Research Article

Effect Analysis of Carbon Information on Enterprise Value Based on Big Data

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An effect analysis approach of carbon information on enterprise value based on big data is proposed. This study first systematically expounds on the sources of research data and data collection methods and then comprehensively analyzes corporate carbon information disclosure status and characteristics. It also conducts an empirical study on the short-term impact of carbon information disclosure on corporate value creation and draws the following conclusions. Industry classification has an important impact on corporate carbon information disclosure in terms of the status and characteristics of corporate carbon information disclosure. Except for the financial and insurance industry, the average amount of carbon information disclosure in susceptible sectors such as the extractive industry and construction industry is relatively high. In terms of carbon information disclosure content, the carbon information disclosed by enterprises is mainly related to low-carbon technology and low-carbon product plans. Through empirical analysis of the impact of carbon information disclosure on short-term stock market performance and investor returns, it is found that the trading volume and value of stocks in the 5 trading days after the information event were higher than those in the previous 5 trading days. Still, the increase in the overall stock market value was not significant. This shows that the occurrence of carbon information disclosure events can improve the liquidity and trading activity of the stock market, trigger the stock market’s market response to carbon information disclosure, and enable investors to obtain more abnormal returns among short-term investors. It has a certain impact on short-term enterprise value creation.

1. Introduction

As the world enters the era of low-carbon economy, the impact of enterprise carbon emission activities on human survival and development has attracted more and more attention from all walks of life. As a way and tool for enterprises to talk with the outside world about their carbon emission management, carbon information disclosure has been highly valued by enterprise regulators, stakeholders, and the public, and has become an important practical problem [1–9].

Whether carbon information disclosure contributes to enterprise value creation is a highly controversial issue, which needs to be further studied. Especially in China, in the face of huge pressure on emission reduction and the absence of a unified regulation on carbon information disclosure management, actively encouraging enterprises to practice carbon emission reduction and disclose carbon information will effectively promote the realization of the government’s emission reduction target. At the same time, in the domestic research on the impact of carbon information disclosure on enterprise value creation, a few relevant studies have not found that the carbon information disclosure has a significant impact on market performance and enterprise value creation.

Therefore, what impact will carbon information disclosure have on the formation and creation of enterprise value in China? What is the path through which this impact is realized? These important questions have not been well answered. We need to further explore the impact mechanism and path of carbon information disclosure on enterprise value creation in theory and practice, and test the actual
effect of carbon information disclosure on enterprise value creation. We will conduct research on the impact of carbon information disclosure on enterprise value creation.

This study mainly explores the dynamic process and internal mechanism of carbon information disclosure affecting enterprise value creation, verifies the short-term impact, long-term impact, and lagging impact of carbon information disclosure on enterprise value creation through empirical research, and answers the question of whether carbon information disclosure is conducive to enterprise value creation. This study can not only enrich the theoretical and empirical research in the field of carbon information disclosure in China, but also provide a theoretical basis for enterprises to strengthen the management and governance of carbon information disclosure, and provide an important reference for the government to supervise enterprise carbon information disclosure and relevant policy-making.

2. Data Collection

2.1. Data Collection Design Based on Web Crawler. We will take 2012 Chinese A-share listed companies as research samples, use web crawler technology to collect carbon information disclosed by companies through non-annual report channels, reprocess the information, and finally form the research database of this paper. This data collection method is inspired by Lee et al. [1]; when they studied the frequency of corporate carbon information disclosure, they used web crawler technology to measure the number of carbon information reported by companies through the media. The specific data collection idea mainly includes the following three steps:

The first step is to determine the data source. The company website, media reports, and carbon information released by the company based on other web forms are selected as data sources. The company website and the media are the two most important channels. This is mainly because: First, under the unique domestic institutional background, the amount of carbon information disclosed by my country’s listed companies through annual financial reports is small, and no company has disclosed it through independent reports (except social responsibility reports and environmental reports). Second, scholars such as Isemann and Lenz [2], Adams and Fros [3] have confirmed in their research on environmental information disclosure that with the development of network technology, more and more enterprises will use the website to publish the information related to business operations. When companies use websites and independent annual reports to disclose information, the relevant information disclosed in the annual reports will be reduced, thereby reducing the value of the annual report as a source of information [4]. Scholars such as Frost [5], Clarkson et al. [6], and Aerts and Cormier [7] also confirmed that the media is another critical channel for corporate information disclosure. The research of Pellegrino and Lodhia [8] further confirmed that corporate websites and media are essential channels for companies to disclose carbon information.

The second step is data collection based on a web crawler. To collect information comprehensively, this paper will use JAVA language to write a web crawler program and use a web crawler to automatically crawl information, respectively, to crawl carbon information disclosed by enterprises through company websites, media, and other web-based forms. The carbon information disclosed by the enterprise in this paper refers to any information related to the enterprise’s GHG emission reduction disclosed by the enterprise to its stakeholders, which includes the enterprise’s carbon emission, carbon emission reduction plan, and implementation of the carbon emission reduction plan. After clarifying the connotation of corporate carbon information disclosure, based on web crawler technology, “company name + keywords” are used to crawl, and the database of this paper is initially formed. Lee et al. [1] used keywords such as climate change and business, greenhouse gas emissions, low carbon, green development, green management, environmental management, and carbon management when collecting carbon information disclosed that topics related to carbon disclosure and the definition of news coverage. Since the corporate carbon information disclosure in my country has just started, the carbon information disclosed by enterprises is relatively small, and the subject is single. To improve the relevance of the collected data, this paper only selects low-carbon, emission reduction of 2 keywords to capture information, and improve the quality of information collection.

The third step, data preprocessing, mainly includes two aspects of data deduplication and classification. The first is to deduplicate the data. Since the sources of information obtained through web crawlers are multi-channel, there is some duplication of information, and further deduplication processing is required for the received information. This paper adopts data mining technology, sorts the total amount of information each enterprise obtains according to the information title, automatically deletes the duplicated information title, and retains all non-duplicated information. Then, the collected data is processed by text classification, etc., to lay the foundation for the subsequent carbon information disclosure level calculation.

The essence of a web crawler is algorithm-based information crawling program. The information crawling workflow is: firstly, initialize a URL set, build a waiting queue that meets the information crawling requirements, and then the crawler starts from the waiting queue and uses the waiting queue in turn. The URL in the line is used to crawl web pages and page information, and a new URL is obtained. In contrast, the URL in the waiting queue is used to crawl the data so that the original URL queue is updated, and a new waiting line is formed to guide the crawler to continue crawling and repeat this process.

To collect carbon information disclosed by enterprises in a targeted manner, the information crawling is limited by a specific theme, so in the process of crawler program design, a theme-oriented crawler program [2, 5, 6], that is, a theme web crawler, should be designed. The main difference between the theme crawlers and general crawlers is that available crawlers follow the principle of random crawling
when crawling web pages, while theme crawlers are limited by themes when crawling web pages. Therefore, the direction of the theme crawler is based on the simple crawler, crawling more targeted content, crawling more accurate information in a particular field, for example, using a web crawler to crawl agricultural and financial information, etc. [9–11]. In a specific program operation, the topic web crawler will receive program instructions related to the topic before crawling the data. According to this instruction, the irrelevant web pages will be excluded to retain the web pages closely related to the subject, that is, form a waiting queue for URLs related to the case, and then the crawler starts to crawl information from this waiting queue, and repeats the above process until it stops when the preset conditions are met [12–14].

To collect the information disclosed by enterprises on the specific topic of low carbon and emission reduction, it is necessary to add requirements to the general web crawler design program so that the web crawler can only crawl the subject-related information during work—information search strategy, rather than a system of crawling a web page when it encounters it. In the program design process, a calculation module for the relevance of each URL and page theme is added. This module judges whether the read information relates to the theme. Crawl and record information if relevant; discard and re-crawl if irrelevant. In this way, crawlers can only process web pages about low-carbon fields, significantly reducing the search scale and improving the search efficiency.

The theme crawler indicates the direction of crawler information collection through the two keywords of "low carbon/emission reduction" during information crawling. When designing the crawler program, the researchers collected the company websites of A-share listed companies and made a "seed set" of the theme crawler. In this paper, we check all the information disclosed by A-share listed companies in the Huike news database and build a "seed set" of the theme crawler with a single enterprise as a unit. After the two "seed sets" are aggregated, the theme crawler program "seed set" is formed, and the theme crawler will start from this "seed set" to crawl carbon information.

2.2. Implementation of Web Crawler Data Collection.
Based on the subject crawler, the general steps for collecting carbon information disclosed by each enterprise are information collection and preprocessing. Information collection is to download the web page information captured by the web crawler to the local; information preprocessing deals with the noise and other problems in the collected information to prepare for the subsequent data analysis. In this paper, through the operation of the theme crawler, the web pages and text information extracted by the crawler are stored in the database for subsequent research. In the actual crawled data, we can see the amount of carbon information disclosed by each enterprise, the time of disclosure, and the number of words in each disclosed information. At the same time, this program also deduplicates the captured data, records the same information only once, and displays the number of times the information is repeated.

The information collected in the above way will be automatically stored in txt format with the name of the stock symbol. The content of the file storage includes the title of each piece of carbon information disclosed by the enterprise, the time of disclosure, and the specific content of the disclosure. When opening each text, the text first records the total number of information collected this time. It displays the link of each piece of data, the specific text content captured, the number of text and the source of the text, and other information. In addition, data preprocessing mainly uses text mining technology (Text Mining) to separate the collected text data. Since the web crawler collects data by putting the collected information into a text with a single enterprise as a unit, it is necessary to use text separation technology to separate the carbon information disclosed by a single enterprise as a unit to separate the texts to prepare for the later carbon information classification and calculation. The separation of text data is essentially a process of knowledge discovery. First, all the data received from the data are deduplicated and preprocessed, and then the Chinese text data is formed, followed by knowledge mining.

3. Research Hypothesis
The information asymmetry theory believes that information asymmetry exists in the capital market. In terms of corporate carbon information disclosure, there are mainly two scenarios for information asymmetry between companies and investors: First, the information about corporate carbon emissions and carbon trading is unevenly distributed between companies and investors, and companies possess more information than investors possess. This directly leads to an increase in the investors’ demand for information, making investors obtain information through various channels. Different information acquisition methods have different costs. The cost of receiving information from the enterprise is low for investors. The price of searching for information from other channels is high for investors, making it difficult to get information. The ease of access to information varies. In this context, information disclosure effectively alleviates the degree of information asymmetry between the two parties. Based on the theory of information asymmetry, corporate carbon information disclosure will help solve the problem of information asymmetry between companies and stakeholders.

At the same time, efficient market theory believes that the market and information are inseparable, the stock price integrates the expectations and information of all market participants, and the stock price is unpredictable. The market price is the reasonable expected value of the intrinsic value of the stock [15]. Investors’ investment behavior is a systematic information processing process, which is affected by many factors (such as information factors and environmental factors) in the investment decision-making process of measuring risks and returns. The information factor is necessary for investors to make decisions. Investors will pay attention to different stocks because of the difference in the amount of information on other stocks, which will eventually lead to changes in investor behavior, leading to
changes in stock market performance, and induce changes in stock market performance and volatility in investor returns.

The disclosure of carbon information by companies is conducive to eliminating investors' hesitation and worry when purchasing stocks due to insufficient information, promoting traders to conduct transactions quickly, and shortening the transaction time so that the stock price, transaction volume, and transaction amount fluctuate on the day when the information event occurs and during the event window. At the same time, when traders have sufficient information in the market and the transaction cost is relatively small, traders can conduct free transactions. The trading market activity can be effectively improved, thereby promoting many transactions and transactions quotas, increasing stock liquidity and investor interest in investing [16]. In addition, in an active market with a short trading time and large trading volume, even if there are many transactions, the security price can still reproduce the equilibrium price in a short period, making the trading market elastic.

Some empirical studies have also confirmed the impact of carbon disclosure on short-term stock market performance and investor returns. For example, Antoine [17] used European listed companies in the Dow Jones Index as a research sample and used regression analysis to test the relationship between the climate change crisis and stock market prices; it was found that there is a certain correlation between climate change exposure and stock returns. Griffin et al. [18] systematically analyzed whether the stock market would respond to climate change-related news reports using the S&P500 and TSE200 companies that participated in the CDP project from 2006 to 2009. The stock price and market trading volume will fluctuate significantly on the day or the next day when the relevant emission reduction information is disclosed, which means that investors' value judgment will be affected by the company's GHG emission information. Company stock market performance can also fluctuate based on carbon disclosures. Elias [19] further found in the survey and interview of investment companies, individual investors, and fund managers in South Asia that fund managers are very concerned about the carbon information disclosed by enterprises and other non-financial information and believe that such information will affect the short-term performance of a company's stock price. Haigh and Shapiro [20] surveyed 30 financial institutions in the United States, Europe, and Australia in 2010. They found that carbon emission reports will affect investors' evaluation and investment decisions on corporate investment projects, affecting investors' stock purchase behavior.

This paper believes that carbon information disclosure will affect investors' decision-making, leading to changes in stock market performance, which affects investors' short-term returns, and ultimately affects corporate value creation. Based on the above discussion, this paper proposes the following assumptions:

Hypothesis 1. Carbon information disclosure will have a short-term impact on corporate value creation.

The short-term impact of carbon information disclosure on corporate value creation is mainly manifested in the difference in investors' attention and understanding of different stocks due to the carbon information disclosed by enterprises, thereby affecting investors' investment decisions and stock purchase preferences. Differences in buying preferences and changes in stock behavior will cause fluctuations in the performance of the entire stock market and ultimately affect investors' profits. Based on this, this paper proposes the following two sub-hypotheses:

Hypothesis a: The stock market performance will fluctuate before and after the carbon information disclosure event.

Hypothesis b: Investor returns will fluctuate before and after the carbon information disclosure event.

4. Research Design

We use the entire fiscal year from January 1, 2012, to December 31, 2012, as the time of information collection in the interval, the carbon information disclosed by enterprises based on non-annual report channels is collected through web crawler technology as the data source, and other financial data are from the Guotaiminan Economic and Financial Research Database. The software used in the data processing is SPSS17.0.

4.1. Determination of Information Events. When examining the short-term impact of carbon information disclosure on corporate value creation and verifying the "disclosure effect" of carbon information, the primary research method used in the existing empirical research is the event study method. The event research method is a standard practical analysis method in finance. It is a research method that reflects the stock market's response to information by observing the cumulative abnormal returns and fluctuations of abnormal returns during the event window period [21].

Event research begins with the definition of an information event, i.e., the determination of the information event’s estimated window, event window, and information event occurrence date. Information event day generally takes the day when the event occurs as the event day. Therefore, the information event must be determined first before selecting the event day. Foreign researchers mainly use specific corporate environmental events to determine events such as corporate environmental accidents, corporate environmental penalties, and environmental report disclosure events.

It can be seen that the existing research mainly focuses on the specific environmental accidents of individual enterprises as information events because typical environmental accidents have a significant impact on the stock market performance of enterprises, and the effect on the creation of enterprise value is more important. Since this paper examines the short-term impact of carbon information disclosure on corporate value creation, it focuses on the differences in stock market performance before and after the corporate carbon disclosure event. As far as corporate carbon information disclosure is concerned, the carbon information disclosed by enterprises is mainly positive information, and there is less disclosure of negative information and major corporate
carbon emissions pollution accidents. For this reason, this paper draws on the research method in Reference [22]. It does not use specific events as the basis for judgment when determining information events. Still, it determines the information events by examining the amount of carbon information disclosed by enterprises on the information disclosure day. That is, if the value of the carbon information disclosure amount of stock $i$ on a certain day deviates from the mean by $2$ times the standard deviation, it is considered that the carbon information disclosure amount of stock $i$ is higher than its average level, and an information disclosure event occurs. That is:

$$\text{CIQ}_i \geq u + 2\sigma.$$  \hspace{1cm} (1)

In financial research, researchers mainly conduct research by observing market changes caused by information events within a certain window period. The selected event window period is five trading days before and after the occurrence of the information event; that is, the window period is $[-5,5]$. After the initial determination of information events based on the above methods, the events of step screening are processed as follows, and the following observations are eliminated:

1. During the event window period, the company disclosed other significant events (such as allotment of shares, dividends, mergers and acquisitions, and other events);
2. Disclosure of annual financial report, social responsibility report, and environmental report during the event window;
3. During the event window, companies with incomplete individual stock income data or trading suspension;
4. Companies that have continuously disclosed information multiple times within an event window. Based on the above principles, $89$ information events were finally identified as research events. The content analysis found that the information events were all positive information disclosure, so there was no need to distinguish between positive and negative events in later empirical studies.

### 4.2. Selection of Measure Indicators for Short-Term Enterprise Value Creation

Based on the research assumptions of this paper, this paper chooses the short-term performance of the stock market and investor returns during the carbon disclosure event window to reflect its short-term impact on corporate value creation. On the short-term performance measure of the stock market, this paper chooses to describe the trading volume, trading volume, stock price fluctuation, and stock market value fluctuation before and after the occurrence of information events.

In terms of the short-term benefits of carbon information disclosure to investors, this paper measures the abnormal return rate and the cumulative abnormal return rate. Returns can be divided into normal returns and abnormal returns. Normal returns refer to the expected and reasonable returns that investors can obtain under normal circumstances. Abnormal returns are the portion of investment returns that exceed normal returns, i.e., abnormal returns are equal to the actual rate of return minus the expected rate of return. It is necessary to calculate normal return before calculating abnormal return and cumulative abnormal return. Its calculation methods mainly include the following four: the first is the constant income model method, the second is the market adjustment model method, the third is the constant mean model method, and the fourth is the market model method.

This paper uses the market adjustment model method to measure the standard rate of return, measured by the average market rate of return. Since this paper analyzes the short-term impact of corporate carbon information disclosure on corporate value creation, this paper chooses the market monthly average rate of return weighted by the circulating market value as the market rate of return. Based on this, the abnormal return of stock $i$ in period $t$ during the event window is obtained as:

$$AR_{it} = R_{it} - R_{mt}.$$  \hspace{1cm} (2)

In formula (2), $AR_{it}$ represents the abnormal return rate of stock $i$ in period $t$, $R_{it}$ represents the rate of return of stock $i$ in period $t$ considering cash dividend reinvestment, and $R_{mt}$ represents the market rate of return in period $t$. This paper uses the average monthly market return weighted by the float market capitalization.

By summing and averaging the abnormal returns of individual stocks, the average abnormal returns of all sample stocks in period $t$ are

$$AAR_t = \frac{1}{N} \sum_{i=1}^{N} AR_{it}.$$  \hspace{1cm} (3)

In formula (3), $AAR_t$ represents the average abnormal return of all sample stocks in period $t$, and $N$ represents the number of sample stocks in period $t$. Therefore, the average cumulative abnormal return can be recorded as:

$$ACAR(t_1,t_2) = \sum_{t=t_1}^{t_2} AAR_t.$$  \hspace{1cm} (4)

In formula (4), $ACAR(t_1,t_2)$ represents the average cumulative abnormal return in the event window period $[t_1,t_2]$.

### 4.3. Analysis Model of Emotion Cognition Based on Regular Semantic Analysis

#### 4.3.1. Emotion Dictionary in Semantic Analysis Model of User Emotion Cognition

Emotion dictionary can distinguish special information elements separately in emotion dictionary. Therefore, the quality and quantity of constructing effective emotion dictionary will also affect consumers’ emotion judgment. Applying more characteristic elements
of consumer news to the establishment of emotion dictionary can effectively improve the accuracy of emotion analysis of consumer news. Figure 1 describes in detail the formulation method of emotional cognition in this paper.

The emotion classification in the text is to complete the emotion analysis according to the characteristic words. Among them, the core is feature extraction, and the quality of features has a great impact on the accuracy of emotion analysis. Therefore, constructing the characteristics of emotional dictionary is an important link in this paper. We will build relevant dictionaries based on the characteristics of diversified information elements and flexible language of consumer messages.

(1) Basic Emotional Dictionary of Consumer Words. Emotion dictionary is composed of a large number of words expressing emotion. The construction of emotion dictionary is the main way to obtain the characteristics of emotion words. There are two methods to construct emotion Dictionary: manual construction and automatic generation. This paper synthesizes the above two methods, and then uses the semi-automatic construction method to complete the construction of the dictionary.

Word2vec is an implementation of word vectorization. Through word vectorization, the synonyms of emotional word features or words with similar context are calculated, and the dimensions are set to add emotional word features.

In order to get a more comprehensive and accurate emotional dictionary, this paper uses word2vec to cluster the labeled emotional words, and selects the synonyms to complete the expansion function of the dictionary. At the same time, through the discovery of new words, this paper completes the extraction of consumer emotional words.

(2) Degree Adverb Dictionary. According to How Net dictionary, the degree adverbs in the dictionary are weighted, and these degree adverbs are divided into six levels. They are super, extremely, very, relatively, slightly, and under and negative adverbs, but they do not give the weight of degree. Therefore, combined with Chinese semantic rules, this paper expands the emotional intensity of the modified emotional words according to the six levels of adverbs, and sets the multiples as 2 times, 1.75 times, 1.5 times, 1.25 times, 0.5 times, and 0.25 times, respectively. The dictionary is shown in Table 1.

(3) Dictionary of Network Terms. After investigation and research, it shows that most consumers like to use online language. Network words have the characteristics of gradually increasing with the passage of time.

Words are often used as the smallest processing unit in natural language processing. Moreover, different meanings can be expressed by different words. Words with emotion are usually defined as emotional words. Emotional words are used to describe people’s feelings for things, such as “happy,” “sad,” and “happy”. The emotional classification of words is the basis for judging the overall emotion of the text. For example, there are a large number of words representing positive emotional bias in an article, but few words showing negative emotional bias. This article is usually judged to express relatively positive emotions, which is also the basis for general emotional analysis and judgment. Emotional analysis at the sentence level is conducive to preserving the integrity of the sentence. Emotional words are used as the characteristic basis for the classification of sentence level by characteristic words. In this paper, the definition rules are applied to calculate the comprehensive emotion of sentence level text, which can not only ensure the integrity of sentences, but also realize the calculation of a small number of sentence level emotional texts.

4.3.2. Semantic Cognitive Rule Algorithm for Emotion Cognition. In order to ensure the semantic analysis of sentence level and small quantity level, when emotional words are matched through emotional dictionary, corresponding strategies are made for the possible combination of a sentence according to the law of general sentences.

### Table 1: Degree adverb dictionary.

<table>
<thead>
<tr>
<th>Degree adverb</th>
<th>Level</th>
<th>Weight multiple</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Super, too much…</td>
<td>Over</td>
<td>2</td>
<td>31</td>
</tr>
<tr>
<td>One hundred percent,</td>
<td>Most</td>
<td>1.75</td>
<td>83</td>
</tr>
<tr>
<td>doubly, extremely…</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not a few, mostly…</td>
<td>Very</td>
<td>1.5</td>
<td>39</td>
</tr>
<tr>
<td>More, comparatively,</td>
<td>More</td>
<td>1.25</td>
<td>37</td>
</tr>
<tr>
<td>further…</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More or less, a little,</td>
<td>Ish</td>
<td>0.5</td>
<td>30</td>
</tr>
<tr>
<td>slightly…</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very small or short…</td>
<td>Inefficient</td>
<td>0.25</td>
<td>12</td>
</tr>
<tr>
<td>No, none…</td>
<td>Inverse</td>
<td>−1</td>
<td>50</td>
</tr>
</tbody>
</table>

![Figure 1: Affective cognitive recognition method framework.](image)
Addition is the method of weighting emotional words or expressions; multiplication is the method of weighting emotional words of modifiers, and finally additive weighting.

This paper defines six rules, including: rules that rely only on basic emotional vocabulary, the calculation rules of the expression in the text, rules that rely on Network Vocabulary weighting, the rule of negative words in front of emotional words, the rules of degree adverbs in front of emotional words, and rules of negative adverbs in front of emotional words. We use $O$ to represent the emotion value of the corresponding sentence combination, $A$ to represent each basic emotion word, $Q$ to represent each degree adverb, $C$ to represent each network word, and $E$ to represent each emoticon. The emotional cognitive rules are shown in Table 2.

5. Analysis of Empirical Results

5.1. Analysis of Stock Market Performance before and after the Carbon Information Disclosure Event. According to the occurrence time of the information event, the event research method is used to analyze the data reflecting the stock market performance, such as the stock trading volume, trading volume, bid-ask spread, standard return rate, and stock market value during the window period of each information event, to fully understand the short-term impact of carbon information disclosure on corporate value creation.

Figure 2 depicts the distribution of average transaction volume and transaction value before and after the information event. In Figure 2, the vertical axis represents the quantity, and the horizontal axis represents the number of days before and after the information event.

Figure 2 shows that before the information event occurs, the stock trading volume fluctuates, and there is a phenomenon of one day high and one day low. The average trading volume of stocks was the largest on the day when the information event occurred. The trading volume of stocks began to decline in the next 4 trading days after the information was disclosed, and the trading volume of stocks increased on the fifth trading day. In general, the average stock trading volume in the 5 trading days after the information event is higher than the average stock trading volume in the 5 trading days before the information event occurs. From Figure 2, it is not difficult to find that the fluctuation and change trend of stock trading volume and the changing trend of stock trading volume converge during the event window period. When the information event occurs, the stock trading volume reaches the maximum value. On the whole, the transaction volume of the five trading days before the occurrence of the information event is smaller than the transaction volume of the five trading days after the occurrence of the information event. Moreover, the trading volume fluctuated wildly on the day when the information event occurred, which increased significantly compared with the previous trading day and began to decline on the first trading day after the information event occurred.

Figure 3 shows the distribution of the average bid-ask spread before and after the information event. In Figure 3, the vertical axis represents the average bid-ask spread and the horizontal axis represents the number of days before and after the information event. As shown in Figure 3, the average bid-ask spread on the day when the information event occurred was 0.043, and the overall bid-ask spread in the stock market was relatively small. However, from its standard deviation data statistics, it is found that the standard deviation of the bid-ask spread in the five trading days before the occurrence of the information event is generally higher than the standard deviation of the bid-ask spread in the five trading days after the occurrence of the information event. This shows that the fluctuation range of the bid-ask value before the occurrence of the information event is higher than the fluctuation range of the bid-ask spread after the occurrence of the information event and the fluctuation range of the bid-ask spread decreases after the occurrence of the information event.

In addition to examining the volatility of stocks in terms of trading volume, trading value, and bid-ask spreads before and after the information event. This paper also analyzes the changes in stock market value during the information event window. Table 3 describes the distribution of stock market capitalization during the information event window. Similarly, the stock market value on the day and the second day of the information event was higher than that on the two days before the information event, indicating that the information event had a particular impact on the stock market value. Still, before and after the information event, the overall average market value of the stock did not fluctuate much.

Based on the above analysis, it can be seen that the trading volume and trading volume in the five trading days before the occurrence of the carbon information event are smaller than the trading volume and trading volume in the five trading days after the occurrence of the information event, and the fluctuation range of the bid-ask spread is reduced after the occurrence of the information event. This shows that carbon information disclosure affects the stock trading volume and transaction amount on the day of information disclosure and the five trading days before and after it, and makes stock prices and stock market values fluctuate in a short period of time, effectively triggering the stock market’s response to the information. The overall trend of the stock market’s short-term response to carbon information disclosure is that the stock transaction volume and transaction amount have increased on the day of the information event and the five trading days after that, which is conducive to the short-term value creation of enterprises. However, in the short term, carbon information disclosure will indeed cause fluctuations in the performance of the stock market, but the increase in stock market value is not obvious, which makes Hypothesis a proposed in this paper partially supported.

5.2. Investor Income Analysis before and after the Carbon Information Disclosure Event. After examining the short-term impact of carbon information disclosure on stock market performance, this paper further examines the short-
term effect of carbon information disclosure on investor returns by comparing the difference between normal and abnormal stock returns before and after the carbon information disclosure event. The test results are shown in Figures 4 and 5. In Figure 4, the vertical axis represents the average yield and the horizontal axis represents the number of days before and after the information event.

At the same time, the stock’s return rate was negative within the first 5 trading days of the information event. It showed a gradual upward trend, reaching the maximum value on the day of the information event. The rate of return began to decline on the first trading day after the occurrence of the information event, reached the lowest point on the second trading day, and the normal rate of return gradually

Table 2: Affective cognitive rule method.

<table>
<thead>
<tr>
<th>Tagging</th>
<th>Rules</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rule 1</td>
<td>$O = A_1 + A_2 + \cdots + A_k$</td>
<td>Rely on basic emotional words</td>
</tr>
<tr>
<td>Rule 2</td>
<td>$O = E_1 + E_2 + \cdots + E_k$</td>
<td>Rely on emoticons</td>
</tr>
<tr>
<td>Rule 3</td>
<td>$O = C_1 + C_2 + \cdots + C_k$</td>
<td>Rely on network words</td>
</tr>
<tr>
<td>Rule 4</td>
<td>$O = (-1) * k * A$</td>
<td>Negative words appear before emotional words</td>
</tr>
<tr>
<td>Rule 5</td>
<td>$O = Q * A$</td>
<td>Adverbs of degree appear in front of emotional words</td>
</tr>
<tr>
<td>Rule 6</td>
<td>$O = (-1) * Q * A$</td>
<td>Negative word + degree adverb + emotion</td>
</tr>
</tbody>
</table>

Table 3: Statistics analysis of stock market value before and after information event.

<table>
<thead>
<tr>
<th>Number of days since the event</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Minimum value</th>
<th>Maximum value</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>-5</td>
<td>6.11</td>
<td>1.26</td>
<td>4.34</td>
<td>7.82</td>
<td>0.13</td>
<td>-1.84</td>
</tr>
<tr>
<td>-4</td>
<td>6.06</td>
<td>1.26</td>
<td>4.21</td>
<td>8.01</td>
<td>0.18</td>
<td>-1.74</td>
</tr>
<tr>
<td>-3</td>
<td>6.02</td>
<td>1.25</td>
<td>4.23</td>
<td>7.72</td>
<td>0.2</td>
<td>-1.83</td>
</tr>
<tr>
<td>-2</td>
<td>6.01</td>
<td>1.25</td>
<td>4.32</td>
<td>7.97</td>
<td>0.21</td>
<td>-1.79</td>
</tr>
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<td>6.02</td>
<td>1.26</td>
<td>4.3</td>
<td>7.85</td>
<td>0.2</td>
<td>-1.79</td>
</tr>
<tr>
<td>0</td>
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<td>1.28</td>
<td>4.34</td>
<td>7.7</td>
<td>0.2</td>
<td>-1.9</td>
</tr>
<tr>
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<td>6.05</td>
<td>1.29</td>
<td>4.21</td>
<td>7.82</td>
<td>0.18</td>
<td>-1.83</td>
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<tr>
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<td>7.82</td>
<td>0.25</td>
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<td>4.35</td>
<td>7.72</td>
<td>0.22</td>
<td>-1.74</td>
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<tr>
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<td>1.15</td>
<td>4.43</td>
<td>7.76</td>
<td>0.25</td>
<td>-1.74</td>
</tr>
</tbody>
</table>

Note. Unit of stock market value: one billion yuan.
increased in the following three trading days. In general, the normal rate of return is higher in the five trading days after the information event than in the five trading days before the information event.

Figure 4 depicts the changes in the average abnormal rate of return (AAR) and the average cumulative abnormal rate of return (ACAR) before and after the carbon information disclosure event. In Figure 5, the vertical axis on the left represents the number of AAR, the vertical axis on the right represents the number of ACAR and the horizontal axis represents the number of days before and after the information event. From the analysis results in Figure 5, it can be seen that the average abnormal return begins to show an increasing trend on the third trading day before the occurrence of the information event. The average abnormal rate of return begins to change from negative to positive on the second trading day before the information event occurs. The average abnormal rate of return reaches the maximum value in the current period when the information event occurs. On the first trading day after the information event, the average abnormal return declined, remained positive for the next 3 trading days, and turned negative on the fourth trading day. Overall, the average abnormal return shows a trend of rising first and then falling during the window period of the information event, which shows that the occurrence of the information event has led to the change in the abnormal return of investors. In the first 3 days of the information event, the average return Abnormal returns begin to rise, and average abnormal returns begin to decline after informational events.

The average cumulative abnormal rate of return is consistent with the trend of the average abnormal rate of return. It began to show an upward trend in the first 3 trading days of the event. However, before the event, the average cumulative abnormal rate of return was still negative. It was positive until the current period of the information event and continued to rise within 3 trading days after the event until the fourth trading day after the event. This shows that the market has reacted in advance to the carbon information disclosed by enterprises. On the whole, in the three trading days before the occurrence of the information event, the average abnormal return rate and the average cumulative abnormal return rate both began to show an increasing trend. After the occurrence of the information event, although the average abnormal rate of return showed a downward trend, the average cumulative abnormal rate of return was still positive. This shows that investors can still obtain additional income within 5 trading days after the event. This conclusion strongly supports Hypothesis $b$ proposed in this paper.

6. Conclusions

The disclosure of carbon information has caused the stock market to react, leading to fluctuations in stock trading volume, transaction value, and stock price, which will have an impact on the creation of short-term corporate value, but the short-term increase in stock market value is not apparent. In the empirical analysis, it is found that during the event window period, the fluctuation and change trend of the stock transaction quota is similar to the changing direction of the stock transaction volume, which both show that the transaction volume and transaction value on the day of the information event have a relatively significant increase and the decline began on the first trading day after the informational event. On the whole, however, the trading volume and transaction value in the 5 trading days before the occurrence of the carbon information event are smaller than that in the 5 trading days after the occurrence of the information event. In terms of price fluctuations, the overall fluctuation range of the bid-ask spread in the five trading days before the occurrence of the carbon information event is higher than that in the five trading days after the occurrence of the information event, which indicates that the fluctuation range of the bid-ask spread decreases after the occurrence of the information event. Also, the stock market value on the day and the second day of the carbon information event is higher than that on the 2 days before the information event. This shows that carbon information disclosure affects the stock trading volume and transaction amount on the day of information disclosure and 5 trading days before and after, making stock prices and stock market values fluctuate in a short period, triggering the stock market’s response to the information. The overall trend of the stock market’s short-term response to carbon information disclosure is that carbon information disclosure promotes an increase in trading volume and stock market
value on the day of the information event and 5 trading days after that, which is conducive to short-term corporate value creation, but the increase in stock market value is small.

The disclosure of carbon information increases the short-term income of investors, thereby affecting the creation of short-term corporate value. In the empirical analysis, it is found that within the first 5 trading days of the information event, the normal return rate of the stock shows a gradual upward trend, reaching the maximum value on the day the information event occurs, and the return rate on the day after the information event occurs. On the other hand, the normal rate of return 5 trading days after the occurrence of the information is higher than the 5 trading days before the occurrence of the information event. In the first 3 days of the information event, the average abnormal rate of return began to rise. After the information event occurred, the average abnormal rate of return began to decline. It can be seen that the average abnormal rate of return showed a trend of rising first and then falling during the window period of the information event. It shows that the occurrence of information events leads to changes in the abnormal returns of investors. The average cumulative abnormal rate of return is consistent with the trend of the average abnormal rate of return, which shows that carbon information disclosure increases the amount of information for investors, makes investors’ decision-making more scientific and reasonable, and is conducive to investors to obtain additional returns in the short term. The empirical analysis of the impact of comprehensive carbon information disclosure on short-term stock market performance and investor returns found that the stock trading volume, trading volume, and stock market value on the day of the information event increased to a certain extent, and the stock price fluctuation range decreased. The five trading days’ overall market liquidity and trading activity were higher than those of the previous five, effectively triggering the stock market’s market response to carbon information disclosure. At the same time, due to the improvement of market liquidity and activity caused by information events, investors can obtain more abnormal returns among short-term investors. The above research conclusions generally show that carbon information disclosure will positively impact short-term corporate value creation.

Data Availability

The dataset can be obtained from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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References


