Research on the Relationship between Text Information Disclosure and Transformation Efficiency of Listed Companies from the Perspective of Heterogeneity  
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**Abstract:** After the "dual carbon" goals were proposed, the power industry has been accelerating its low-carbon transformation, and power generation enterprises have successively incorporated low-carbon transformation into their development plans and strategies. To deeply examine the matching degree between the commitment to low-carbon development goals and the actual implementation effect, and reveal the key elements affecting the effectiveness of low-carbon transformation, this study focuses on exploring the correlation mechanism between text information and transformation efficiency. Thirty listed companies in the power industry from 2016 to 2022 were selected as samples. From the perspective of differentiation, the efficiency of their low-carbon transformation and its evolution trend were systematically evaluated. Firstly, text mining technology is employed to establish an index system for measuring the degree of information disclosure in low-carbon transformation. Subsequently, a bidirectional fixed-effect panel data model is adopted to verify the correlation between the level of information disclosure and the transformation efficiency. The research also conducts a heterogeneity analysis from two dimensions: the quality of financial information disclosure and the characteristics of the controlling entity. The empirical results show that the low-carbon information disclosure and transformation efficiency of listed companies in the power industry present a nonlinear relationship of promotion first and then inhibition. This research not only expands the theoretical framework of enterprise information disclosure and transformation and development, but also provides empirical basis for listed companies to optimize the information disclosure mechanism and select transformation paths.

**Key words:** Heterogeneity Listed power generation company Text information disclosure Low-carbon transformation

# 1 Introduction

With the globalization of the economy and the rapid development of information technology, the operating environment of enterprises is becoming increasingly complex and changeable. Against this backdrop, enterprises are seeking transformation one after another in order to maintain their competitive edge and achieve sustainable development. Enterprise transformation is a complex process involving multiple aspects, including but not limited to the adjustment of strategic direction, the optimization of organizational structure, and technological innovation. The effective implementation of these transformation measures largely depends on the transparency of enterprise information disclosure. Transparent information disclosure can enhance the confidence of external investors and stakeholders, and provide necessary support and resources for enterprise transformation. Under the background of "dual carbon", low-carbon transformation is an important development direction and implementation goal for listed power generation companies. In recent years, with the support of national policies and the impetus of market development trends, many listed power generation companies have put forward low-carbon transformation target plans, disclosing relevant information on low-carbon transformation through descriptive texts such as annual reports, demonstrating their determination and goals for low-carbon transformation and development.

The position of text information disclosure in enterprise information disclosure has gradually become prominent. Compared with traditional financial data disclosure, text information disclosure can provide richer and more comprehensive enterprise information, including enterprise strategy, business risks, market prospects, etc. These information have important reference value for external investors and stakeholders. Especially during the process of enterprise transformation, the timeliness and accuracy of text information disclosure directly affect the external assessment of the progress and effectiveness of enterprise transformation. Different enterprises have significant heterogeneity in terms of resource endowment, governance structure, industry characteristics, etc. This heterogeneity may lead to differences in the quality and effect of text information disclosure among enterprises, thereby affecting the efficiency of enterprise transformation. For instance, enterprises with abundant resources may be more capable of providing detailed and comprehensive textual information, thereby guiding external resources to support their transformation more effectively. Enterprises with a sound governance structure may ensure the accuracy and timeliness of text information disclosure through efficient decision-making mechanisms, thereby enhancing the success rate of enterprise transformation.

Enterprise information disclosure is closely related to the development of enterprises. This study adopts quantitative analysis methods to transform the textual descriptions related to the low-carbon transformation of power generation enterprises into measurable indicators, and deeply explores the correlation between the quality of information disclosure and the transformation efficiency. The consistency degree between the commitment content and the actual implementation effect of listed power generation enterprises in the practice of low-carbon transformation was mainly examined, and it was evaluated whether they effectively advanced the process of low-carbon transformation in accordance with the publicly disclosed goals. This research not only expands the theoretical framework of the relationship between enterprise information disclosure and operational efficiency, but also identifies the key factors affecting the efficiency of low-carbon transformation, providing practical guidance for the low-carbon development of the power industry. The research results are conducive to enterprises optimizing the information disclosure mechanism and constructing a more competitive sustainable development model in the dynamic market environment. Meanwhile, this research is also conducive to the regulatory authorities improving the relevant information disclosure system and enhancing the operational efficiency of the capital market.

# 2. Theoretical Analysis and Research Hypotheses

## 2.1 The Relationship between the Disclosure of Low-Carbon Transformation Text Information and Transformation Efficiency

Although information disclosure can promote the improvement of the relevant efficiency of the company to a certain extent, due to the wide scope of text information disclosure, it is easily influenced by the subjective ideas and discretionary power of the management, increasing the difficulty for investors, regulatory authorities and other stakeholders to judge its authenticity and reliability. It may also become a tool for the company to conduct strategic disclosure or even information manipulation. Achieving the goals of carbon peaking and carbon neutrality will strongly promote technological innovation and industrial upgrading in our country. This is not only the core demand for high-quality economic development but also a key task in ecological and environmental protection work. Under the framework of the "dual carbon" strategy, the green transformation of the energy structure has become an important deployment at the national level. As a key area for carbon emissions, the low-carbon development process of the power industry is directly related to the strategic layout of listed power generation enterprises. According to the principle of information asymmetry, senior executives of enterprises hold core information such as the specific implementation of low-carbon transformation, strategic planning and future deployment, and occupy a dominant position in the information disclosure process. This information advantage enables enterprises to have two choices in their disclosure strategies: true presentation or exaggerated promotion. It is worth noting that the low-carbon transformation has typical characteristics such as large investment scale, long implementation period and slow manifestation of results. Under the dual influence of policy support and market attention, based on the impression management theory, regardless of the actual progress of the transformation, listed power generation enterprises may process soft information through text packaging or concept marketing, deliberately catering to the market hotspots of low-carbon transformation. This kind of operation is prone to cause a disconnection between the disclosed content and the actual results, resulting in the phenomenon of "inconsistency between words and deeds". This kind of behavior of spending more time and energy on non-productive activities is a kind of management resource input behavior with non-direct benefits. It will correspondingly generate higher management costs, affect the rational allocation of resources and actual production and operation activities, and further lead to the reduction of the efficiency of low-carbon transformation. Therefore, based on the above analysis, this paper proposes the core hypothesis 1:

H1: The level of text information disclosure for low-carbon transformation has an inverted "U" -shaped relationship with the efficiency of low-carbon transformation.

## 2.2 Heterogeneity in the Relationship between Text Information Disclosure of Low-Carbon Transformation and transformation efficiency

Accounting information can play a compatible role of incentives and constraints in corporate governance. For listed power generation companies, accounting information can reflect the business performance in the process of low-carbon transformation and development. Expressions related to low-carbon transformation can directly reflect the degree to which enterprises attach importance to practicing environmental protection concepts. Among listed companies in the power industry with relatively high quality of financial information disclosure, they often tend to disclose detailed written content related to low-carbon development to ensure that environmental protection commitments are consistent with actual actions. By leveraging the supervisory function in the corporate governance system, a scientific basis can be provided for the formulation of low-carbon development strategies, thereby enhancing the implementation effect of the transformation. For listed companies with relatively low accounting information quality, in order to make up for the deficiency of mandatory disclosure of data-based hard information, it is highly likely that they will beautify and cover up the true transformation performance through text-based soft information, do a good job in impression management, and weaken the possible impact of negative information, thereby resulting in the low-carbon text information they disclose not accurately reflecting the corresponding transformation efficiency. There exists a phenomenon of inconsistency between words and deeds. Based on the above analysis, Hypothesis 2 is proposed:

H2: The impact of low-carbon transformation text information disclosure on the low-carbon transformation efficiency of listed power generation companies with low accounting information quality is more significant.

Under the dual factors of strict regulation and the development opportunities of energy transformation, based on the stakeholder theory, central-controlled listed power generation companies have stricter control over information disclosure and are less likely to manipulate text information. Appropriate information disclosure makes it more in line with the implementation effect and reduces the probability of "exaggeration". However, the regulatory intensity of local holding power generation listed companies is not as strong as that of central holding listed companies. To effectively attract capital investment, enterprises tend to proactively disclose more comprehensive and detailed data on the low-carbon development process. Such information disclosure behavior will increase management and supervision costs, and thereby impose constraints on the transformation process. From this, research Hypothesis 3 is derived:

H3: Among the listed companies in the power industry controlled by local state-owned assets, the public disclosure of text information on low-carbon transformation has a more prominent impact on the transformation efficiency.

# 3 Research Design

## 3.1 Sample Selection and Data Sources

This paper takes the proportion of thermal power installed capacity of listed power generation companies at 30% as the threshold and selects 30 state-owned listed power generation companies above the threshold as the research objects. Among them, 14 are centrally controlled listed power generation companies and 16 are locally controlled listed power generation companies. By the end of 2022, the total installed power capacity of the various sample power generation listed companies selected by the research institute ranged from 1.28 million kilowatts to 127.228 million kilowatts, among which the total installed capacity of thermal power accounted for approximately 46.45% of the national thermal power installed capacity. Furthermore, the "13th Five-Year Plan" and the "14th Five-Year Plan" are crucial periods for the low-carbon transformation of the power industry. To implement relevant measures for low-carbon transformation and promote its high-quality and efficient development, this paper selects 30 listed power generation companies from 2016 to 2022 as the initial research samples. The samples were screened as follows :① Samples that were marked with \*ST or ST between 2016 and 2022 were excluded; ② Eliminate the samples with missing financial data. Ultimately, a total of 256 sample observations were obtained. The annual reports of the companies required for the research were all sourced from the Juchao Information Network, while the financial data information of the companies came from the annual reports. Among them, the carbon emission data required for the research was obtained through the relevant document information disclosed by the listed companies, including the company's official website, sustainable development reports, social responsibility reports, etc. Companies that did not disclose the data obtained it by estimation.

## 3.2 Variable Definitions

(1) Measurement of text information disclosure for low-carbon transformation

First, convert the obtained PDF file of the annual report into a TXT document and clean the data. All the annual report documents after cleaning are merged, and the words related to low-carbon transformation are extracted using Python. Representative words are selected to generate a word cloud graph. Meanwhile, with the help of the word segmentation system "Deep Learning Similar Words" of the WinGo Financial text data platform, this paper expands the relevant topic words from the four aspects of word set construction, reduces the impact caused by the omission of relevant words due to manual screening, and makes the measurement of the relevant words for the information disclosure of low-carbon transformation texts more scientific and reasonable. Ultimately, four dimensions were constructed, totaling 82 thematic vocabularies related to the information disclosure of low-carbon transformation texts.

Secondly, based on the keyword set of information disclosure for low-carbon transformation, Python was used to automatically perform word segmentation for each sample power generation listed company, and the word frequency of related theme words for low-carbon transformation was calculated. The proportion of the number of theme words to the total number of words in the full text of the annual report was calculated to measure the information disclosure indicators of the low-carbon transformation text, which is the core explanatory variable of this study. The larger the value of this indicator is, the more detailed the text information related to low-carbon transformation is depicted, and the higher the level of information disclosure correspondingly. The higher the attention and emphasis that power generation listed companies pay to low-carbon transformation, the greater the degree of attention and importance attached to it.

(2) The explained variable

The core task for the power industry to achieve green development lies in effectively controlling carbon emissions. As the main force in emission reduction efforts, listed thermal power enterprises must accelerate the pace of transformation towards a low-carbon model. The concept of carbon emission density specifically refers to the amount of greenhouse gas emissions corresponding to each dollar of economic value created. It can visually demonstrate the actual effectiveness of power generation enterprises in their environmental protection transformation. This study adopts carbon emissions per unit of revenue (CI) as the quantitative criterion for evaluating the low-carbon development level of listed enterprises. The specific calculation method is: the total annual carbon dioxide emissions of the enterprise divided by its total operating income to obtain the value.

(3) Control variables

To effectively manage the degree of influence of the corporate governance structure and basic financial indicators on the information transparency of low-carbon transformation, this study selected five key control variables: the scale of enterprise assets (treated as the natural logarithm), the capital-liability ratio, the return on total assets, the shareholding ratio of controlling shareholders, and the proportion of independent director seats. It is particularly necessary to note that the enterprise asset scale indicator adopts the logarithmic transformation processing method. Meanwhile, in the model design, fixed effect parameters of individual enterprises and the time dimension have also been incorporated. By introducing the individual fixed effect of enterprises, the endogenous interference problem caused by the heterogeneity characteristics of enterprises can be significantly alleviated, thereby more accurately identifying the causal relationship among various variables.

## 3.3 Model Construction

The panel regression model can simultaneously reflect the variation laws and characteristics of variables in the two-dimensional space of cross-section and time. To test the impact of text information disclosure of low-carbon transformation of listed companies on the transformation efficiency, based on the research hypothesis, this paper uses scatter plots to fit the data of low-carbon information disclosure and transformation efficiency of listed power generation companies for the possible interval effect in the hypothesis. It is shown that the nonlinear relationship between Transition Text Disclosure (TTD) and Technical Efficiency of low-carbon transition (TE) cannot be excluded. Therefore, the square term of the level of information disclosure of low-carbon transition is added to construct the following model for verification:

（1）

In this model, as the explained variable, represents the low-carbon transformation performance of Enterprise C in the i-th accounting year; as a key independent variable, reflects the degree of text information disclosure related to low-carbon transformation of enterprise i in year t, and is its secondary term. The "scale" indicator is used to measure the size of an enterprise. The ROA indicator reflects the profit level of a company's total assets. The Top1 variable represents the shareholding ratio of the controlling shareholder; Idr represents the proportion of independent directors on the board of directors. Furthermore, the two dummy variables, "enterprise" and "year", are respectively used to control the individual and time effects. Based on the aforementioned theoretical derivation, if the empirical results show that the coefficient α\_1 is statistically significant and positive, and α\_2 is significantly negative, and pass the "U" -shaped curve test at the same time, it indicates that the degree of information disclosure of low-carbon texts has an interval impact on the transformation efficiency, presenting a nonlinear correlation characteristic, thereby verifying the main theoretical hypothesis of this study.

## 3.4 Descriptive Statistical Analysis

As shown in Table 2, the average level of low-carbon transformation text information disclosure (TTD) of the sample listed companies is 19.018, that is, the average proportion of low-carbon transformation keywords in the total number of words in the full annual report is approximately 19%, and the median is lower than the average value. It indicates that the information disclosure level of most of the listed power generation companies in the samples has not reached the average level of the samples, reflecting that the disclosure level of listed companies regarding information related to low-carbon transformation is still relatively low and needs to be strengthened and improved. Research data shows that the degree of information disclosure related to enterprises' low-carbon transformation shows significant fluctuations, with the highest value reaching 43.030 and the lowest value being only 6.047. This numerical distribution feature fully reflects that there are significant differences among listed companies in the practice of environmental information disclosure.

Figure 1 shows the evolution trajectory of information disclosure on low-carbon transformation by listed companies in the power generation industry from 2016 to 2022, with an overall upward trend. However, from the perspective of the three key indicators of technical efficiency (TE), pure technical efficiency (PTE), and scale efficiency (CSE), although their mean values are higher than the median values, they have never broken through the critical point of 1, indicating that these enterprises have not yet reached the production possibility boundary of the industry. This phenomenon reveals that there is a significant efficiency gap among the power enterprises in the research sample during the process of low-carbon transformation. At the same time, it also confirms that the overall efficiency of listed power generation companies in China is still at a relatively lagging development level in the initial stage of low-carbon transformation.

Table 1 Descriptive statistics of variables

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variable | N | Minimum value | Maximum value | Mean value | Standard deviation |
| TE | 256 | 0.401 | 1.703 | 0.851 | 0.241 |
| PTE | 256 | 0.431 | 1.992 | 0.938 | 0.258 |
| SE | 256 | 0.408 | 0.997 | 0.913 | 0.127 |
| TTD | 256 | 6.051 | 43.030 | 19.018 | 6.061 |
| Size | 256 | 4.289 | 8.518 | 6.368 | 1.055 |
| Lev | 256 | 32.087 | 111.198 | 63.387 | 15.058 |
| ROA | 256 | -12.106 | 9.159 | 1.298 | 3.201 |
| Topl | 256 | 16.208 | 75.607 | 47.726 | 14.718 |
| Idr | 256 | 22.218 | 59.987 | 36.207 | 5.728 |

Figure 1 shows the changes in the text information disclosure level of low-carbon transformation of sample listed companies from 2016 to 2022

# 4. Analysis of Empirical Results

## 4.1 Benchmark Regression Results

As shown in Table 2, the data in column (1) of Table 2 indicates that regarding the degree of text information disclosure of enterprises' low-carbon transformation, the regression coefficient of the core indicator (TTD) shows a significant positive correlation within the 5% confidence interval, while the regression coefficient of the quadratic term (TTD\_sq) shows a negative relationship at the same significance level. The critical value was calculated to be 19.501, which is completely within the measured range of the low-carbon information disclosure level of the sample enterprises [6.047, 43.026]. The P value of 0.028 in the "U" -shaped relationship test rejects the null hypothesis that "the inflection point is not within the data range" at the 5% level, indicating that with the increase of text information disclosure of low-carbon transformation, the comprehensive efficiency of low-carbon transformation shows an inverted "U" -shaped interval effect of first rising and then declining, and Hypothesis 1 is supported. That is, within a certain range, the level of information disclosure on low-carbon transformation texts of listed power generation companies can enhance the efficiency of low-carbon transformation. However, excessive disclosure of texts beyond the range instead reduces the efficiency of low-carbon transformation and fails to accurately reflect the actual transformation efficiency of the company. This might be the result of information manipulation. As the low-carbon transformation is a long-term process characterized by large investment, long cycle and slow results, the information related to it disclosed in the company's annual report is mostly voluntary, forward-looking or historical textual information. The management has greater convenience in manipulating such textual soft information. The richer the textual information on transformation and upgrading is, the more difficult it is to verify its reliability and the more challenging the information analysis becomes. For listed companies with poor implementation results in low-carbon transformation, in order to obtain continuous and stable investment, the management is more willing to disclose text-based soft information and conceal the actual achievements by depicting rich texts related to low-carbon transformation. And other better data-based hard information was chosen to provide good business performance, thereby confusing the relationship between text information disclosure and the efficiency of low-carbon transformation. Furthermore, it can be known from the regression results that the inflection point of the low-carbon text information disclosure level is 19.501, which is greater than the average of the sample power generation listed companies. This indicates that at the present stage, the low-carbon text information disclosure level of power generation listed companies is on the left side of the inverted "U" -shaped inflection point, that is, the stage where information disclosure is positively correlated with the efficiency of low-carbon transformation. With the improvement of the information disclosure level, The efficiency of low-carbon transformation can be improved accordingly. Therefore, at this stage, listed power generation companies still need to expand the scope of information disclosure related to low-carbon transformation, enrich the content of disclosure and improve the quality of disclosure. They should implement low-carbon transformation measures in accordance with the criteria and target planning of information disclosure, so as to effectively improve the efficiency of low-carbon transformation and promote the transformation process.

The data in column (2) of Table 2 indicates that the analysis results on the degree of text information disclosure regarding low-carbon transformation present significant characteristics: The TTD indicator shows a positive correlation within the 10% confidence interval, while the TTD\_sq parameter shows a negative trend at the 5% significance level, with a turning point value of 20.908. Within the value range of the information disclosure level of low-carbon transformation texts, The P value of 0.051 for the "U" -shaped relationship test rejects the null hypothesis that" the inflection point is not within the data range "at the 10% level, indicating that as the text information disclosure of low-carbon transformation increases, the pure technical efficiency of low-carbon transformation shows an inverted" U" -shaped trend of first rising and then falling, once again verifying Hypothesis 1. Similarly, in this result, the inflection point value of text information disclosure for low-carbon transformation is greater than the average value.

However, column (3) of Table 2 shows that the regression coefficient of the primary term (TTD) of the text information disclosure level of low-carbon transformation is positive, and the regression coefficient of the secondary term (TTD\_sq) is negative, but neither is significant. This is because the scale efficiency is calculated as the ratio of the comprehensive efficiency of low-carbon transformation to the pure technical efficiency. It is mainly influenced by the company's production scale and is related to the company's ability to invest resources on a large scale. Therefore, there is no significant correlation with the level of information disclosure in the low-carbon transformation text.

Table 2 Regression Results of Information Disclosure and low-carbon Transformation Efficiency of Listed power generation Companies

|  |  |  |  |
| --- | --- | --- | --- |
| Variable | （1）TE | （2）PTE | （3）SE |
| TTD | 0.021\*\*（2.11） | 0.021\*（1.79） | 0.004（0.58） |
| TTD\_sq | -0.001\*\*（-2.36） | -0.001\*\*（-2.19） | -0.000（-0.18） |
| Size | 0.021（0.29） | 0.003（0.04） | 0.004（0.11） |
| Lev | -0.007\*\*\*（-3.58） | -0.007\*\*\*（-3.61） | -0.001（-0.038） |
| ROA | 0.003（0.57） | 0.002（0.29） | 0.001（0.51） |
| Topl | -0.003\*\*（-2.12） | -0.003（-1.51） | -0.001（-0.79） |
| Idr | -0.001（-0.38） | 0.000（0.23） | -0.001（-0.87） |
| Constant | 1.001\*\*\*（3.01） | 1.204\*\*\*（3.23） | 0.887\*\*\*（4.21） |
| Observations | 256 | 256 | 256 |
| R-squared | 0.368 | 0.279 | 0.115 |
| Number of ID | 30 | 30 | 30 |
| Company | YES | YES | YES |
| Year | YES | YES | YES |
| turning point | 19.501 | 20.908 | — |
| "U" -shaped relationship test (p value) | 0.031 | 0.048 | — |

Note：\*\*\*p<0.01,\*\*p<0.05,\*p<0.1

## 4.2 Correlation Analysis

Table 3 presents the correlation results among the main variables. The Pearson correlation coefficient is reported in the table. If the correlation coefficient is close to 1 or -1, multicollinearity may exist. The results show that the degree of correlation among all variables is within the acceptable range, and the correlation coefficients of the core explanatory variable, control variable and explained variable are all lower than 0.8. There is no serious multicollinearity problem among the main variables. Furthermore, through the results of the correlation analysis, it can be known that the correlation coefficients between the text information disclosure (TTD) of low-carbon transformation and the comprehensive efficiency (TE), pure technical efficiency (PTE), and scale efficiency (SE) of the transformation are all positive, but not significant. It can be preliminarily determined that there is no linear relationship between the text information disclosure and the transformation efficiency.

Table 3 Results of correlation analysis of each variable

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variable | TE | PTE | SE | TTD | Size | Lev | ROA | Topl | Idr |
| TE | 1.000 |  |  |  |  |  |  |  |  |
| PTE | 0.809\*\* | 1.000 |  |  |  |  |  |  |  |
| SE | 0.349\*\* | -0.234\*\* | 1.000 |  |  |  |  |  |  |
| TTD | 0.087 | 0.024 | 0.121 | 1.000 |  |  |  |  |  |
| Size | -0.241\*\* | 0.148\* | -0.701\*\* | 0.044 | 1.000 |  |  |  |  |
| Lev | -0.561\*\* | -0.474\*\* | -0.149\* | 0.098 | 0.181\* | 1.000 |  |  |  |
| ROA | 0.211\*\* | 0.213\*\* | -0.021 | -0.051 | -0.006 | -0.658\*\* | 1.000 |  |  |
| Topl | 0.165\* | 0.089 | 0.047 | -0.255\*\* | -0.061 | -0.448\*\* | 0.244\*\* | 1.000 |  |
| Idr | 0.204\*\* | 0.186\*\* | -0.012 | 0.081 | -0.072 | -0.103 | 0.001 | 0.211\*\* | 1.000 |

Note：\*\*\*p<0.01,\*\*p<0.05,\*p<0.1

## 4.3 Heterogeneity Analysis

### 4.3.1 Analysis of Quality Differences in Company Accounting Information Disclosure

Based on the differences in the level of financial report disclosure, this study divides listed companies in the power industry into two groups: the group of enterprises with high-quality financial information and the group of enterprises with poor financial information. Refer to the current year's enterprise financial transparency rating data provided by the Guotai 'an database: Companies with an assessment result of 1(excellent), 2(good), 3(qualified), and 4(unqualified) are marked as high accounting information quality companies, while the rest of the companies with an assessment result greater than 1 are marked as low accounting information quality companies. Regression tests were conducted based on the groups, and the coefficient difference test between groups was carried out by referring to Lian Yujun's seemingly uncorrelated model. The data in Table 4 shows that the p value of the coefficient difference test between the two groups reached the statistically significant standard (p<0.05), which indicates that there are indeed significant differences in the level of text information disclosure among different groups. Therefore, the conditions for conducting coefficient comparison analysis between groups are met. Column (1) of Table 4 shows that in high-quality accounting information companies, the impact of low-carbon transformation text information disclosure on transformation efficiency shows a significant inverted "U" -shaped relationship at the 10% level, while in column (<2) of low-quality accounting information companies, the impact of text information on transformation efficiency shows a significant inverted "U" -shaped relationship at the 5% level. Secondly, from the perspective of the quadratic term coefficient, the inverted "U" -shaped relationship curve between the information disclosure of low-carbon transformation texts of high-quality accounting information and the transformation efficiency is more gentle, while the relationship with low-quality accounting information companies is steeper. Thus, it can be seen that the information disclosure of low-carbon transformation texts has a more significant impact on the transformation efficiency of power generation listed companies with low-quality accounting information, verifying Hypothesis 2. The financial information and non-financial information in an enterprise's annual report are complementary to each other. For companies with a higher quality of accounting information disclosure, the quality of their text information disclosure is relatively higher, and they are more willing to choose the information disclosure that matches it, with a relatively lower probability of over-disclosure. For companies with low-quality accounting information, it is hoped that through impression management, the possible impact of negative information can be weakened, thereby increasing more textual descriptive information about the company's green and low-carbon development, maintaining a good corporate image, enhancing investors' willingness to invest, spending more time and energy on non-productive activities, and generating more redundant resources. It has reduced the actual efficiency of implementing transformational production activities, resulting in a decline in transformational efficiency.

Table 4 Analysis of Differences in the Quality of Accounting Information Disclosure of Companies

|  |  |  |
| --- | --- | --- |
| Variable | High-quality Accounting Information（1）TE | Low-quality Accounting information（2）TE |
| TTD | 0.056\*（1.89） | 0.033\*\*（1.98） |
| TTD\_sq | -0.002\*（-1.81） | -0.001\*\*（-2.19） |
| Size | 0.214\*\*\*（3.26） | 0.149（1.51） |
| Lev | -0.014\*\*\*（-4.42） | -0.005（-1.59） |
| ROA | -0.012（-1.49） | -0.004（-0.71） |
| Topl | -0.005\*\*（-2.63） | -0.002（-0.39） |
| Idr | 0.001（0.19） | -0.001（-0.19） |
| Constant | -0.085（-0.17） | 0.045（0.08） |
| Observations | 98 | 112 |
| R-squared | 0.312 | 0.113 |
| Number of ID | 20 | 20 |
| Company | YES | YES |
| Year | YES | YES |
| turning point | 20.659 | 23.829 |
| "U" -shaped relationship test (p value) | 0.061 | 0.028 |
| Inter-group coefficient difference test (P value) | 4.61\*\*（0.033） | |

Note：\*\*\*p<0.01,\*\*p<0.05,\*p<0.1

### 4.3.2 Analysis of Differences in the Company's Holding Units

The samples selected for this study are all state-owned power generation enterprises, including 14 listed companies controlled by central enterprises and 16 listed companies controlled by local state-owned assets. To investigate the impact of different ownership structures on the effect of low-carbon information disclosure, we conducted a group regression analysis. The data in column (1) of Table 5 indicates that among the sample enterprises controlled by central enterprises, there is no significant inverted U-shaped correlation between the degree of low-carbon information disclosure and the transformation performance of enterprises. In (2), both the primary and secondary items of the text information disclosure of the local holding company in Renshi are significantly correlated with the transformation efficiency at a level of 5%, and the coefficient of the secondary item is negative. That is, as the text information disclosure of low-carbon transformation increases, the comprehensive efficiency of low-carbon transformation shows an inverted "U" shaped trend of first rising and then falling. It can be seen from this that the text information disclosure of low-carbon transformation has a more obvious impact on the transformation efficiency of local holding listed companies, and Hypothesis 3 has been verified. This might be because centrally controlled listed companies are generally directly managed by the central government, hold a dominant position in the main industries and key fields of the national economic lifeline, and have good opportunities for reform. For central-controlled listed power generation companies, there is more favorable policy support for the low-carbon transformation of energy. At the same time, under strict regulatory pressure, they will be more rigorous and cautious in information disclosure, and disclose relevant information on the low-carbon transformation text in a timely and appropriate manner to reduce the risks that may be brought by excessive information disclosure. Therefore, the impact of information disclosure on the low-carbon transformation text on the transformation efficiency is not significant. For local holding listed companies, within a certain range, low-carbon text information can effectively reflect the transformation efficiency. By implementing corresponding low-carbon transformation measures in accordance with the formulated criteria, the transformation efficiency can be improved. However, due to the possible phenomenon of information manipulation in some listed companies and the slow progress and effectiveness of the transformation, the transformation efficiency is relatively low. This leads to a mismatch between the goal planning and the implementation effect, as well as a inconsistency between the text information and the transformation efficiency.

Table 5 Analysis of the Differences of the Company's Holding Units

|  |  |  |
| --- | --- | --- |
| Variable | Central Holding Listed Company（1）TE | Local holding listed company（2）TE |
| TTD | 0.016\*（1.22） | 0.059\*\*（2.58） |
| TTD\_sq | -0.000（-1.41） | -0.002\*\*（-2.49） |
| Size | 0.046（0.59） | 0.123（1.16） |
| Lev | 0.000（0.16） | -0.011\*\*\*（-3.88） |
| ROA | 0.012（2.12） | -0.002（-0.25） |
| Topl | -0.006\*\*（-2.31） | -0.003（-1.78） |
| Idr | -0.003（-1.49） | 0.004（1.33） |
| Constant | 0.391（0.83） | 0.271（0.51） |
| Observations | 98 | 112 |
| R-squared | 0.631 | 0.344 |
| Number of ID | 14 | 16 |
| Company | YES | YES |
| Year | YES | YES |

Note：\*\*\*p<0.01,\*\*p<0.05,\*p<0.1

# Conclusion

This study established a panel data regression model to deeply explore the correlation between the disclosure of text information related to low-carbon transformation and the implementation efficiency of the transformation. The empirical analysis results show that among the samples of listed companies in the power generation industry, there is a significant parabolic relationship between the level of low-carbon information disclosure and the transformation efficiency, specifically manifested as the initial promoting effect gradually transforming into the later inhibitory effect. That is, within the appropriate scope of information disclosure, the text information can serve as a self-supervision mechanism to effectively promote and improve the transformation efficiency. However, excessive information disclosure may have the phenomenon of information manipulation by the management. At the same time, it will also lead to the spillover of non-direct benefits in management input, causing the text information to be inconsistent with the transformation efficiency, resulting in inconsistent words and deeds and reducing the efficiency of low-carbon transformation. This inverted "U" -shaped relationship is more obvious in listed companies with lower accounting information quality and local holding, that is, the impact of text information disclosure on these two types of companies is greater. At the current stage, listed enterprises in the power generation industry show an inverted "U" -shaped curve feature in terms of low-carbon information disclosure. Currently, they are in an upward curve stage, and at this time, the quality of information disclosure is positively correlated with the effectiveness of low-carbon transformation. When enterprises enhance the degree of information disclosure, their low-carbon transformation process will also accelerate accordingly.

Although this study analyzed the correlation between text information disclosure of listed companies and transformation effectiveness from a differential perspective and obtained some valuable findings, there are still several deficiencies in the research.

(1) In terms of data sources, this paper mainly relies on public information such as the annual reports and social responsibility reports of listed companies. Although these information have a certain degree of reliability, there may also be situations where the disclosure is incomplete or distorted. Furthermore, due to the incomplete information disclosure of some small and medium-sized enterprises or enterprises in emerging industries, the data of these enterprises were not included in the research sample, which might have affected the universality of the research results.

(2) In terms of the selection of heterogeneous characteristics, this paper mainly considers factors such as the quality of the company's accounting information disclosure and the company's holding units. However, the heterogeneity of enterprises goes far beyond this. It also includes multiple aspects such as corporate culture, the characteristics of the management team, and innovation capabilities. These factors may all have an impact on the relationship between text information disclosure and transformation efficiency.

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