# The impact of the "dual carbon" target on China's coal industry stock prices--Analysis based on the dual event study method

Xinru Feng[1,*], Kaili Zhang[1] and Ran Yi[1]

School of Economics and Management, Nanjing University of Science and Technology, Nanjing, China

* Corresponding Author Email: fengxinru@njust.edu.cn

**Abstract.** The proposal and implementation of the "dual carbon" target has a profound impact on the stock price of China's coal industry. 75 coal enterprises are selected as research objects, and based on the daily closing price data of each stock from 2020 to 2023, the coal industry stock index is constructed by using the Rathbair index method. The dual-event research method is used to empirically test the impact of the proposal and implementation of the "dual-carbon" target on the stock price of China's coal industry, and the transmission path and heterogeneity are analyzed. The results show that: (1) the proposal of the "dual carbon" target has no significant impact on the stock price of the coal industry, while the implementation of the "dual carbon" target policy has a significant negative impact on the stock price of the coal industry; (2) The implementation of the "dual carbon" target has a negative impact on both state-owned shares and non-state-owned shares, but state-owned shares are more obvious. (3) The implementation of the "double carbon" target has a greater impact on the GEM and is uncertain, and has a negative impact on the main board and the original small and medium-sized board. (4) The implementation of the "dual carbon" target has a negative impact on stock prices in different regions, and the fluctuation range is ranked as follows: central region > Western region > Eastern region > Northeast region. (5) The implementation of the "double carbon" target has a negative impact on both directly and indirectly participating enterprises, and the negative fluctuation of directly participating enterprises is more severe. Based on this, this paper puts forward suggestions from four aspects: the government, regulators, coal industry enterprises and investors, in order to jointly promote the implementation of the "dual carbon" goal and the transformation and upgrading of the coal industry.

**Keywords:** "dual-carbon" target, coal industry, stock price, dual event study method, heterogeneity analysis.

## 1. Introduction

As the problem of global climate change becomes more and more serious, the international community is generally concerned about how countries can achieve peak carbon and carbon neutrality, the so-called "dual-carbon" targets. On September 22, 2020, Chinese President Xi Jinping announced the "dual-carbon" goal at the 75th UN General Assembly, stating that China will strive to achieve carbon peak by 2030 and carbon neutrality by 2060.On October 26, 2021, two programmatic documents for the “dual-carbon” goal, “Opinions of the Central Committee of the Communist Party of China and the State Council on the Complete and Accurate Implementation of the New Development Idea and Doing a Good Job of Peak Carbon Neutrality” and “Peak Carbon Action Plan by 2030” were issued, further clarifying the concrete path of action for this policy.

As China is the world's largest coal consumer, these policies have had a profound impact on the coal industry and its stock market. However, there is still limited research on how these events affect the stock price of the coal industry. Therefore, the purpose of this paper is to explore the impact of two important events, President Xi Jinping's announcement of the "dual-carbon" target and the release of the "dual-carbon" policy, on the stock price of the coal industry through the event study method. This paper selects 75 listed companies in the coal industry in Shanghai and Shenzhen from January 2, 2020 to December 29, 2023 as the research samples, and chooses the "dual-carbon" target as the exogenous shock, and adopts the event study method to observe the stock prices of listed companies in the coal industry before and after the implementation of the "dual-carbon" target, by which we

explore the impact of the "dual-carbon" target on the stock price of the coal industry and analyze the impact based on the heterogeneity of the enterprises.

The innovation of this study is that it is the first time to quantify the impact of the "double carbon" target on the coal industry from the perspective of macro policy, combined with company-specific stock price data. At the same time, the existing studies have vaguely defined the overall situation of the market share price of the coal industry, so this paper constructs a coal market index based on 75 companies in the coal industry today. In addition, a two-event approach is adopted to further explore the impact of the "dual carbon" target on the share price of the coal industry in the long run, and its heterogeneous impacts on the four aspects of shareholding scope, listed sector, enterprise's location, and enterprise's business scope.

Under the background of "dual-carbon", the coal industry as the first industry, the disclosure of "dual-carbon" related information will certainly affect the fluctuation of the industry's stock price and the future development trend. This study is of practical significance for coal enterprises to realize their corporate value with the help of "dual-carbon" strategy, and it is also of reference significance for investors to improve their investment income by using "dual-carbon" and other information. This study can not only improve people's understanding of the impact of China's "dual-carbon" policy on the coal industry, but also provide useful decision-making references for policy makers, investors, and company management; at the same time, this study can also help to promote the cross-study of environmental economics and financial economics, and provide inspiration and a foundation for future related research.

## 2. Literature review

### 2.1. Studies on the economic consequences of the "dual carbon" target

#### 2.1.1. Economic impact study of the "dual carbon" target

In terms of the macroeconomic impact of the "dual carbon" target, Xiao Zushin et al. (2023) portrayed the dynamic process of atmospheric carbon stock accumulation and the negative externality of carbon emissions on corporate production and household utility in a dynamic stochastic general equilibrium framework, and pointed out that the steady-state values of the macroeconomic variables deviated negatively after the implementation of the carbon emission reduction measures, and that the reduction of environmental negative externalities could improve the overall economic welfare[1] . Bian Chen et al. (2024) constructed an NK-DSGE model including environmental systems, and discussed the impacts of carbon tax rate changes, carbon tax rule changes on the effects of joint policies and the loss of social welfare [2] .

In terms of the impact of the "dual-carbon" goal on the transformation of energy structure, Zhu Yi (2024) based on the three-dimensional analytical framework of "policy tools-policy participant-policy goal", and finally obtained six paths for realizing the "dual-carbon" goal in the field of energy by coding and analyzing and summarizing. Under different paths, the focus and combination of policy instruments, policy participants and policy objectives differed [3] . Sun Xiangyu (2023) used the mediation effect model and technological innovation as the mediator variable, and concluded that industrial restructuring under the "dual-carbon" goal would inhibit the carbon emissions of each region, and the population size would increase the carbon emissions of each region [4] .

In terms of the potential impact of the "dual carbon" goal on investment and financial markets, Qi Linhai (2023) suggests that there are impediments to the development of China's carbon financial market, such as the lack of innovation in carbon financial products and services, low market liquidity, low and volatile carbon prices, and lack of regulatory oversight. The overall low degree of financialization of the carbon market has a negative impact on the formation of effective carbon price signals [5]

### 2.1.2. Sectoral impact study of the "dual carbon" target

The "dual-carbon" goal mainly has a direct impact on the fossil energy industry. XiaoY et al. (2019) proposed the concept and technical framework of "multi-energy integration", which realizes the complementary integration of multiple energy sources through technological innovation [6]. CaiR et al. (2022) Based on the concept of multi-energy fusion, a multi-energy fusion technology system is proposed with four main lines: clean and efficient utilization of fossil energy and coupled substitution, multi-energy complementary application of non-fossil energy and scale application of industrial low-carbon and zero-carbon process reengineering, and digital and intelligent integration and optimization [7].

The "dual-carbon" goal also brings development opportunities for the renewable energy industry. Li Shuangcheng et al. (2024) argued that the development of renewable energy and ecological protection can be achieved through scientific and technological progress, rational planning and management [8] . Jin Zhijun and Zhang Chuan (2024) argue that achieving carbon neutrality is crucial for the transition from traditional fossil energy sources to renewable energy sources [9] .

### 2.1.3. Regional impact study of the "dual carbon" target

The "dual-carbon" goal has a differential impact on the economic development of different regions. Liu Jia et al. (2023) argued that enhancing the regional competitiveness of Northeast China is conducive to boosting the regional economic transformation and promoting the industrial transformation and upgrading of Northeast China [10] . Zhang Jianping (2021) believes that we should vigorously cultivate and develop new industries, strive to optimize the business environment, enhance the competitive advantages of the manufacturing industry in the Northeast, release the development potential, and promote the comprehensive revitalization and high-quality development of the Northeast region [11] .

Under the goal of "double carbon", resource cities and heavy industrial bases are also facing challenges and transformation pressure. Based on the spatial progressive double-difference model, Deng Shicheng and Wu Yuming (2024) examined the impact of low-carbon city construction on green technology innovation in resource cities and its spatial and temporal heterogeneity from the perspective of spatial spillover, and combined with the mediating effect model to reveal the mechanism of low-carbon city construction affecting green technology innovation in resource cities [12]. Luo Xing et al. (2024) put forward the following policy recommendations: first, the government must fully understand and pay attention to the catalytic role of the digital economy in the low-carbon transformation of resource cities; second, give full play to the resource allocation effect and labor production effect of the digital economy in promoting the low-carbon transformation of resource cities; third, formulate differentiated strategies for the development of the digital economy and measures for the low-carbon transformation according to the developmental characteristics and conditions of resource cities[13] .

## 2.2. Analysis of factors influencing the stock prices of coal industry

### 2.2.1. Macro factors influencing the stock prices of coal industry

The global economic situation has an impact on the share price of the coal industry. He Yao (2018) selected the China Coal Price Index (CCPI) national composite index (hereinafter referred to as coal price) released by China Coal Industry Association as the research object, and selected interest rate, exchange rate, new energy price index, international crude oil futures price, iron and steel industry stock price index, chemical industry stock price index, electric power industry stock price index, cement manufacturing industry stock price index, and money supply as the financial factors affecting coal price in the three aspects of supply, demand, and substitution [14] .

There is also a macro effect of international energy market volatility on the share price of the coal industry. SDBekiros, CGHDiks (2007) analyzed the long-run relationship and linear causality between WTI and NYMEX through the VECM model, and the nonlinear causality between oil spot prices and oil futures prices through the GARCH-BEKK model [15] . RDemirer, AMKutan (2010)

analyzed the informational efficiency between crude oil futures as well as crude oil spot prices after the release of SPR announcements and PEC meetings through a time study approach [16] .

### 2.2.2. Meso factors influencing the stock prices of coal industry

Supply and demand, excess or shortage of production capacity in the coal industry have an impact on its share price. Yuan Guiqiu and Zhang Lingdan (2009) in "Analysis of the Influencing Factors of Coal Prices in China" argue that the development of coal prices and international oil prices are largely convergent, and that the demand of downstream enterprises and the gross domestic product affect coal prices [17] . Cui Wei and Wen Xiaolong (2011) categorized the influencing factors of coal price into supply factors, demand factors, and comprehensive influencing factors of supply and demand, and mainly analyzed the two aspects of supply and demand [18] .

Technological innovation and alternative energy development also have a potential impact on the share price of the coal industry. Wang Di (2013) and other research results show that coal demand factors and coal supply factors present asymmetric effects on coal price fluctuations, while coal supply factors have a weaker impact on domestic coal prices compared to other factors, and coal demand in major coal-consuming industries has a significant role in guiding domestic coal price fluctuations, while the guiding role of coal supply is not significant [19] . Lei Qiang (2014) analyzed the relationship between coal prices in the Asia-Pacific region and domestic coal prices in the Study on the Relationship between Coal Production and Consumption and Economic Growth in China. The results proved that there is a long-term equilibrium relationship between the two and they are causal to each other, and the spot price of Australian BJ power coal is an important factor influencing the domestic coal price [20] .

### 2.2.3. Micro factors influencing the stock prices of coal industry

The internal management, cost control, and profitability of coal enterprises have an impact on the stock price. Duan Yun (2024) briefly explains the importance of strengthening the enterprise's own management in the new economic environment, and analyzes the problems existing in the management process of coal enterprises, and puts forward effective solution strategies and optimization paths for relevant personnel to learn from [21] . Lina Yuan (2024) believes that in order to do a good job in the transformation of financial management under the background of big data, enterprises should not only grasp the key points of transformation, clear direction of transformation, and do a good job in transformation planning, but also need to comprehensively analyze the current financial management deficiencies, combined with the deficiencies to develop specific transformation measures [22] .

There is an impact of financial health and debt level of coal companies on their stock prices. Lili Xu (2011) used statistical regression method to derive the micro-factors affecting the capital structure of coal enterprises and the dynamic capital structure model [23] . You Xiang (2024) suggested that there are significant financial risks in current coal enterprises, which affect the sustainable development of enterprises and hinder the realization of the dual-carbon goal [24] .

The environmental and social responsibility performance of coal companies also has a potential impact on stock prices. Zhang Yu and Wang Shijin (2021) concluded that there is a positive and positive impact relationship between environmental responsibility and financial performance of listed coal companies in China. And the positive relationship between the two is more obvious in the long run[25] . Wu Qiang (2018) used literature reading method, content analysis method and empirical research method, and chose the results of factor analysis of 12 financial indicators to measure financial performance, and the results of the study showed that the environmental responsibility of coal enterprises and financial performance showed a positive correlation [26] .

# 3. Theoretical analysis and research hypothesis

## 3.1. The impact mechanism of "dual carbon" targrt on coal industry stock prices

This paper analyzes the impact of the "dual carbon" goal on coal industry stock prices from the perspectives of signal transmission theory, information asymmetry theory, sustainable development theory, and energy transition theory, based on the two dimensions of signal transmission and financing channels. The basic impact mechanism is shown in Fig. 1.

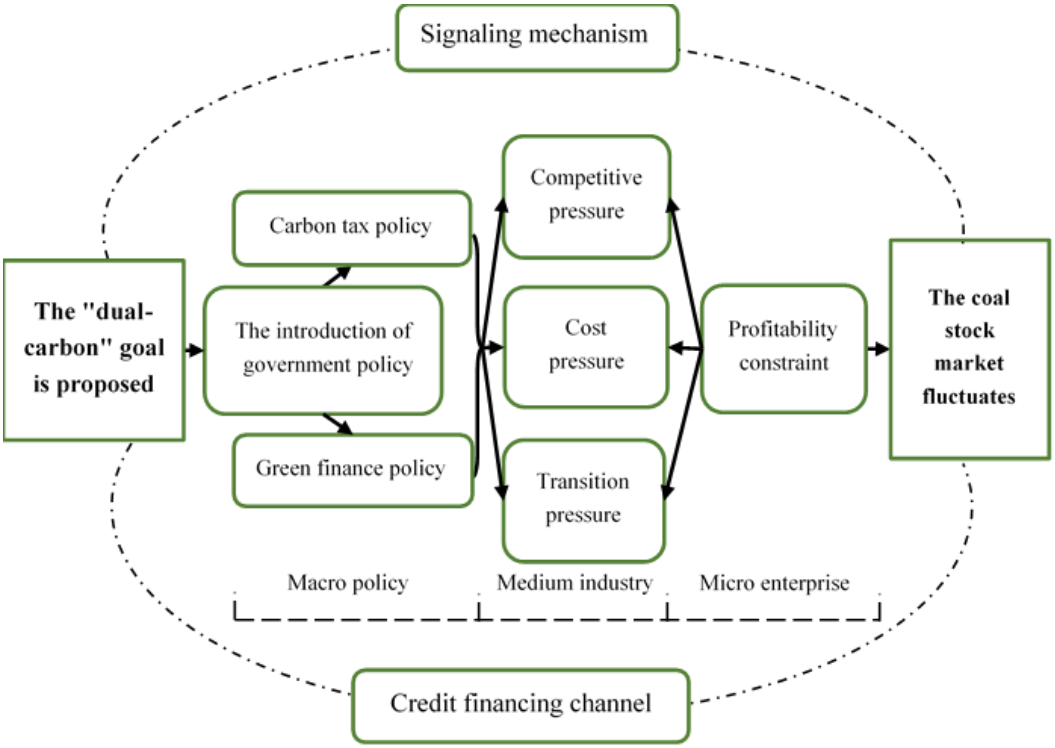


**Fig. 1** The impact mechanism of "dual carbon" target on the stock price of coal industry

### 3.1.1. Signaling mechanism

The implementation of the "dual carbon" target means that the coal industry will face greater competition, cost, transformation and other aspects of pressure, which will release a negative signal to the capital market, which will affect the volatility of the coal industry stock price.

After the implementation of the "double carbon" goal, the government has guided resources from the traditional energy industry with high emissions and high energy consumption to the new energy industry with low carbon and environmental protection through a series of policy means, such as the collection of carbon taxes and the promotion of green finance policies. This policy-oriented signal conveys to the market that the new energy industry will gain more development opportunities, while the coal industry may gradually lose its market advantage. Investors therefore expect that coal companies will face greater competition and cost pressure in the future, and profitability may further decline, which leads to a decline in investor confidence in the coal industry, which will have a negative impact on stock prices.

The "dual carbon" target clearly points out the direction of reducing carbon emissions and promoting the transformation of energy structure, while the high pollution and high energy consumption characteristics of traditional coal mining and burning methods make coal enterprises face great pressure for transformation. Coal enterprises need to invest more funds in the construction of environmental protection facilities, technological transformation and clean energy development, etc. These investments will increase the operating costs of enterprises, and then affect the profitability of enterprises. This transition pressure signal conveyed to the market that investment in these coal enterprises will face greater risks, and investors' worries spread in the market, resulting in the suppression of the stock prices of coal enterprises.

### 3.1.2. Credit financing channel

The proposal of the "double carbon" target has promoted the development of green finance and sustainable investment, and financial institutions and investors have begun to pay more attention to the environmental performance and social responsibility of enterprises. Moody's (2023) points out that the green finance policy guides banks to provide financial support such as taxation, asset rediscount and asset-backed securities issuance facilitation to green enterprises in the new energy industry when allocating credit resources [27] , while strengthening credit examination for enterprises in the coal industry, restricting loan support or imposing punitive interest rates for projects with high pollution and high energy consumption. The rising financing costs of the coal industry have further increased the operating pressure of coal enterprises and reduced their profitability, which has a negative impact on stock prices.

Based on the above theoretical analysis, hypothesis 1 is proposed:

H1: The implementation of the "dual carbon" target has had a negative impact on coal industry stock prices.

## 3.2. The firm heterogeneity of the effect of "dual-carbon" target

### 3.2.1. Property right heterogeneity

According to the property rights of enterprises, enterprises can be divided into state-owned and non-state-owned enterprises. The nature of property rights of state-owned enterprises determines that while obtaining policy support in the operation process, state-owned enterprises also need to bear more environmental protection and social responsibilities, and will be concerned by investors and regulators, while non-state-owned enterprises focus on financial performance indicators and less consider environmental protection. Therefore, it is of practical significance to further study the extent to which enterprises with different property rights are affected by the "dual carbon" target. Ning Jinhui et al. (2021) found that the introduction of green credit policy makes the market more strict to the implementation of environmental and social responsibilities of state-owned enterprises, and the policy has a stronger punishment effect on state-owned enterprises, especially state-owned heavy polluter enterprises[28] , while non-state-owned enterprises have more difficulty in obtaining bank credit support than state-owned enterprises before the implementation of the policy. Deliver a positive signal to market investors for non-state-owned green enterprises, so the stock price of non-state-owned enterprises is less volatile.

Based on the above theoretical analysis, hypothesis 2 is proposed:

H2: The impact of the "dual carbon" target on the stock price of state-owned coal enterprises is significantly higher than that of non-state-owned enterprises.

### 3.2.2. Listing sector heterogeneity

The listed sectors of China's capital market are mainly divided into main board (Shanghai and Shenzhen), small and medium-sized board, GEM and science and technology board. Companies in different listed sectors, due to differences in regulatory environment, investor structure, corporate characteristics and other aspects, may have different reactions to the "dual carbon" target, thus showing heterogeneity in stock prices. Therefore, it is an important perspective to analyze the heterogeneity of companies according to their listed sectors. Coal companies listed on the main board are usually large, profitable and mostly enterprises, which may be subject to more policy attention and regulatory pressure, so the negative impact of the "dual carbon" target on the stock price of these companies may be larger. Compared with the main board companies, small and medium-sized board listed coal companies are smaller, but the growth potential is larger, these companies may be more flexible, can adapt to market changes more quickly, therefore, the stock price of these companies under the negative impact of the "dual carbon" target may return to normal levels more quickly. Gem, science and technology board listed coal companies are mostly innovative, high-growth enterprises, these companies may pay more attention to technological innovation and research and development investment, in response to the "dual carbon" goal brought challenges, therefore, "dual carbon"

negative impact may accelerate these enterprises to green technology transformation, so as to release a positive signal to the market, so as to the stock market a positive impact.

Based on the above theoretical analysis, hypothesis 3 is proposed:

H3: The "dual carbon" target has a negative impact on the stock price of the main board and small and medium-sized board enterprises and a greater impact on the main board enterprises, while the impact on the stock price of the GEM and science and technology board enterprises is positive.

### 3.2.3. Regional heterogeneity

Because the distribution of coal resources has regional differences, this paper divides the regions of enterprises into northeast, eastern, western and central regions. The northeast and western regions are rich in coal resources, but the economy is relatively backward, the energy structure is relatively simple, and the green transformation is more difficult. Therefore, when the listed companies in these regions face the negative impact of the "dual carbon" goal, their stock prices will fluctuate more sharply. With the promotion of the "dual carbon" goal, the eastern region may pay more attention to the use of clean energy and reduce the dependence on traditional coal energy. At the same time, due to the relative lack of coal resources in the eastern region, the proportion of the coal industry in the region is relatively small, so the negative impact of the "dual carbon" goal on stock prices may be relatively limited. As a "big coal province", Shanxi is located in the central region, with relatively rich coal resources, moderate geographical location and convenient transportation. However, due to the relatively backward economic level of the central region compared with the eastern region, enterprises in these regions are facing greater financial pressure in the process of green transformation, so the negative impact of the "dual carbon" goal on the region is also large.

Based on the above theoretical analysis, hypothesis 4 is proposed:

H4: The "dual carbon" target has a large negative impact on the stock prices of enterprises in the northeast, western and central regions, while the negative impact on the stock prices of enterprises in the eastern region is small.

### 3.2.4. Business scope heterogeneity

According to the correlation between the company's main business and coal, listed companies can be divided into two categories: one is directly engaged in coal-related main business enterprises, the main business of such enterprises is directly related to coal mining, processing, sales and other links, and their core business is centered on coal resources, so the implementation of the "double carbon" target will directly affect the daily business of enterprises. Affect the profitability of enterprises, and then lead to sharp fluctuations in corporate stock prices. The other is the upstream and downstream enterprises of the coal industry chain, such as power companies mainly burn coal to generate electricity, building materials companies in the production process of some building materials products (such as cement, glass, etc.) need to use coal or its derivatives as fuel or raw materials, etc. The operation of these companies is closely related to coal supply, but because these enterprises in the coal supply is insufficient, Alternative energy sources can be found, so the implementation of the "dual carbon" target has less impact on the share price of such listed companies.

Based on the above theoretical analysis, hypothesis 5 is proposed:

H5: The "dual carbon" target has a greater impact on the stock prices of enterprises directly engaged in coal-related main business, while the impact on the stock prices of upstream and downstream enterprises in the coal industry chain is less.

## 4. Research design

### 4.1. Sample selection and data source

In this paper, listed companies in the coal industry in Shanghai and Shenzhen from January 2, 2020 to December 29, 2023 are selected as the initial research samples. Based on the impact of the sample data on the empirical results of the paper, the obtained data are processed as follows: (1) The

listed companies with missing or abnormal relevant variables are excluded; (2) This paper studies the impact of the "dual carbon" target on the stock price of the coal industry, so companies listed after 2020 are excluded. Finally, this paper selects 75 listed companies, with a total of 12825 samples. The data came from Resset, Wind and CSMAR databases, and all the data processing and empirical studies involved were done through Excel, Eviews and Stata.

### 4.2. Construction of coal industry index

#### 4.2.1. Construction method

Since there is no unified standard coal industry stock price index in the market, and the existing coal industry stock price index is not clear enough in the definition of the constituent stocks, the coverage is not broad enough, therefore, this paper will mainly focus on the coal industry listed companies in the market to build a coal industry market index. In order to reflect the changes in the stock price of a certain industry in different periods, this paper mainly adopts the Lasbair index proposed by Italian statistician Rathbair to measure the changes in the stock price index of the coal industry before and after the "dual carbon" goal is proposed. The specific calculation formula is as follows:

$$\text{Weighted stock price index} = \frac{\sum P_1 Q_0}{\sum P_0 Q_0} \times 100$$

$P_0$ represents the stock price of the base period, $P_1$ represents the stock price of the reporting period, and $Q_0$ represents the total share capital of the base period.

#### 4.2.2. Construction process

This paper mainly studies the impact of "dual carbon" target on the coal industry stock price, so the construction of coal industry stock price index has a certain significance for the development of research. This paper sets the base period of the index as January 2, 2020, and selects 75 coal industry stocks after data cleaning. At the same time, the average closing price of each stock on each trading day is the basic data, the total share capital of each stock in the base period is the weight, and the base period points of the stock price index are 100 points. Through data processing and the application of the Lasbair index formula, This paper obtains the relevant data of the coal industry stock price index during the period from January 2, 2020 to December 29, 2023, and the trend changes are shown in Fig. 2

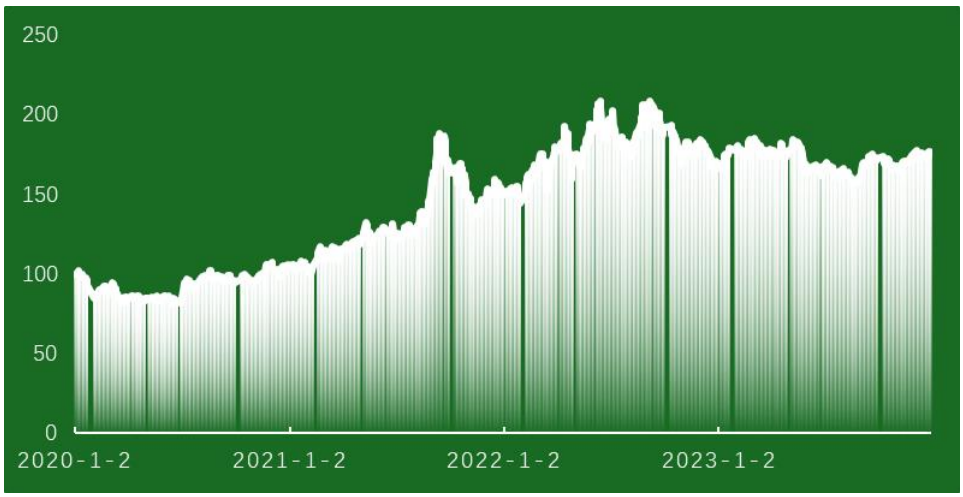


**Fig. 2** Time trend chart of coal industry stock price index

### 4.3. Event model design

In empirical research, the event study method is often used to analyze the short-term impact of a specific event on the volatility of the securities market, and the excess return and cumulative excess return are usually used to test the market response. Therefore, this paper selects the "dual carbon" target as exogenous impact, adopts the event study method, and discusses the impact of "dual carbon"

target on the coal industry stock price by observing the stock price changes of listed companies before and after the implementation of "dual carbon" target, and analyzes the impact of "dual carbon" target on the coal industry stock price based on the heterogeneity of enterprises.

### 4.3.1. Identify the event studied

This paper considers that the proposal of the "dual carbon" target and the implementation of the "dual carbon" policy will have different impacts on stock prices, so two event dates are finally selected. The first event day is the day that the "dual carbon" goal is proposed at the United Nations General Assembly, that is, September 22, 2020. Since October 24, 2021, the day of the promulgation of the "Opinions" policy, is the stock market holiday, and October 26, 2021, the day of the promulgation of the "Plan" policy, is the normal trading day of the stock market, Therefore, October 26, 2021 will be the second event day.

### 4.3.2. Definite event period

Determine the time period of the stock price change caused by the event, including the prior estimate window and the event window. Based on the event date identified above, set the disclosed event date as T=0, T=-1 for the day before the event, and T=1 for the day after the event. The purpose of the estimation window is to estimate the expected return rate of the stock in the event that a specific event does not occur by using the data of the period. It is generally recommended to select a long period before the event occurs, which cannot be overlapped with the event window. Therefore, this paper selects 150 trading days before the event to 11 trading days before the event as the event estimation period, expressed by [-150,-11]. Event window is the key period for analyzing the impact of a specific event on stock price. In order to eliminate the interference of other events in the same period as much as possible, the coverage time of the window period should be as short as possible. In this paper, 10 trading days before the event occurred to 20 trading days after the event occurred were selected as the event window, represented by [-10,20]. The final selected event day, event window period, and estimated window period are shown in Fig. 3

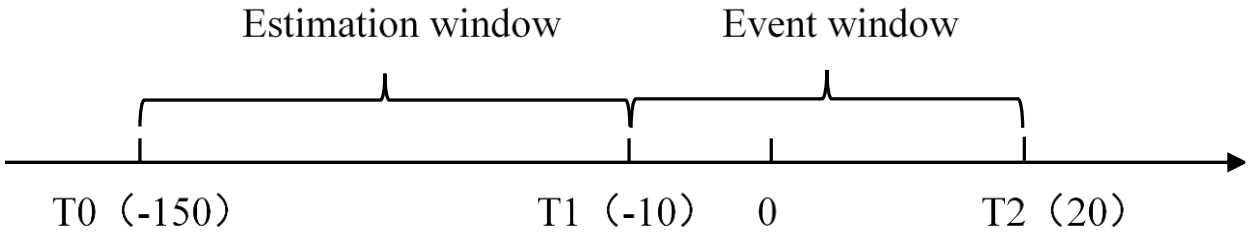


**Fig. 3** Determination of event window and estimation window

### 4.3.3. Calculate normal rate of return

The calculation of normal rate of return of stock assets mainly includes market index adjustment method, market model method and average adjustment method. The theory of market model is clear and easy to understand and widely used, so this paper will choose market model to calculate normal rate of return. Firstly, formula (1) is used to estimate parameters $\alpha_i$ and $\beta_i$ in the market model by using the actual rate of return $R_{it}$ of the sample companies and the corresponding market sector rate of return $R_{mt}$. Secondly, formula (2) is used to predict the normal rate of return $ER_{it}$ of the sample companies in the event window. The calculation formula is as follows:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \quad (1)$$

$$ER_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \quad (2)$$

Where, $R_{it}$ represents the real return rate of stock i in period t, and $R_{mt}$ represents the real return rate of market portfolio M in period t during the estimated period, which is represented by the return rate of CSI 300 index in this paper. $\alpha_i$ and $\beta_i$ are estimated using the least squares method, and $\varepsilon_{it}$ represents the regression residual.

### 4.3.4. Calculate the excess return and cumulative excess return

The excess rate of return (AR) is the difference between the actual rate of return and the normal rate of return in the event window. The cumulative excess rate of return (CAR) is the sum of the excess rate of return of a stock in the event window. The calculation formula is as follows:

$$AR_{it} = R_{it} - ER_{it} \tag{3}$$

$$CAR_i = \sum_{t=-10}^{20} AR_{it} \tag{4}$$

Where, $AR_{it}$ is the excess return of stock i on day t, and $CAR_i$ is the cumulative excess return of stock i in the event window [-10,20].

### 4.3.5. Calculate the average and cumulative average excess return

Since there are many uncertainties in the estimation process of each company, no valid conclusions can be drawn by looking at the excess return alone. In order to reduce the interference of accidental events on the excess return of individual stocks, we adopt the method of averaging the excess return of all samples, so as to reduce the impact of these factors on stock returns, and then obtain the average excess return (AAR). The cumulative average excess return (CAAR) is the average of the cumulative excess return, which reflects the average impact of an event on a sample of all firms. The calculation formula is as follows:

$$AAR_{[-10,20]} = \frac{1}{n}\sum_{i=1}^{n} AR_{it} \tag{5}$$

$$CAAR_{[-10,20]} = \frac{1}{n}\sum_{i=1}^{n} CAR_{it} \tag{6}$$

Where, n is the number of sample stocks, $AAR_{[-10,20]}$ is the average excess return of sample stocks within the event window [-10,20], and $CAAR_{[-10,20]}$ is the cumulative average excess return of sample stocks within the event window [-10,20].

The empirical research in this paper is divided into two parts. In the process of exploring the impact of "dual carbon" target on the stock price of coal industry, AR and CAR are used; In the process of exploring enterprise heterogeneity, AAR and CAAR are adopted.

### 4.3.6. Significance test statistic

For abnormal returns, J1 statistic is usually adopted to test the significance of excess returns, as shown in formula (7). For cumulative abnormal returns, J2 statistics or t statistics are usually used to test the significance of cumulative excess return, as shown in formulas (8) and (9). The null hypothesis is set: "double carbon" target has no impact on stock return, that is, the excess return (or cumulative excess return) is 0.

$$\mathrm{J}_1 = \left(\frac{\mathrm{N(L-2)}}{L-4}\right)^{\frac{1}{2}} \frac{1}{n}\sum_{i=1}^{n} AR_{it} \sim N(0,1) \tag{7}$$

$$\mathrm{J}_2 = \frac{\overline{CAR(t_1,t_2)}}{\sqrt{t_2-t_1+1}} \left(\frac{\mathrm{N(L-2)}}{L-4}\right)^{\frac{1}{2}} \sim N(0,1) \tag{8}$$

$$\mathrm{t}_{CAR} = \frac{CAR_{[-10,20]}}{\frac{S_{CAR_{[-10,20]}}}{\sqrt{n}}} \tag{9}$$

Where $S_{CAR_{[-10,20]}}$ represents the standard deviation of the cumulative excess return within the event window [-10,20]. If the test results are significant, it indicates that the implementation of the "dual carbon" target has a significant impact on stock returns; On the contrary, it shows that the implementation of the "dual carbon" target has not caused a significant deviation in stock prices.

# 5. Empirical results and analyses

## 5.1. Impact of the "dual carbon" target on coal industry share prices

### 5.1.1. Trend detection and initial guesses

Prior to the regression using the market model, the constructed coal industry share price index was initially tested for trend against the CSI 300 index, and the results are shown in Fig. 4 and Fig. 5. It can be seen that the trends of the two are highly close to each other during the event 1 window period, while the coal industry share price index has significant fluctuations relative to the CSI 300 index during the event 2 window period. Based on the event study method used in this paper, the market model constructed by regressing the coal industry stock price index on the CSI 300 index is used to estimate the normal rate of return, and then the difference between the actual rate of return and the normal rate of return estimated by the model is used to calculate the excess rate of return, and then judge whether the event has an impact on the stock price of the coal industry. And as can be seen from the figure, event 1 coal industry stock price index has roughly the same trend with CSI 300 index, which can be explained by more part of the prediction, and the probability of significant abnormal return is smaller; event 2 coal industry stock price index has greater fluctuation relative to CSI 300 index, and the probability of significant abnormal return is higher.

Therefore, the preliminary guess is that event 1, i.e. the proposal of "dual carbon" target has no significant impact on the share price of the coal industry, while event 2, i.e. the policy implementation of "dual carbon" target has a significant impact on the share price of the coal industry.

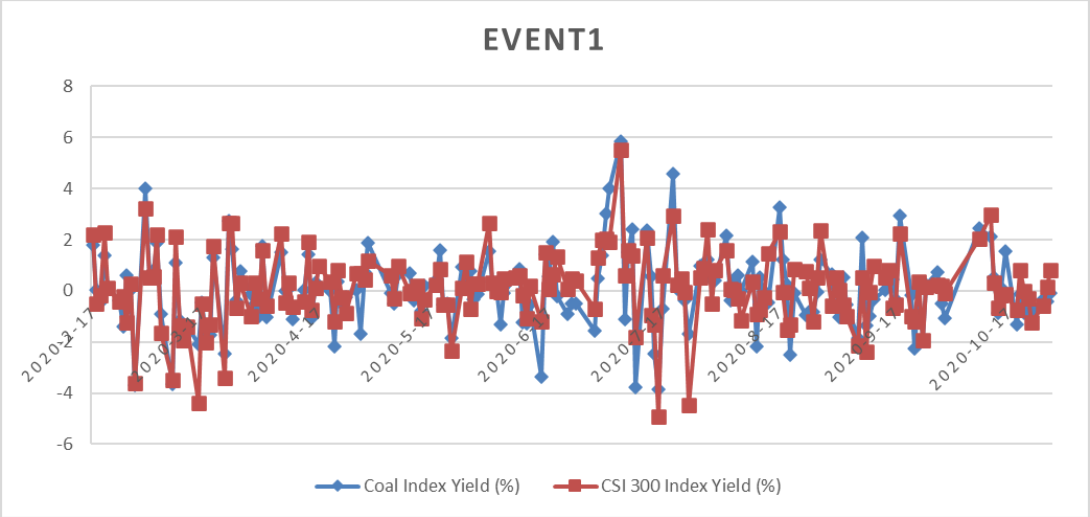


**Fig. 4** Event 1 coal industry stock price index vs. CSI 300 index trend detection

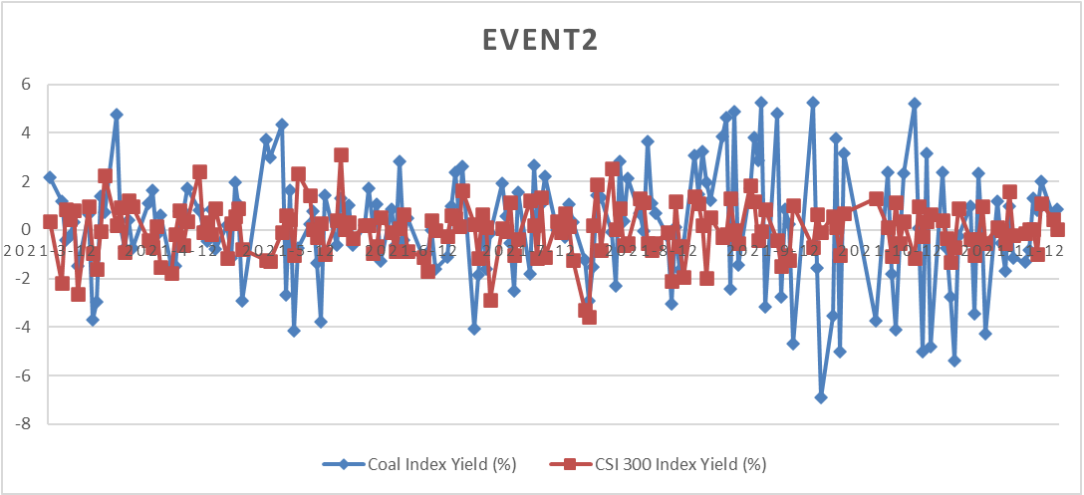


**Fig. 5** Event 2 coal industry stock price index vs. CSI 300 index trend detection

### 5.1.2. Estimation of abnormal rate of return

The market model for the estimation window is regressed through Eviews software to obtain the regression coefficients, and then the calculation of abnormal returns is carried out in the event window, i.e., the actual return of each company is used ($R_{it}$ ) minus the expected return of each company ($ER_{it}$ ), thus obtaining the abnormal return ($r_0$ ), followed by the calculation of (AR) by averaging the cross-section of abnormal returns over the event window period for the abnormal return, and finally, the time series are summed sequentially to obtain the corresponding cumulative abnormal return (CAR), and the results are shown in Table 1.

**Table 1.** Average abnormal returns and cumulative abnormal returns for event 1 and event 2

| Event date | Event | AR | CAR | Event | AR | CAR |
|---|---|---|---|---|---|---|
| -10 | | 1.78% | 1.78% | | -1.60% | -1.60% |
| -9 | | 0.84% | 2.62% | | -4.63% | -6.23% |
| -8 | | -1.13% | 1.48% | | -0.70% | -6.93% |
| -7 | | -1.15% | 0.34% | | 1.86% | -5.07% |
| -6 | | -0.32% | 0.02% | | 5.10% | 0.03% |
| -5 | | -0.04% | -0.02% | | -0.43% | -0.40% |
| -4 | | 1.06% | 1.04% | | -5.07% | -5.47% |
| -3 | | 0.14% | 1.18% | | 2.70% | -2.77% |
| -2 | | 1.09% | 2.27% | | -5.13% | -7.90% |
| -1 | | 0.68% | 2.95% | | 2.01% | -5.89% |
| 0 | | -1.20% | 1.74% | | -0.87% | -6.76% |
| 1 | | -0.21% | 1.53% | | -2.43% | -9.18% |
| 2 | | -0.28% | 1.25% | | -5.39% | -14.58% |
| 3 | | 0.13% | 1.37% | | -0.72% | -15.30% |
| 4 | | 0.50% | 1.88% | | 0.75% | -14.55% |
| 5 | **Event 1** | -0.68% | 1.20% | **Event 2** | -3.60% | -18.15% |
| 6 | | -0.96% | 0.24% | | 1.94% | -16.21% |
| 7 | | 0.70% | 0.94% | | -1.06% | -17.27% |
| 8 | | -0.28% | 0.66% | | -4.44% | -21.71% |
| 9 | | 0.33% | 0.99% | | 0.86% | -20.85% |
| 10 | | -0.30% | 0.69% | | -0.57% | -21.42% |
| 11 | | 0.33% | 1.02% | | -1.70% | -23.12% |
| 12 | | 1.71% | 2.73% | | 0.42% | -22.70% |
| 13 | | -0.65% | 2.09% | | -1.34% | -24.04% |
| 14 | | -0.73% | 1.35% | | -1.56% | -25.60% |
| 15 | | -0.87% | 0.48% | | -1.23% | -26.83% |
| 16 | | 0.00% | 0.49% | | 1.03% | -25.79% |
| 17 | | 0.35% | 0.83% | | 0.71% | -25.08% |
| 18 | | 0.18% | 1.02% | | 1.38% | -23.71% |
| 19 | | -0.49% | 0.53% | | 0.20% | -23.51% |
| 20 | | -0.73% | -0.21% | | 0.46% | -23.05% |

As can be seen in Table 1, Event 1 has a final result of -0.21% cumulative abnormal return during the event window period [-10,20] time, but the cumulative abnormal return is positive for 10 days before and 19 days after the event. Event 2 has a final result of cumulative abnormal return of -23.05% during the event window period [-10,20] time and has a negative cumulative abnormal return for 30 of the 31 days of the event period.

In order to show more clearly the changes in the average abnormal return (AR) and cumulative abnormal return (CAR) of the coal industry stock prices during the event window between the introduction of the "dual-carbon" goal and the implementation of the "dual-carbon" goal, graphs are drawn to obtain the results in Fig. 6 and Fig. 7.

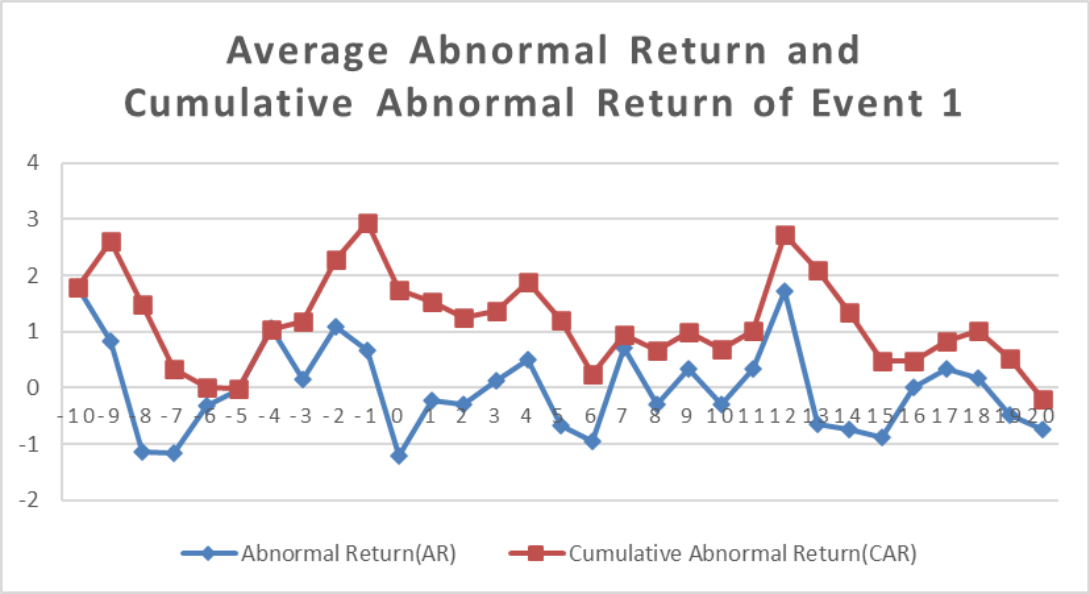


**Fig. 6** Event 1 average abnormal returns and cumulative abnormal returns

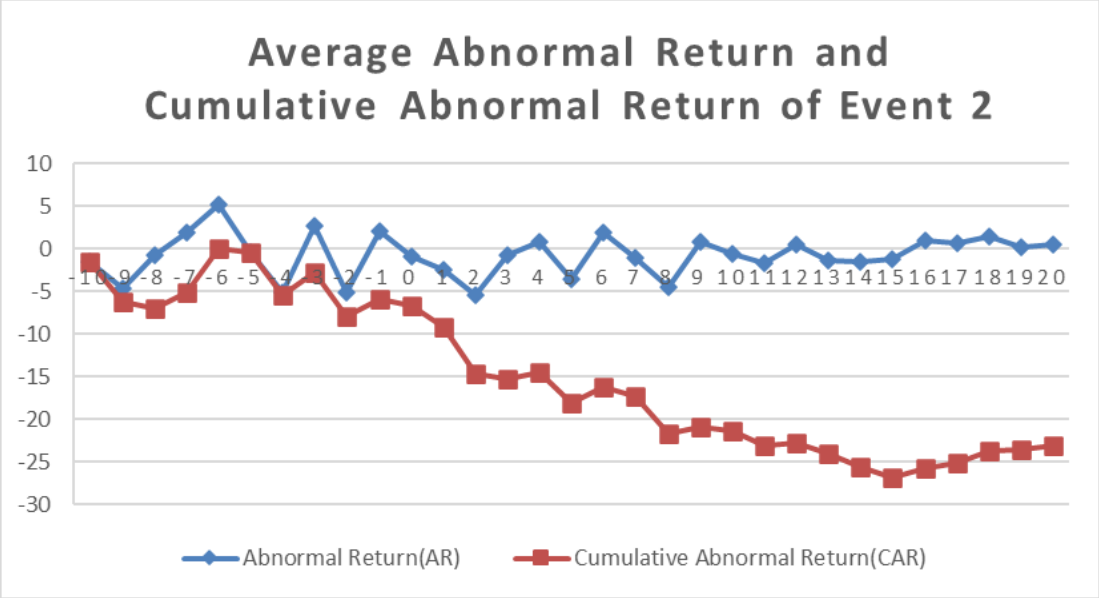


**Fig. 7** Event 2 average abnormal returns and cumulative abnormal returns

As can be seen from Fig. 6, the average abnormal return of event 1 fluctuates around 0, and the cumulative abnormal return is basically positive, which initially shows that the "dual carbon" target has a positive impact on the share price of the coal industry. From Fig. 7, we can see that the average abnormal volatility of event 2 also fluctuates around 0, and the cumulative abnormal return is basically negative, and it is initially seen that the implementation of the "dual-carbon" target has a negative impact on the share price of the coal industry, and the significance of which will be explained in the next section.

### 5.1.3. Test of significance

The significance of abnormal return and cumulative excess return in the event window is tested to determine whether the introduction of the "dual carbon" target and the implementation of the policy will have an impact on the share price of the coal industry by testing whether the abnormal return and the cumulative excess return in the event window are significantly unequal to zero. The significance test statistic for abnormal return is J1, and the significance test statistic for cumulative abnormal return is J2. If the J1,J2 statistic is greater than the critical value at the corresponding confidence level, and the conclusion is 1, the null hypothesis is rejected, i.e., the abnormal return is significantly not equal to 0. Conversely, if the conclusion is 0, then the null hypothesis is accepted, i.e., the abnormal return is 0. The results of the two events are shown in Tables 2 and 3.

**Table 2.** Significance test results for event 1 abnormal returns and cumulative abnormal returns

| Event date | J1 | p-value | Conclusion | J2 | p-value | Conclusion |
|---|---|---|---|---|---|---|
| -10 | 2.167676 | 0.984908 | 1 | 1.303672 | 0.903827 | 0 |
| -9 | 1.021355 | 0.846457 | 0 | 1.565983 | 0.941324 | 0 |
| -8 | -1.381408 | 0.083577 | 0 | 0.768718 | 0.778970 | 0 |
| -7 | -1.399365 | 0.080852 | 0 | 0.155288 | 0.561703 | 0 |
| -6 | -0.386215 | 0.349669 | 0 | 0.007654 | 0.503054 | 0 |
| -5 | -0.050040 | 0.480045 | 0 | -0.009000 | 0.496410 | 0 |
| -4 | 1.296033 | 0.902518 | 0 | 0.381308 | 0.648513 | 0 |
| -3 | 0.175522 | 0.569665 | 0 | 0.409262 | 0.658826 | 0 |
| -2 | 1.323040 | 0.907089 | 0 | 0.744106 | 0.771594 | 0 |
| -1 | 0.822522 | 0.794610 | 0 | 0.920408 | 0.821320 | 0 |
| 0 | -1.463138 | 0.071715 | 0 | 0.521985 | 0.699160 | 0 |
| 1 | -0.259440 | 0.397648 | 0 | 0.440307 | 0.670142 | 0 |
| 2 | -0.344774 | 0.365132 | 0 | 0.345918 | 0.635298 | 0 |
| 3 | 0.152837 | 0.560737 | 0 | 0.367753 | 0.643471 | 0 |
| 4 | 0.611267 | 0.729489 | 0 | 0.486050 | 0.686534 | 0 |
| 5 | -0.826503 | 0.204259 | 0 | 0.301044 | 0.618309 | 0 |
| 6 | -1.169033 | 0.121195 | 0 | 0.058204 | 0.523207 | 0 |
| 7 | 0.859014 | 0.804834 | 0 | 0.224267 | 0.588725 | 0 |
| 8 | -0.346912 | 0.364329 | 0 | 0.152611 | 0.560647 | 0 |
| 9 | 0.406382 | 0.657769 | 0 | 0.224358 | 0.588761 | 0 |
| 10 | -0.364966 | 0.357568 | 0 | 0.153019 | 0.560808 | 0 |
| 11 | 0.401366 | 0.655925 | 0 | 0.220837 | 0.587390 | 0 |
| 12 | 2.083360 | 0.981391 | 1 | 0.577886 | 0.718330 | 0 |
| 13 | -0.787401 | 0.215523 | 0 | 0.432269 | 0.667227 | 0 |
| 14 | -0.892472 | 0.186070 | 0 | 0.275008 | 0.608345 | 0 |
| 15 | -1.058546 | 0.144903 | 0 | 0.096600 | 0.538478 | 0 |
| 16 | 0.002024 | 0.500808 | 0 | 0.095185 | 0.537916 | 0 |
| 17 | 0.420871 | 0.663075 | 0 | 0.160001 | 0.563560 | 0 |
| 18 | 0.223888 | 0.588578 | 0 | 0.192078 | 0.576160 | 0 |
| 19 | -0.595841 | 0.275641 | 0 | 0.097935 | 0.539008 | 0 |
| 20 | -0.894607 | 0.185499 | 0 | -0.038115 | 0.484798 | 0 |

**Table 3.** Significance test results for event 2 abnormal returns and cumulative abnormal returns

| Event date | J1 | p-value | Conclusion | J2 | p-value | Conclusion |
|---|---|---|---|---|---|---|
| -10 | -0.736803 | 0.230621 | 0 | -1.173956 | 0.120206 | 0 |
| -9 | -2.129471 | 0.016608 | 1 | -3.728828 | 0.000096 | 1 |
| -8 | -0.320118 | 0.374439 | 0 | -3.589918 | 0.000165 | 1 |
| -7 | 0.853367 | 0.803272 | 0 | -2.350985 | 0.009362 | 1 |
| -6 | 2.347809 | 0.990558 | 1 | 0.013599 | 0.505425 | 0 |
| -5 | -0.197040 | 0.421898 | 0 | -0.155220 | 0.438324 | 0 |
| -4 | -2.334094 | 0.009795 | 1 | -2.004663 | 0.022500 | 1 |
| -3 | 1.244085 | 0.893266 | 0 | -0.955590 | 0.169640 | 0 |
| -2 | -2.360048 | 0.009136 | 1 | -2.588204 | 0.004824 | 1 |
| -1 | 0.924575 | 0.822407 | 0 | -1.839609 | 0.032913 | 0 |
| 0 | -0.400597 | 0.344359 | 0 | -2.021866 | 0.021595 | 1 |
| 1 | -1.115962 | 0.132219 | 0 | -2.639964 | 0.004146 | 1 |
| 2 | -2.479739 | 0.006574 | 1 | -4.037268 | 0.000027 | 1 |
| 3 | -0.333002 | 0.369566 | 0 | -4.094110 | 0.000021 | 1 |
| 4 | 0.343315 | 0.634319 | 0 | -3.770709 | 0.000081 | 1 |
| 5 | -1.654189 | 0.049045 | 0 | -4.562140 | 0.000003 | 1 |
| 6 | 0.892984 | 0.814067 | 0 | -3.959337 | 0.000038 | 1 |
| 7 | -0.489409 | 0.312276 | 0 | -4.106730 | 0.000020 | 1 |
| 8 | -2.042044 | 0.020574 | 1 | -5.031626 | 0.000000 | 1 |
| 9 | 0.395550 | 0.653782 | 0 | -4.715870 | 0.000001 | 1 |
| 10 | -0.260410 | 0.397274 | 0 | -4.732546 | 0.000001 | 1 |
| 11 | -0.782225 | 0.217041 | 0 | -4.996043 | 0.000000 | 1 |
| 12 | 0.194878 | 0.577256 | 0 | -4.801217 | 0.000001 | 1 |
| 13 | -0.617728 | 0.268377 | 0 | -4.982596 | 0.000000 | 1 |
| 14 | -0.715940 | 0.237014 | 0 | -5.202214 | 0.000000 | 1 |
| 15 | -0.566128 | 0.285653 | 0 | -5.350466 | 0.000000 | 1 |
| 16 | 0.474648 | 0.682481 | 0 | -5.051934 | 0.000000 | 1 |
| 17 | 0.326594 | 0.628012 | 0 | -4.827413 | 0.000001 | 1 |
| 18 | 0.632681 | 0.736529 | 0 | -4.485995 | 0.000004 | 1 |
| 19 | 0.090030 | 0.535868 | 0 | -4.376612 | 0.000006 | 1 |
| 20 | 0.213169 | 0.584402 | 0 | -4.222774 | 0.000012 | 1 |

From the results of Table 2 and Table 3, it can be seen that the abnormal return and cumulative abnormal return of Event 1 are basically insignificant, the abnormal return of Event 2 is significantly non-zero for 4 days during the event window period, and the cumulative abnormal return is significant for 26 days out of the 31 days of the event window and is significantly non-zero for 21 days consecutively after the event occurs. In order to further validate the significance, the stata test is used to test the cumulative abnormal return and its significance for the event window period of Event 1 and Event 2. The results are shown in Table 4. The cumulative abnormal returns and their significance for Event 1 and Event 2 are tested using stata, and the results are shown in Table 4.

**Table 4.** CAR and significance level for event 1 and event 2 under different event window periods

| Event window | Event 1 | Event 2 |
|---|---|---|
| [-10,20] | -0.21% | -23.05%* |
| | (-0.05) | (-1.65) |
| [-5,10] | 0.67% | -21.45%** |
| | (0.25) | (-1.98) |
| [-2,10] | -0.49% | -18.65%** |
| | (-0.20) | (-2.02) |
| [-2,5] | 0.01% | -15.38%** |
| | (0.01) | (-2.02) |
| [-2,2] | 0.06% | -11.81%* |
| | (0.03) | (-1.71) |

Note: t-statistics in parentheses, ** and * indicate significant at the 5 per cent and 10 per cent levels, respectively.

As can be seen from Table 4, event 1 shows a small positive or negative cumulative abnormal return under five different event windows, but none of them is significant; event 2 shows a large negative effect under five event windows, and all of them are significant at the 5 per cent or 10 per cent level. Consistent with the previous preliminary conjecture and EViews test results, it is believed that event 1, i.e., the proposal of the "dual carbon" target, has no significant effect on the share price of the coal industry, and event 2, i.e., the implementation of the policy of the "dual carbon" target, has a significant negative effect on the share price of the coal industry.

### 5.1.4. Interpretation of empirical result

Event 1, i.e. the introduction of the "dual-carbon" target, did not have a significant impact on the share price of the coal industry, which could be attributed to the following three factors. Firstly, market expectation and reaction lag, when the "dual carbon" target was first proposed, the market may not yet fully understand its long-term impact and specific policy direction, so investors and the market's reaction may be relatively cautious and lagging. Secondly, information digestion and interpretation, it often takes a period of time for new policies to be fully understood and digested by the market, during which investors may be in a wait-and-see situation, waiting for more specific information to be released. Thirdly, the uncertainty of the industry's transformation expectations, although the "dual-carbon" target has made the direction of the transformation clear, the details of the specific transformation path, timetable, as well as policy support have not yet been clarified, leading to the uncertainty of the market's expectations for the future of the coal industry. So there is no significant impact on the share price of the coal industry.

Event 2, i.e., the implementation of the "dual carbon" target policy, had a significant negative impact on the share price of the coal industry, possibly for three reasons. Firstly, the pressure of enterprise transformation increases, the implementation of the policy means that the coal industry must accelerate the pace of transformation to reduce carbon emissions, which will have a direct impact on the production and operation of enterprises, investment decisions and profit model, thus triggering significant negative fluctuations in stock prices. Secondly, the market confidence and changes in expectations, the implementation of the policy may have triggered the market's concern about the difficulties of enterprise transformation, which leads to significant negative changes in stock prices. Thirdly, capital flow and reallocation, with the implementation of the "dual carbon" policy, investors may reallocate their capital according to the policy direction, shifting from the high-carbon industry to the low-carbon or green industry, and this kind of capital flow may also have a significant negative impact on the stock price of the coal industry.

## 5.2. Robustness Tests

### 5.2.1. Replacement of explanatory variables

In order to ensure the robustness of the previous research methodology and conclusions, referring to the practice of Zhu Minglai et al. (2024) [29], the explanatory variables are replaced, i.e., the share price index of the coal industry constructed independently in this paper is replaced by the coal index (000820) already available in the market, repeating the previous empirical process, and the results are shown in Fig. 8 and Fig. 9

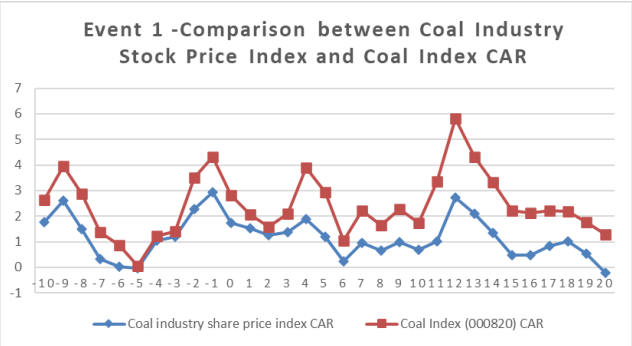


**Fig. 8** Event 1 coal sector share price index vs coal index CAR

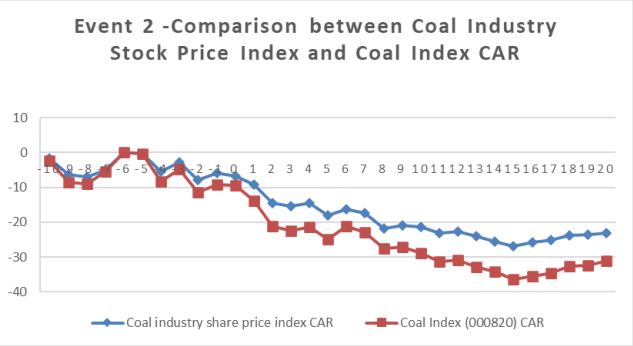


**Fig. 9** Event 2 coal sector share price index vs coal index CAR

As can be seen in Fig. 8 and Fig. 9, the cumulative abnormal returns (CAR) during the event window period after replacing the coal index remain largely consistent with the results of the autonomously constructed coal index used in the previous section, and the significance is again insignificant for Event 1 and significant at the 5% or 10% level for Event 2, which verifies the robustness of the findings in the previous section.

### 5.2.2. Replacement of model settings

To further ensure the robustness of the empirical results, the market model is replaced with the Fama-French three-factor, Carhart four-factor and Fama-French five-factor models to estimate the abnormal returns, respectively, with reference to the study by Lulu Wang et al. (2024) [30] , and the results are shown in Table 5.

**Table 5.** CAR and significance level for event 1 and event 2 under different yield estimation models

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Event | Market model | Three-factor model | Four-factor model | Five-factor model |
| Event 1 | -0.21% | 2.04% | 2.26% | 1.32% |
| | (-0.05) | (0.61) | (0.68) | (0.43) |
| Event 2 | -23.05%* | -3.76%** | -5.22%* | -2.15%** |
| | (-1.65) | (-1.97) | (-1.73) | (-2.03) |

Note: t-statistics in parentheses, ** and * indicate significant at the 5 per cent and 10 per cent levels, respectively.

As can be seen from Table 5, event 1 is not significant under four different models, and event 2 shows a significant negative effect after replacing the yield estimation model, which is consistent with the conclusion of the market model estimation. Therefore, it can be concluded that event 1, i.e., the introduction of the "dual carbon" target does not have a significant effect on the share price of the coal industry, and event 2, i.e., the policy implementation of the "dual carbon" target has a significant negative effect on the share price of the coal industry, is a more robust conclusion.

### 5.3. Heterogeneity analysis

#### 5.3.1. Heterogeneity analysis based on the nature of the shareholding

Based on the different nature of equity, the 75 enterprises are divided into two groups, Group A is state-owned enterprises and Group B is non-state-owned enterprises, and the above empirical process is carried out separately, and their average abnormal returns and cumulative abnormal returns for Event 1 and Event 2 are compared as shown in Fig. 10-13.

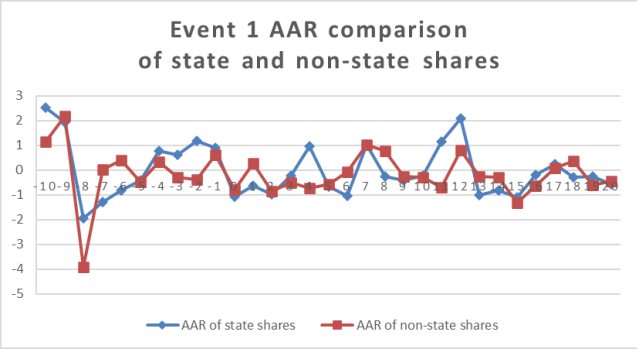


**Fig. 10** Event 1 AAR comparison of state and non-state shares

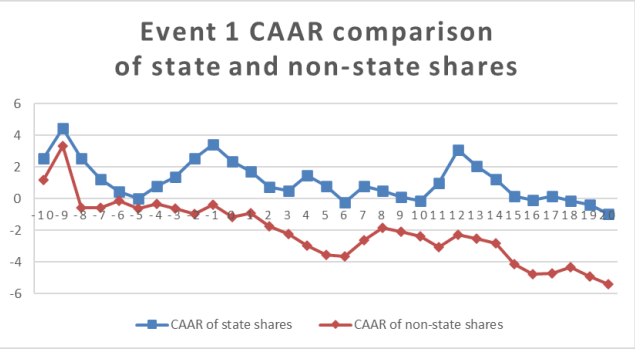


**Fig. 11** Event 1 CAAR comparison of state and non-state shares

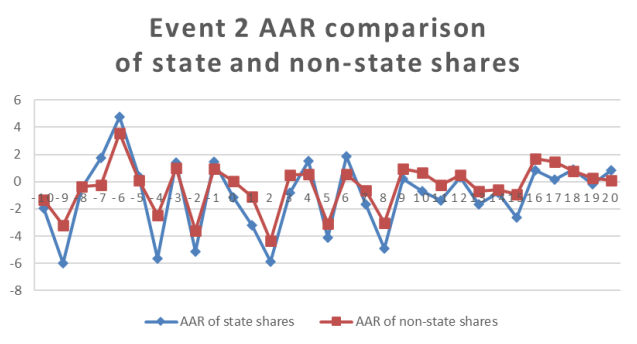


**Fig. 12** Event 2 AAR comparison of state and non-state shares

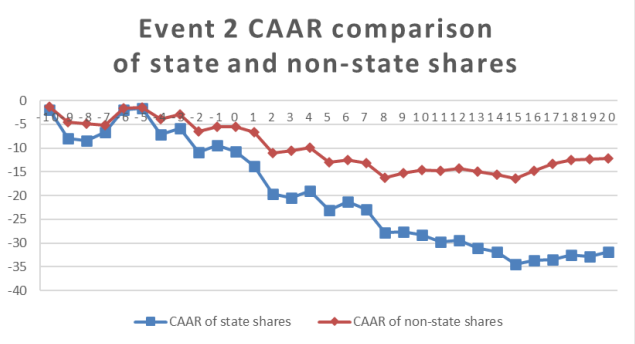


**Fig. 13** Event 2 CAAR comparison of state and non-state shares

As can be seen from Fig. 10-13, the trend of AAR fluctuation of state-owned and non-state-owned stocks in Event 1 is not the same, and the CAAR of state-owned stocks is basically greater than 0, while the CAAR of non-state-owned stocks is basically negative. The AAR of state-owned stocks in event 2 is more volatile than that of non-state-owned stocks, and the CAAR of both state-owned stocks and non-state-owned stocks is negative and more obvious for state-owned stocks, which is consistent with the conclusion of hypothesis 2.

#### 5.3.2. Heterogeneity analysis based on the listed sector

Based on the different listing segments, the 75 companies are divided into four groups: Shanghai Main Board, Shenzhen Main Board, former SME and GEM, respectively, to carry out the above empirical process, and their average abnormal returns and cumulative abnormal returns for Event 1 and Event 2 are compared as shown in Fig. 14-17.

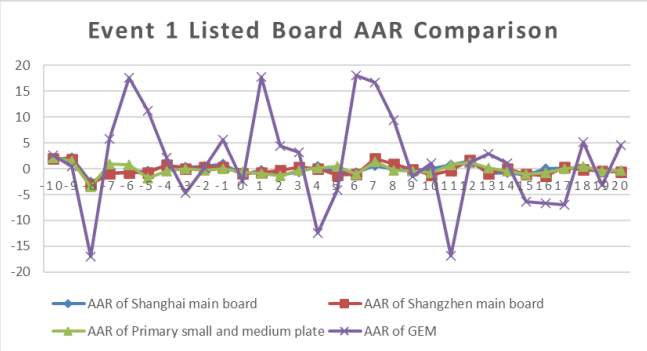


**Fig. 14** Event 1 listed board AAR Comparison

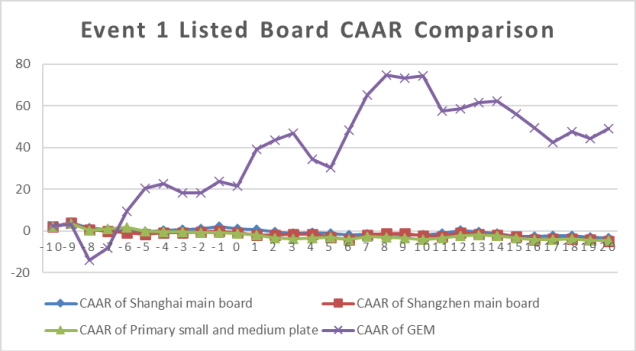


**Fig. 15** Event 1 listed board CAAR comparison Comparison

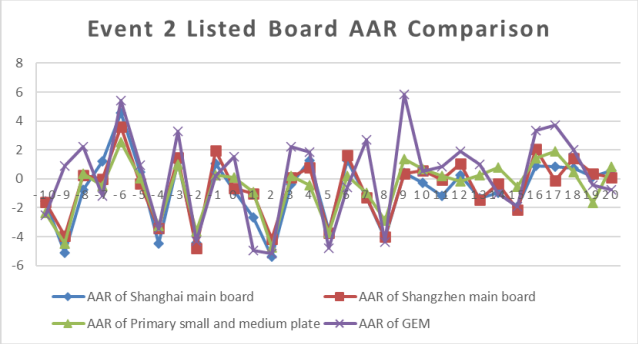


**Fig. 16** Event 2 listed board AAR Comparison

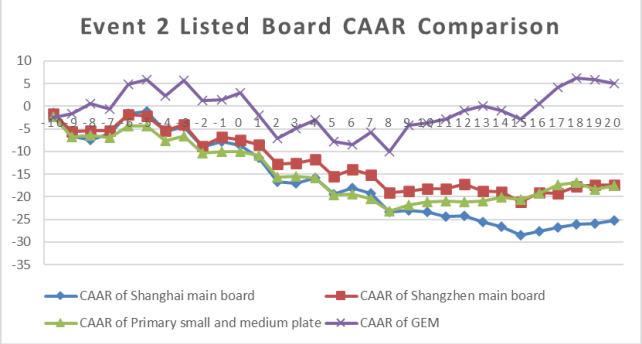


**Fig. 17** Event 2 listed board CAAR Comparison

As can be seen from Fig. 14-17, Event 1 AAR of GEM fluctuates tremendously compared to the other sectors, and CAAR basically fluctuates on 0, while stocks in the other sectors basically fluctuate under 0. Event 2 AAR of all four sectors fluctuates greatly, CAAR of GEM is greater than 0 then less than 0 and greater than 0, and the rest of the sectors fluctuate under 0, which is consistent with the conclusion of hypothesis 3.

### 5.3.3. Heterogeneity analysis based on the region where the firm is located

Based on the different regions where the enterprises are located, the 75 enterprises are divided into four groups: the Northeast region, the East region, the West region, and the Central region, respectively, to carry out the above empirical process, and the average abnormal returns and cumulative abnormal returns of event 1 and event 2 are compared as shown in Fig. 18-21.

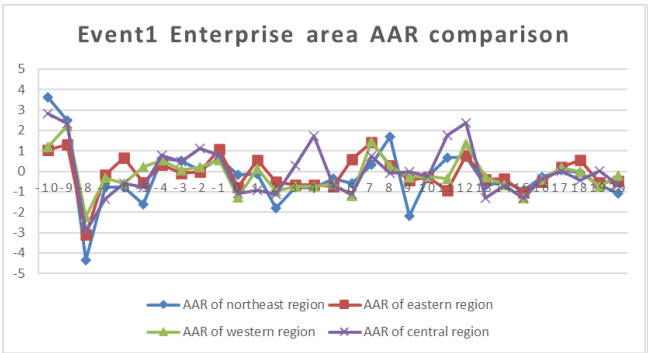


**Fig. 18** Event 1 enterprise area AAR Comparison

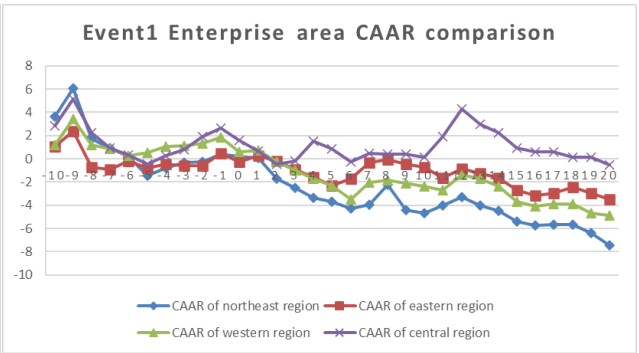


**Fig. 19** Event 1 enterprise area AAR Comparison

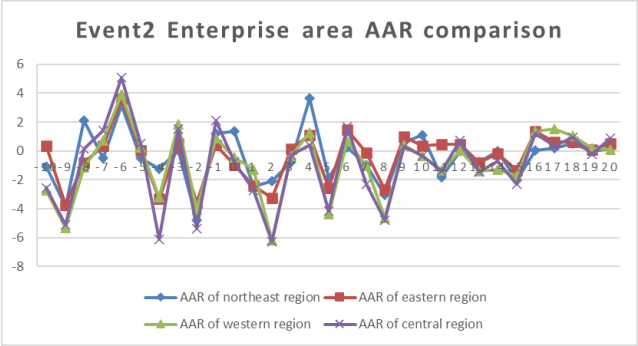


**Fig. 20** Event 2 enterprise area CAAR Comparison

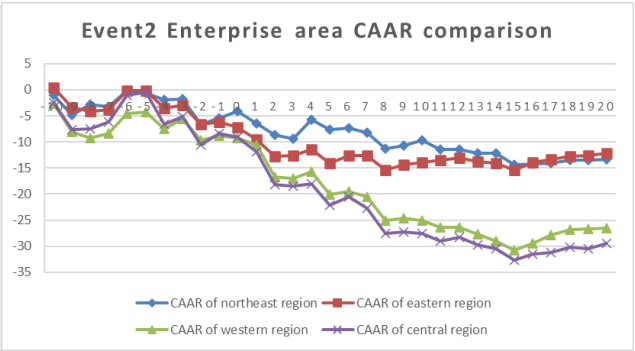


**Fig. 21** Event 2 enterprise area CAAR Comparison

As can be seen from Fig. 18-21, the AAR of enterprises in different regions in Event 1 are all fluctuating, the CAAR of the central region is basically fluctuating on 0, the CAAR of the western region is positive until the third day of the event and negative after that, the CAAR of the northeastern region is positive for the first six days of the event and negative after that, and the eastern region is basically fluctuating on 0. The CAAR of the four regions in Event 2 fluctuates under 0, and the magnitude of fluctuation is in the following order: central region > western region > eastern region > northeastern region. The empirical results are slightly different from hypothesis 4 "less impact on the share price of enterprises in the eastern region", probably because the government of the northeastern region may pay more attention to the sustainable development and transformation and upgrading of the coal industry, and help enterprises to cope with the challenges brought by the "dual-carbon" target through policy support and financial support, which to some extent mitigates the negative impact of the "dual carbon" target on share prices.

### 5.3.4. Heterogeneity analysis based on the firms' scope of operations

Based on the different business scopes of enterprises, the 75 enterprises are divided into two groups, Group A is the enterprises directly engaged in the main business related to coal, and Group B is the enterprises upstream and downstream of the coal industry chain, respectively, to carry out the above empirical process, and the average abnormal return and the cumulative abnormal return of their event 1 and event 2 are shown in the comparison of Fig. 22-25.

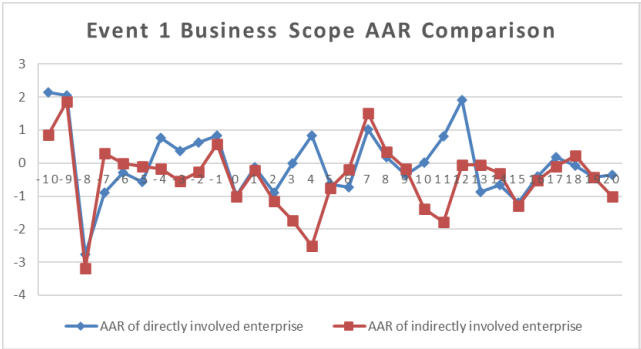


**Fig. 22** Event 1 business scope AAR Comparison

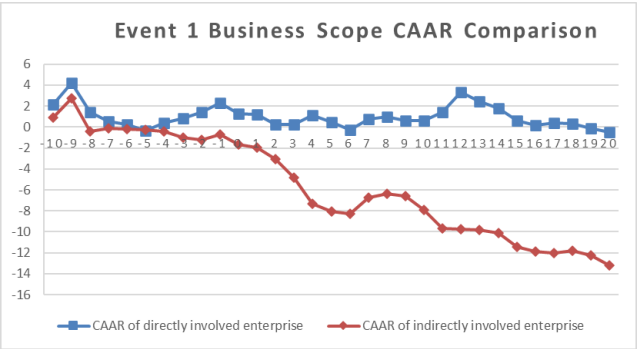


**Fig. 23** Event 1 business scope CAAR Comparison

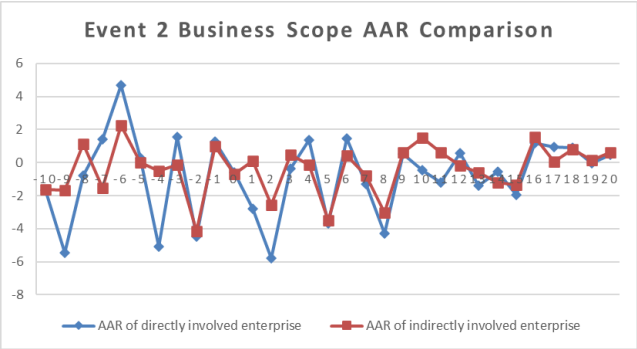


**Fig. 24** Event 2 business scope AAR comparison

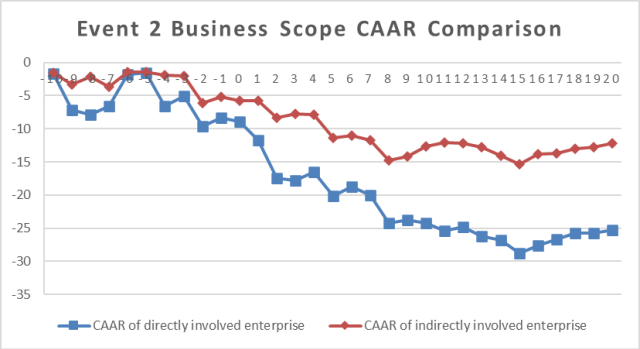


**Fig. 25** Event 2 business scope CAAR comparison

As can be seen from Fig. 22-25, the AAR of both directly and indirectly participating enterprises in Event 1 fluctuates more sharply, and the CAAR of directly participating enterprises basically fluctuates on 0, while the CAAR of indirectly participating enterprises basically fluctuates on 0. Event 2 CAAR of both directly and indirectly participating enterprises fluctuates under 0, and the negative fluctuation of directly participating enterprises is more intense, which is consistent with the conclusion of hypothesis 5.

## 6. Research findings and policy recommendations

### 6.1. Conclusions of the study

Based on the daily closing price data of 75 coal companies from 2020 to 2023, this paper utilizes the Rathbair index method to construct a coal industry stock price index, which portrays the overall situation of the coal stock market; adopts a two-event research method to explore the impact of the "dual-carbon" target and the implementation of the policy on the stock price of the coal industry; and further explores the possible mechanism effect and the heterogeneous impact of the "dual-carbon" policy on the scope of equity, the listed sector, the region of the company, and the business scope of the company.

Under the background of "double carbon", the economic development model of improving quality and efficiency will remain unchanged for a long time, and the development direction of low-carbon economy in the future is also very clear. Stock price can reflect the development prospects of an industry and a company, elongate the timeline of stock price, and stock price will inevitably reflect the truth of the market. The results of this study show that (1) the proposal of the "dual carbon" target has no significant impact on the stock price of the coal industry, while the implementation of the policy has a significant negative impact on the stock price of the coal industry; (2) The proposal of the "dual carbon" target has a positive impact on state-owned shares, while a negative impact on non-state-owned shares. The implementation of the policy has a negative impact on both state-owned shares and non-state-owned shares, but the state-owned shares are more obvious; (3) The proposal of the "dual carbon" target and the implementation of the policy have a huge impact on the GEM, and the impact is uncertain. The remaining three plates: the main board of Shanghai stock market, the main board of Shenzhen Stock market, and the original small and medium-sized board basically have a negative impact; (4) The proposal of the "dual carbon" target has caused large fluctuations in the stock prices of enterprises in the central, western, eastern and northeastern regions to varying degrees. The implementation of the policy has a negative impact on the stock prices of the four regions, and the fluctuation range is ranked as follows: central region > Western region > Eastern region > Northeast region; (5) The proposal of the "dual carbon" target has a positive impact on the directly participating enterprises, while the indirect participating enterprises have a negative impact. The implementation of the policy has a negative impact on both the direct and indirect participating enterprises, and the negative fluctuation of the directly participating enterprises is more severe.

### 6.2. Policy recommendations

China's time cycle from the goal of "carbon peak" to the goal of "carbon neutrality" is relatively short, from "carbon peak" to "carbon neutrality", some developed countries in Europe and the United States have promised to realize this goal in about 40 to 50 years, of which the European Union has committed to 60 years and the United States has committed to 45 years, and our country is the largest carbon emitter, and we have to realize this goal in 30 years, so the time constraints and the heavy task are the main features on the road to realize the goal. Therefore, this paper puts forward the following suggestions for the development of the coal industry based on the background of "double carbon":

To the central and local governments: the central and local governments should coordinate and cooperate with each other, and for high-pollution and high-energy-consumption industries such as coal and chemical industries, the local governments should actively guide them to carry out industrial structural adjustment, and through the policy dividend of low-carbon emission reduction and strict punitive measures against environmental pollution, prompt such enterprises to increase their technological investment, rapidly improve the efficiency of energy utilization, effectively control the total amount of consumption of fossil energy, and push the industrial chain toward low-carbon and green development.

To the relevant regulatory authorities: It is recommended that the relevant regulatory authorities further improve the relevant policies and measures to provide support and guidance for the coal industry to develop in the direction of cleaner and low-carbon development and to promote sustainable economic development, and at the same time, to strengthen the supervision of the coal industry and environmental protection.

For coal industry companies: It is recommended that coal industry companies actively respond to the challenges posed by the "dual-carbon" target policy, increase the research and development and application of clean energy and low-carbon technologies, transform and upgrade in order to adapt to the future market demand, and raise the awareness of corporate social responsibility and actively participate in environmental protection actions.

To investors: Investors are advised to establish rational expectations based on the results of this study, cautiously assess the investment value of companies in the coal industry and pay attention to diversification of investment risks, as well as pay attention to investment opportunities in the clean energy and low-carbon sectors. It is important to establish a correct investment concept and rationally view the ups and downs of the carbon trading sector market. When investing in carbon concept financial products, investors need to pay close attention to the main business and production and operation status of the relevant companies, invest in the underlying assets of high-quality companies in the carbon market, and reduce the investment risks caused by information asymmetry.

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