lead to foreign-invested enterprises to cooperate with local companies to reduce performance losses due to social trust. Energy companies have attracted foreign investment and are supported by advanced technology and equipment from foreign companies. On the one hand, local companies can not only access and understand more new products, new knowledge and new technologies, but also enhance their opportunities to acquire complementary technologies and resources, thereby optimizing their resource structure, improving the level of technology, and increasing their own competitiveness. Which are all beneficial to improve performance. Local companies may be able to collect information provided by export-oriented investors about foreign markets and competitors in order to better respond to improve performance [29]. On the other hand, foreign investment helps companies to develop their management capabilities and expand other businesses to increase corporate

profits. Conversely, if the level of regional openness is low and foreign companies entering cost is higher, it is difficult to attract their investment. The technology of local enterprises cannot be improved, the scope of business is difficult to expand, and the corresponding corporate performance is difficult. Therefore, this paper proposes the following assumptions:

H3: The impact of regional openness on the performance of energy companies is positive, that is, the higher the level of regional openness, the higher the performance of energy companies.

*C. Regional Marketization and Energy Enterprise Performance*

The level of marketization is an indicator reflecting transition from planned economy to market economy. It fundamentally reflects the ability of the market as a means of regulating resource allocation. The level of regional marketization refers to the extent a region has market-oriented institutions [13]. The impact of marketization on the performance of local energy companies is mainly reflected in the following aspects: First, reduce government intervention and promote fair competition. In general, a higher level of marketization means that the market dominates the allocation of resources, sound institutional guarantees, and lower government intervention. The degree of marketization in high regions can intensify the degree of competition in the market, create a fair competitive business environment, give play to the competitive advantages of enterprises, stimulate the entrepreneurial spirit of managers, and make the company pay more attention to resource allocation and efficiency, and help energy companies improve their performance. Second, promote the transformation of results. Mature markets promote technology transfer by foreign companies, and weakly developed markets often do not provide local companies with the means to transfer technology [37]. The higher the degree of marketization, the more perfect the development of the property rights trading market and technology transfer mechanism, the more favorable it is for enterprises to exchange their own achievements with the outside world and increase the sales revenue of enterprises. What's more, enhance the internal resources of the company. The degree of marketization in high regions promotes labor mobility, and the level of education in the region is generally higher, which helps companies recruit more high-quality talents, enriches the internal resources of the entire enterprise, and is more conducive to the promotion of energy corporate performance [38]. Therefore, this study proposes the following assumptions:

H4: The impact of regional marketization on the performance of energy companies is positive. That is to say, the higher the degree of regional marketization, the higher the performance of energy companies.

### III. DATA AND ANALYSIS METHODS

#### *A. Analysis method*

The influencing factors of energy enterprise performance are multi-faceted, not determined by the net effect of a single (or multiple) variables. Specific combinations can produce specific results, so they cannot be analyzed in isolation, and they must be studied in combination. Traditional statistical techniques are based on the independence of explanatory

variables, the linear relationship between conditions and results, and the causal symmetry to analyze the marginal "net effect" of independent variables and dependent variables, and cannot explain complex causal relationships. There are many explanatory variables in this study. It is impossible to draw accurate relationships by linear combination, adjusting influence and mediation. Comprehensive consideration of the complex relationship between variables will make the whole model messy, so in order to solve the complicated relationship between variables and meet the requirements for a comprehensive combination of variables, we decided to adopt qualitative comparative analysis (QCA) method in the management field, and analyze the high performance configuration and low performance configuration from the perspective of causal asymmetry. One of the limitations of QCA is that the explanatory variable can only be one. Since the subject of this research is energy enterprise performance, and it has a single metric and exactly avoid the limitations of QCA. Second, QCA cannot handle time series problems, the cross-section data used in this study does not need to consider the problem of time series. In summary, QCA is a method that is more suitable for this study. QCA could help us understand what combination of conditions is driving energy companies to achieve high performance. Compared with the clear set qualitative comparison analysis (csQCA) and the multi-valued set qualitative comparison analysis (mvQCA), the fuzzy set qualitative comparison analysis (fsQCA) is less prone to get contradictory configuration, and more effective conclusions can be drawn. fsQCA recodes the value of each variable to a number between 0 and 1, and the change in the degree or level of the variable implies both qualitative (case) and quantitative (variable) approach. ('1' indicates complete membership, '0' indicates complete non-affiliation, and '0.5' indicates maximum ambiguity). All conditions in the configuration are related to the Boolean operators 'and' (represented by the '\*' symbol), 'Non' (represented by '~') and 'or' (represented by the '+' symbol). The three operations is used to combine all configurations that result in the corresponding result. The core of QCA is the Boolean minimization process, which reduces complexity by simplifying the initial solution to a more concise expression containing logical remainders.

**B. Measurement**

Referring to Wang Xiao Feng, the ratio of operating profit to average total assets (the average of the current period and the total assets of the previous period) is used as a measure of the performance of new energy companies. Since independent research and development usually refers to the corporate own research and development, it does not rely on the technology and personnel of other institutions to complete the R&D project, which is independently developed. Therefore, the paper mainly uses the ratio of internal R&D expenditure to the number of employees to reflect independent R&D to determine the impact on corporate innovation performance [15]. The improvement of the level of intellectual property protection depends not only on the improvement of the intellectual property legislation system, but also on the enforcement of intellectual property rights [17]. This study follows the practice of Yi to measure the level of intellectual property protection in the region by the proportion of provincial infringement disputes in the number of

infringement disputes [31]. In the literature measuring the level of national openness, Frankel & Romer measurement standards can be used as a key reference [30]. They use the ratio of import and export trade to GDP to measure the degree of openness of a country. Later generations [8][31] also used this method when studying the openness of the regional level, and achieved good results. Therefore, this study also uses the ratio of provincial import and export trade volume to GDP to measure the level of openness at the regional level. To control the unobserved heterogeneity at the enterprise level, we have added two companies' own variables, including firm size and human capital. The size of the company is measured by the natural logarithm of the company's total assets. Human capital is measured by the proportion of full-time R&D in the company as a percentage of the total number of employees. Table 1 below summarizes the calculation methods for each variable.

Table 1. Definition of main variables

Variable type	Variable name	Calculation method
Explained variable	Energy enterprise performance	Operating profit / average total assets
	Independent research and development	Internal R&D expenditures / number of employees
	Regional intellectual property protection level	Number of infringement disputes / number of infringement disputes
Explanatory variables	Regional openness	Import and export trade volume of each province / province GDP
	Regional marketization degree	Fan Gang and other reports on the relative progress of marketization in various regions of China (2011)
	Business scale	Logarithm of total assets of the enterprise
	human capital	Full-time R & D number / number of employees

**IV. MEASUREMENT RESULTS**

*A. experiment procedure*

In this study, the maximum values of the variables such as enterprise performance, independent research and development, regional openness level, regional intellectual property protection degree, regional marketization degree, human capital, and enterprise scale are set as complete membership points, and the minimum value is set to completely non-affiliation points, the maximum fuzzy point of each variable is set to 0.05 (expert evaluation); 2.786 (median) Number); 0.2 (larger spacing); 0.87 (larger spacing); 6 (larger spacing); 0.098 (mean); 9.864 (mean). Then analyze the necessary conditions. We found that the consistency of regional intellectual property protection  $\geq$  enterprise performance is as high as 0.89, indicating that in the case of high enterprise performance, 89% of cases will have high-level intellectual property protection. Therefore, this study

regards regional intellectual property protection as a necessary condition for corporate performance. Next, analysis the truth table. The results are shown in Table 2. The solution coverage was 0.80; the solution consistency was 0.83.

High performance of mineral enterprises = independent research and development \* regional intellectual property protection degree \* regional marketization degree \* (human capital \* ~ enterprise scale + ~ human capital \* enterprise scale) + independent research and development \* regional openness \* regional marketization degree \* (regional knowledge Property protection degree + human capital \* ~ enterprise scale) + regional openness \* regional marketization degree \* (regional intellectual property protection degree \* ~ enterprise scale + ~ independent research and development \* ~ human capital \* enterprise scale) + ~ independent research and development \* ~ region Degree of openness\* Regional intellectual property protection\*~Regional marketization degree\*Human capital\*Enterprise size.Third, enterprises are located in areas where the openness of high areas and the degree of marketization of high areas coexist. Enterprises with low enterprise scales in areas with high intellectual property protection or enterprises with high enterprise scale, low independent research and development and low human capital are also may achieve high performance. Finally, high-enterprise scale, high human capital, and low-independent R&D companies may also achieve high performance in areas with high intellectual property protection, low regional marketization, and low regional openness. This path validates the human capital as described in Hypothesis 1 and the positive impact of firm size on firm performance.

**B. Results of the non-outcome**

The research method of low performance influencing factors is the same as before. The results are shown in Table 3. The solution coverage was 0.72; the solution consistency was 0.92.

Low performance of mineral enterprises = ~ regional openness \* regional intellectual property protection \* ~ regional marketization degree \* (~ enterprise scale + independent research and development) + ~ independent research and development \* ~ regional openness \* (~ regional marketization degree + ~ regional knowledge Property protection degree\* enterprise scale)\*~human capital+~independent research and development\*regional openness\*~regional intellectual property protection degree\*regional marketization degree\*~human capital\*~corporate scale.

**Table II. Intermediate solution of high performance**

Conditional configuration	raw coverage	unique coverage	consistency
Regional openness* regional intellectual property protection *Regional marketization degree*~Enterprise size	0.52	0.06	0.86
Independent research and development * regional openness * regional intellectual property protection * Regional marketization ~Independent R&D*Regional Openness* Regional Marketization* ~Human Capital*Enterprise Size	0.49	0.01	0.90
Independent research and development* Regional openness* Regional marketization* Human capital*~corporate scale	0.38	0	0.91

Independent research and development * regional intellectual property protection degree * regional marketization degree * human capital * ~ enterprise scale	0.42	0.01	0.91
Independent research and development * regional intellectual property protection degree * regional marketization degree * ~ human capital * enterprise scale ~Independent R&D*~Regional	0.48	0.02	0.96
Openness*Regional Intellectual Property Protection*~Regional Marketization Degree*Human Capital*Enterprise Size	0.37	0.06	0.96

The results show that there are a variety of conditional configurations that can result in low performance for mining companies. Enterprises, located in areas with high intellectual property protection, low regional openness and low marketization degree, will likely have low performance even if their R&D investment is not small, and if their size is small, the possibility of low performance will be very high. Secondly, enterprises with low R&D investment and low human capital, and in areas with low openness, if the market level of the region is low, it is likely to lead to low performance. And if the region's intellectual property protection is low, even if the company is still large, it is likely to lead to low performance. Finally, if the company's own independent R&D investment is low, human capital is small, and the scale of the company is small, coupled with the low intellectual property protection, even if the region's openness and marketization are high, It is difficult for companies to achieve high performance.

**Table III. Intermediate solution of the non-outcome**

Conditional configuration	raw coverage	unique coverage	consistency
~ Independent research and development * ~ Regional openness * ~ Regional marketization degree * ~ Human capital	0.58	0.07	0.92
~Regional opening degree*Regional intellectual property protection degree*~Regional marketization degree* ~Enterprise size	0.45	0.01	0.95
Independent research and development*~Regional opening degree*Regional intellectual property protection* ~ Regional marketization	0.40	0.03	0.95
~ Independent research and development * ~ regional openness * ~ regional intellectual property protection * ~Human Capital*Enterprise Size	0.40	0.01	0.98
~ Independent research and development * Regional openness * ~ Regional intellectual property protection * Regional marketization degree*~human capital*~corporate scale	0.26	0.03	0.98

**V. CONCLUSION**

This paper studies the high performance of Chinese energy companies and has achieved some conclusions. There are some shortcomings. First, the measurement of variables is not authoritative, such as the measurement of energy enterprise performance, the methods of various scholars to measure performance are not uniform, this study only adopts the measurement standards of individual scholars, and the measurement indicators are single. The measurement of the level of intellectual property protection in the region has same question. Second, in addition to the average value of the two

assets used in the total assets of the company, the other data only use a single year, which may affect the universality of the conclusion. It is recommended that scholars who study the topic later collect more data from the enterprise. Third, there are not many explanatory variables to choose from, and subsequent scholars can use enough variables to analyze the high performance and low performance configuration of energy companies.

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