



Research on the Relationship between Carbon Accounting Information Disclosure Quality and Corporate Market Value

—Take Contemporary Amperex Technology Co.,limited as an example

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Abstract. This paper selects the most representative enterprise of new energy industry, Contemporary Amperex Technology Co., Limited(CATL), as a case enterprise. By constructing a carbon neutral information disclosure quality scoring system and using the evaluation method of entropy weight-Topsis to evaluate the carbon information disclosure quality. the correlation degree of enterprise carbon neutral information disclosure quality and enterprise value is analyzed. It is found that the carbon neutral information disclosure quality and enterprise value have a strong correlation, that is, the higher the carbon neutral information disclosure quality is, the greater the enterprise value is. It is hoped that this study can make enterprises realize the close relationship between carbon neutrality and enterprise value, urge enterprises to actively respond to the national carbon neutral policy, and take active and effective carbon emission reduction measures to create a win-win situation between the environment and enterprises.

Keywords: carbon information quality; Enterprise value; Information disclosure evaluation

1 Introduction

Climate change has long been a concern of governments around the world, and China, like other countries, is gradually recommending new sustainable development models such as green development, green living, green construction and green production to reduce the degree of climate change^[13].

Since 1992, China has put forward a sustainable development strategy, and now the "double carbon target" policy proposed by 2020, China has never lost touch with the world on the way to fulfill its responsibility as a major country. On the one hand, national policies will influence the behavior of enterprises, especially state-owned enterprises, and enterprises will bear more policy costs^[14], and such cost input will affect the

profits of enterprises, and may cause the market performance of enterprises (disclosed statements) to be lower than in the past^[1].

Some scholars in the study of carbon disclosure quality of listed companies in China and its impact on enterprise value found that the higher the quality of carbon disclosure has a negative effect on the increase of long-term market value of enterprises^{[7][11]}, but it is not obvious. On the other hand, some scholars found that enterprises with high quality of carbon information disclosure will have higher requirements for themselves than general enterprises, so that the investment risk is smaller and the return rate is higher, and thus investors will tend to buy the stocks of enterprises with high level of disclosure, so as to increase the market value of the enterprises^{[3][10]}.

From the above two different points of view. We can verify and analyze a representative company in a high-emission and high-pollution industry to find out the impact of the quality of carbon information disclosure on its market value and the internal mechanism of action, so as to put forward suggestions for improving the level of carbon disclosure and increasing the market value of enterprises.

2 Literature Review

Han Jin and Teng Zhonglu pointed out that the release of high-quality reports by enterprises is helpful to the enhancement of enterprise value. Song Xiaohua and Jiang Xiao et al. argue that carbon disclosure has a positive effect on corporate value in terms of long-term market value^[12], and that the positive effect on corporate value is more pronounced in firms with a good legal environment than in firms with a poor legal environment^[2]. Porter and Linde also argue that a firm's environmental reputation is similar to a firm's business reputation, which is helpful in expanding the firm's business revenue.

Some other scholars have a different viewpoint: Wang Zhongbing and Jin Xiaochao's 2013 study on the correlation between carbon disclosure indicators and firm value found that the results were not significant. Trumpp and Thomas (2017), through a four-year long study of over 2,000 international samples, found that the relationship between carbon emission performance and profitability is not linear, but more of a U shaped relationship.

Xuexin Liu (2021) studied carbon information reporting and corporate value of industrial firms listed in A-share companies, and concluded that the quality of carbon disclosure does not significantly enhance corporate value in a short period of time, but rather affects corporate value through accumulation over a long period of time. Fisher-Vanden and Thorburn's (2011) study pointed out that the environmental costs associated with climate change that exceed a firm's internal capacity to absorb them. Due to the failure of market mechanisms in this regard, companies that participate in GHG emission reduction programs may suffer a significant decline in firm value and financial performance.

In summary, scholars have three views on the impact of carbon disclosure on corporate value: the first is that carbon disclosure is positively related to corporate market value, the second is that carbon disclosure is negatively related to corporate value, and

the third is that the impact of carbon information on corporate value is very small and will exert a cumulative effect in the long run. Thus it seems that domestic and foreign scholars are still controversial about the impact of carbon disclosure quality on enterprise value. Therefore, this paper is still of practical significance to study the impact of carbon information disclosure on enterprise value of typical companies.

3 Research Theory

Since energy enterprises are high-consumption, high-pollution enterprises, so for the government, as long as the initiative to assume social responsibility for the government to contribute to the carbon emission targets of the energy enterprises will gain the goodwill of the government, the next time the enterprise and the government cooperation will be favored by the government in support^[8]. For investors, energy companies have a slow return on investment, disclosure of data opacity and other characteristics, so the higher the degree of corporate disclosure, the investment risk will fall more attractive to investors to invest^[8].

For energy companies, energy saving and emission reduction often involves the research and development of new low-carbon technologies, the renovation of old equipment and other costly projects, which are often large enough to affect corporate profits, so energy companies will invest more money in order to achieve energy saving and emission reduction and high-quality carbon disclosure, which may lead to a decline in corporate profits and corporate market value.

4 Research Method

4.1 Company Market Value Study

Tobin's Q is one of the indicators to analyze the investment decision of enterprises and measure the investment effect, which was proposed by the American economist Tobin in the 1960s. The market value of enterprise assets is the sum of its equity market value and debt market value. The replacement cost of the company's assets, that is, the cost of the company's fixed assets in the current production or reconfiguration expressed in its stock price, and also refers to the cost of the company's additional assets^[5]. The Q value refers to the discounted value of the future marginal return of the company's additional unit assets expected in the stock market.

$$\text{Tobin's } Q = \frac{MV}{RC} \quad (1)$$

MV represents the sum of the market value of the enterprise's equity and the market value of the creditor's rights, and RC represents the replacement cost of the enterprise's assets. As for equity capital market value, this paper uses the market value of tradable shares and the net assets per share of non-tradable shares to calculate. As for the debt capital market value, this paper uses the sum of current and non-current liabilities to calculate; As for the replacement cost of enterprise assets, because it is difficult to

obtain detailed data, this paper uses the total book value of enterprise assets to replace the replacement cost.

4.2 Enterprise Carbon Information Disclosure Quality Evaluation Framework

The quality evaluation framework of carbon information disclosure is a key step to measure the implementation of social responsibilities and national policies by enterprises. It can evaluate the implementation methods and effects of carbon neutrality objectives of enterprises from multiple perspectives, and provide methods and basis for the state and society to supervise enterprises to take environmental protection measures. Among them, the selection and design of each element is the core and foundation of the framework.

Li Huiyun (2015) established indicators from five dimensions, including timeliness, completeness, comparability, comprehensibility and reliability of information disclosure. CDP, the world's most authoritative carbon information disclosure organization, believes that the most important thing for carbon information disclosure is environmental governance and the elimination of corporate information opacity. The opportunities and dangers brought by climate change, the ways to deal with climate change, and the governance of climate change should be disclosed as much as possible^[4]. Zhao Lina et al. (2023) built an accounting system with carbon emission reduction strategy and response, carbon emission reduction action and management, carbon emission reduction performance and reward, carbon emission accounting, trading and audit as the first-level indicators on the basis of the indicators constructed by CDP and the actual situation of Chinese enterprises, and well evaluated the quality of enterprise carbon information reporting.

4.3 Quality Evaluation Method of Enterprise Carbon Information Disclosure

At present, most domestic scholars use either analytic hierarchy process (AHP), entropy weight method or a combination of the two methods to assess the quality of corporate carbon information disclosure, which has the advantage of being simple, fast and systematic. However, AHP is a process of simulating human brain decision-making, and the decision-making process will inevitably be subject to subjective biases brought by decision-makers due to differences in age and experience, and entropy weight method is difficult to avoid the impact of data errors^[9]. Therefore, this paper adopts the method of Entropy Weight Topsis to evaluate the quality of corporate carbon information disclosure^[6].

5 Case Studies

5.1 Case Company Profile

Founded in 2011, Contemporary Amperex Technology Co., Limited (hereinafter abbreviated as CATL) is a leading global new energy innovation and technology company, which was listed on June 11, 2018 on the Shenzhen Stock Exchange. As a global leading new energy innovation and technology company, CATL is a leading enterprise in China's lithium-electronic battery manufacturing industry, specializing in the research, development, production and sales of power battery systems and energy storage systems for new energy vehicles.

The company adheres to independent innovation and possesses core technologies in the field of power and energy storage batteries, including key areas of the whole industry chain such as battery materials, cells, battery systems and battery recycling and secondary utilization, etc. CATL has set up a well-thought-out and perfect R&D, production and sales service system, and is committed to the continuous research and development of high-quality new energy products.

5.2 CATL Enterprise Value Calculation

According to the calculation formula of Tobin's Q, the value of Tobin's Q from 2018 to 2022 in the CATL can be calculated as shown in Table 1:

Table 1. Tobin's Q value in CATL from 2018 to 2022

Year	2018	2019	2020	2021
Market value (million)	86432.48	206333.99	553438.44	1425385.80
Book value of total assets (millions)	73883.71	101351.98	156618.42	307666.86
Tobin's Q value	1.17	2.04	3.53	4.63

Using the Tobin's Q model, the enterprise value is evaluated based on the annual reports of CATL from 2018 to 2022 and the data disclosed in the database of Cathay Pacific Database. Among them, the market value data comes from Cathay Pacific, and the book value of total assets comes from the company's financial statements. The calculation shows that the Tobin's Q value of CATL from 2018 to 2022 is 1.17, 2.04, 3.53, 4.63 and 2.06.

From the data in Table 1, it can be seen that since the listing of CATL the Tobin's Q value is greater than 1, indicating that the market price generated by the investment behavior of CATL after the subsidy regression are greater than the cost of the investment, and its investment behavior creates the value of wealth for the enterprise.

However, due to the fact that since 2022, CATL stock price has fallen all the way down, retraced more than 40% from the high point at the end of last year, and the market value has shrunk by nearly 600 billion, the decline in CATL stock price has led to the dislocation of its market value estimation, so its Tobin's Q value of 2022 is removed, and the following study takes the data of 2018 to 2021 as the study.

5.3 Construction of Carbon Disclosure Indicators for CATL

Although the domestic evaluation system of carbon information disclosure quality varies, the central idea still reflects the characteristics of information disclosure advocated by Li Huiyun, therefore, this paper follows Li Huiyun (2016) on the five characteristics of corporate carbon information disclosure should have, and then refine the understandability into accuracy and clarity to construct a six-dimensional level 1 indicator, and comprehensively consider the evaluation methods used by CDP and the existing Chinese Taking into account the evaluation method used by CDP and the evaluation framework of enterprise carbon disclosure designed by scholars, and combining with the actual situation of the new energy industry, X secondary indicators are selected to make an all-round evaluation of the quality of enterprise carbon disclosure, and the specific indicators are shown in Table 2.

In this paper, key fields are crawled through the public information on the official website of enterprises, and scoring evaluation is carried out according to the key fields. Overall, the undisclosed information is assigned a value of 0, the disclosed information is assigned a value of 1, and then 1-2 points are added to the quality of the content richness of the disclosed information.

Table 2. Carbon disclosure framework of CATL

Year	2018	2019	2020	2021
Availability of previous year's carbon emissions data for comparison	1	1	2	2
Timing of disclosure of social responsibility reports	1	3	3	3
Availability of basis for calculation	0	1	1	3
Accuracy of measurement of carbon emission targets	1	2	2	2
Availability of relevant carbon emission regime basis	2	1	3	3
Availability of third-party verification reports	0	1	2	3
Availability of graphic descriptions	0	1	3	3
Specific data on carbon emissions	1	2	2	2
R&D investment in carbon reduction technologies	1	1	1	2
Enterprise Carbon Emissions Management System	1	1	2	2
Disclosure of environmental rewards and penalties	0	1	1	2
Integration of climate change into strategies	0	0	2	3
Whether to analyze risks from climate change	0	1	1	3
Whether to analyze the opportunities presented by climate change	0	1	3	3
Whether to conduct carbon neutral education and training for employees	0	1	1	2

5.4 Calculation of the Carbon Disclosure Index of CATL

(1) Firstly, the data in the carbon disclosure framework should be standardized.

Construction of a standardized evaluation matrix:

$$Y = (y_{ij})_{m \times n} \tag{2}$$

For each indicator,

$$y_{ij} = \frac{x_{ij} - \min(x_j)}{\max(x_j) - \min(x_j)}, \quad y_{ij} = \frac{\max(x_j) - x_{ij}}{\max(x_j) - \min(x_j)}$$

$\max(x_j)$, $\min(x_j)$ in a formula are the maximum and minimum values of the j th indicator, respectively. $y_{ij} \in [0,1]$.

(2) The weighting coefficients for each indicator are then calculated.

$$H_j = -\frac{1}{1n(m)} \sum_{i=1}^m P_{ij} \ln(p_{ij}). \tag{3}$$

(3) Then calculate the entropy weight of the j th indicator.

$$W_j = \frac{1 - H_j}{n - \sum_{j=1}^n H_j} \tag{4}$$

The greater the entropy weight the greater the weight of j indicator and the more important the indicator is.

(4) Constructing weighted evaluation matrices.

Multiply the entropy weight W of each indicator with the normalization matrix Y to get the weighted evaluation matrix R as in Table 3.

Calculation formula:

$$R = (r_{ij})_{m \times n}, r_{ij} = w_j x y_{ij} \tag{5}$$

Table 3. Carbon Disclosure Weighted Evaluation Matrix R

Year	Weighting factors	2018	2019	2020	2021
Availability of previous year's carbon emissions data for comparison	9.43%	0.094	0.094	0.189	0.189
Timing of disclosure of social responsibility reports	3.98%	0.040	0.119	0.119	0.119
Availability of basis for calculation	5.92%	0.000	0.059	0.059	0.178
Accuracy of measurement of carbon emission targets	3.98%	0.040	0.080	0.080	0.080
Availability of relevant carbon emission regime basis	4.56%	0.091	0.046	0.137	0.137
Availability of third-party verification reports	5.12%	0.000	0.051	0.102	0.154
Availability of graphic descriptions	5.27%	0.000	0.053	0.158	0.158
Specific data on carbon emissions	3.98%	0.040	0.080	0.080	0.080
R&D investment in carbon reduction technologies	18.10%	0.181	0.181	0.181	0.362
Enterprise Carbon Emissions Management System	9.43%	0.094	0.094	0.189	0.189
Disclosure of environmental rewards and penalties	4.72%	0.000	0.047	0.047	0.094
Integration of climate change into strategies	9.59%	0.000	0.000	0.192	0.288
Whether to analyze risks from climate change	5.92%	0.000	0.059	0.059	0.178

Year	Weighting factors	2018	2019	2020	2021
Whether to analyze the opportunities presented by climate change	5.27%	0.000	0.053	0.158	0.158
Whether to conduct carbon neutral education and training for employees	4.72%	0.000	0.047	0.047	0.094

Table 3 shows that whether the enterprise compares the carbon information emission of the previous year, how much R&D investment and whether the enterprise integrates climate change into its strategy have a greater impact on the enterprise's carbon information disclosure, while the accuracy of the carbon information emission index, the time of disclosure of the CSR report and the rewards and punishments for the carbon information disclosure have a relatively small impact on the carbon information disclosure.

(5) Calculate positive and negative ideal solutions.

The positive ideal solution, S^+ , and the negative ideal, S^- , denote the best and the worst solution in the virtual solution set, respectively.

$$\begin{aligned}
 S^+ &= \{S_1^+, S_2^+, \dots, S_n^+\} = \{\max r_{ij}, i = 1, 2 \dots m\} \\
 S^- &= \{S_1^-, S_2^-, \dots, S_n^-\} = \{\min r_{ij}, i = 1, 2 \dots m\}
 \end{aligned}
 \tag{6}$$

Table 4. Positive and negative ideal solutions

term	positive ideal solution	Negative ideal solution
Availability of previous year's carbon emissions data for comparison	0.189	0.094
Timing of disclosure of social responsibility reports	0.119	0.04
Availability of basis for calculation	0.178	0
Accuracy of measurement of carbon emission targets	0.08	0.04
Availability of relevant carbon emission regime basis	0.137	0.046
Availability of third-party verification reports	0.154	0
Availability of graphic descriptions	0.158	0
Specific data on carbon emissions	0.08	0.04
R&D investment in carbon reduction technologies	0.362	0.181
Enterprise Carbon Emissions Management System	0.189	0.094
Disclosure of environmental rewards and penalties	0.094	0
Integration of climate change into strategies	0.288	0
Whether to analyze risks from climate change	0.178	0
Whether to analyze the opportunities presented by climate change	0.158	0
Whether to conduct carbon neutral education and training for employees	0.094	0

(6) Calculate the Euclidean distance and relative closeness of each evaluation object to the positive and negative ideal solutions.

$$\text{European distance: } S_{di}^+ = \sqrt{\sum_{j=1}^n (S_j^+ - \gamma_{ij})^2}, i = 1, 2, \dots, m
 \tag{7}$$

$$S_{di}^- = \sqrt{(\sum_{j=1}^n S_j^- - \gamma_{ij})^2}, j = 1, 2, \dots, m$$

The relative closeness is:

$$\eta_i = \frac{S_{di}^-}{S_{di}^+ + S_{di}^-}, i = 1, 2, \dots, m
 \tag{8}$$

(7) Carbon Disclosure Index (CDI) for each enterprise.

$CDI_i = 100 \times \eta_i$. The value domain of the carbon disclosure index is [0, 100], and the above steps can calculate the carbon disclosure index of CATLs shown in Table 5:

Table 5. Carbon Disclosure Index of CATL

Year	positive ideal solution	Negative ideal solution	relative closeness	Sorted results	CDI
2018	0.547	0.046	0.077	4	7.7
2019	0.455	0.171	0.273	3	27.3
2020	0.278	0.38	0.578	2	57.8
2021	0	0.553	1	1	100

The larger the CDI indicates the higher the quality of carbon information disclosure of the enterprise, as can be seen from the table, the quality index of carbon information disclosure of CATL in 2018 is only 7.7, which indicates that the quality of carbon information is relatively poor, while the carbon disclosure score of the enterprise in 2021 is 100, which proves that the quality of carbon information disclosure of CATL in 2021 is very high.

5.5 Correlation Analysis

We analyze the correlation between the calculated corporate Tobin's Q value of CATL in 2018-2021 and the carbon disclosure quality score in the same period, and the results of the analysis are shown in Table 6:

Table 6. Correlation analysis

		overall score
Tobin's Q	correlation coefficient	0.984*
	p-value	0.016
	sample size	4

* p<0.05 ** p<0.01

Through the test, it can be found that in the correlation test for the market capitalization of CATL and its carbon disclosure score, the correlation coefficient between the market capitalization of CATL and its carbon disclosure score at the same stage is 0.984, with a p-value of 0.016, which is significantly correlated at 5%.

The test proves that the carbon disclosure quality index of CATL is highly correlated with its Tobin's Q value, and the better the quality of carbon disclosure, the higher the corporate value.

6 Research Conclusion

In this paper, following the five characteristics that Li Huiyun (2016) proposed for corporate carbon information disclosure, the comprehensibility was refined into accuracy

and clarity, and a six-dimensional first-level index was constructed. The carbon information disclosure index was constructed using content analysis and Entropy-weight TOPSIS method. The social responsibility report of CATL from 2018 to 2021 was taken as the research object. The carbon information disclosure was analyzed. The results show that the quality index of carbon information disclosure in the CATL is significantly positively correlated with Tobin's Q, that is, the higher the quality score index of carbon information disclosure in the CATL, the higher the quality of carbon information disclosure, the higher the enterprise value. Therefore, it can verify the theory of domestic and foreign scholars that the level of carbon information disclosure is positively correlated with the value of the enterprise.

According to the weighted matrix of each index affecting carbon information disclosure under the application of Entropy Weight method in Table 4 and the positive and negative ideal solutions of each index in Table 5, it can be seen that factors such as R&D investment of carbon emission technology, whether enterprises take into account the strategy of climate change and enterprise carbon emission management system have a large impact on the quality of carbon information disclosure of enterprises. Enterprises can improve the quality of corporate information disclosure by increasing investment in carbon emission technology and comprehensively considering climate and environment factors in strategic decision-making. Such efforts can not only better protect the environment, but also improve corporate value and achieve a win-win future for the economy and the environment. Enterprises can also attract more investors by improving the quality of information disclosure, accumulate corporate reputation, and improve the cooperation support of the government.

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