

Research on the Relationship between Green Low-carbon Transformation and Capital Market Reactions

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Abstract. Green low-carbon transformation can effectively elicit capital market reactions. Based on the annual reports of A-share listed enterprises from 2012 to 2019, this paper defines the green low-carbon transformation behavior of enterprises and uses event analysis to explore the capital market reactions caused by the green low-carbon transformation behavior of enterprises. The results show that the green low-carbon transformation of enterprises can produce significant "announcement" effect, which will bring significant impact effect to the capital market. The results of this paper are still significant after robustness tests for different sectors and different policy shocks. Further investigation shows that the increase in corporate costs and profitability are the key factors that lead to a significant capital market reactions. The research in this paper can provide an important basis for the green low-carbon transformation of enterprises and can further reveal the motivation of green low-carbon transformation of enterprises.

1 Introduction

The long-standing economic development mode with high pollution, high energy consumption and high emissions has brought great damage to the quality of the ecological environment. General Secretary Xi Jinping put forward the ecological development concept of "green water and green mountains are golden mountains" in 2005, and set green development as a long-term policy for China's sustainable development. The carbon peaking and carbon neutrality goals. The introduction of these series of guidelines and policies signifies that China's economy and society are undergoing an extensive and profound green low-carbon transformation. Based on the new development stage, it is more necessary for enterprises to implement the new concept of socialist ecological civilization construction accurately, completely and comprehensively, and vigorously promote green low-carbon transformation of enterprises.

As a major energy consuming and CO₂ emitting country, it is important to actively promote the green low-carbon transformation of enterprises. How does the capital market react to the green low-carbon transformation of enterprises, that is, is the green low-carbon transformation of enterprises to better attract investors' attention and thus bring higher future profits? Or is it to change the existing competitive situation of enterprises to achieve higher profit and value? And whether policies contribute to the green low-carbon transformation, these questions are of significant value to study in the absence of systematic arguments for the green low-carbon transformation.

2 Hypothesis

On September 22, 2020, Chinese President Xi Jinping announced at the 75th session of the United Nations General Assembly that China will increase its autonomous national contribution, adopt stronger policies and measures, and strive to peak CO₂ emissions by 2030 and work towards carbon neutrality by 2060. With the determination of the time to achieve the carbon peak and carbon neutral target, it has caused more and more scholars to study the two carbon targets of enterprises. Among them, green low-carbon transformation is an important way and technological innovation to guarantee enterprises to achieve the carbon neutral goal (Cao et al., 2020) [1]. However, there is an obvious gap in domestic research related to the behavior of enterprises' green low-carbon transformation. In China, the information disclosed by listed enterprises is an important source for investors to understand the behavior of listed enterprises, such as annual and quarterly reports, earnings forecasts, earnings presentations and prospectuses of listed enterprises. The disclosure of such information can not only reveal corporate profitability, innovation, transformation, risk and future development strategies (Li, 2008) [2], but also cause changes in the corresponding market returns and trading volume (Cheng et al., 2020) [3]. Meanwhile, based on information asymmetry theory, it is known that firms

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exaggerate positive information and hide negative news through information manipulation behavior, and the market will react incorrectly to this one-sided information, exacerbating the risk of market collapse (Zhao et al., 2020) [4]. According to the efficient market hypothesis, all useful information of a firm can be fully reflected by the stock market price. Therefore, by examining the stock prices of listed firms whose annual report disclosures include the key words "green low carbon transformation", the following hypotheses are made in this section.

Hypothesis 1: Green and low carbon transformation has a significant and positive impact on the cumulative abnormal returns of firms.

The securities market as an important component of the capital market is inevitably influenced by policies. Domestic studies have found that different policies affect the securities market prices of different industries, such as industrial policies that support enterprises to carry out innovation (Li & Zheng, 2016) [5], which help change the intrinsic value of enterprises, obtain financing facilities, and promote rational investment of investors. For investors, listed enterprises supported by industrial policies are more likely to gain investors' attention (Dou et al., 2020) [6]. In addition, institutional investors also consider the government's industrial policy in the allocation process of credit resources (Chen et al., 2018) [7]. However, Lucas critical theory states that changes in policy make people's expectations change (Lucas, 1972) [8]. As in the aftermath of the 2008 global financial crisis, a large number of scholars have focused extensively on the impact of economic policy uncertainty on firms. Economic policy uncertainty significantly affects firms' investment and financing behavior (Zhang & Liu, 2018) [9], which in turn causes significant fluctuations in the market prices of firms' securities. Based on this, the following hypotheses are proposed in this section.

Hypothesis 2: Policies will have a significant shock effect on the cumulative abnormal returns of green low-carbon transformation firms

Since the target of this paper is to define the green low carbon transformation enterprises by including the term "green low carbon transformation" in the annual report disclosure information, some scholars have found that corporate managers may distort the information disclosure for their private interests (Schipper, 1989) [10], which is also an important part of behavioral finance theory. research. Listed corporate managers can seek to expand investment (Wang, 2014) [11] or conceal under investment, among other behaviors (Baginski et al, 2016) [12] by accruing surplus management on accounting profits in annual reports, and listed corporate managers can even send false signals to the market by setting sensitive information in annual reports, such as rendering R&D, risk, and strategic parts that are used to match behaviors such as selling or buying back shares. Or, the textual information in the annual report may emphasize the future prospects of the firm to achieve the goal of concealing the low performance of the firm and misleading investor behavior (Wang and Wang, 2018) [13]. Corporate profitability, may become an important factor influencing the behavior of green low-carbon transformation in corporate annual report disclosure. Based on this, this section proposes the following hypotheses.

Hypothesis 3: Improved corporate profitability will have a significant impact on the cumulative abnormal returns of green low-carbon transformation enterprises.

3 DATA and methodology

3.1 Sample selection and data sources

This section takes A-share listed enterprises from 2012-2019 as the research object to examine the market response to green low-carbon transformation enterprises. Since the disclosure of annual reports is concentrated in January-April of the second year, this section selects December 2020 as the sample cut-off time. The data of listed enterprises' annual reports are obtained from CNINF, and the individual stock returns, market index and company size are obtained from CSMAR database. Considering that the disclosure date of annual reports may have special circumstances such as trading suspensions, weekends and public holidays, the next available trading day is taken as the announcement date. In addition, in order to estimate the market index-adjusted returns, each listed company is selected in this section to have a trading history of at least 210 days prior to the announcement.

The sample selection process in this section is as follows: (1) manufacturing enterprises with letter classification C are selected as samples according to the SEC Industry Classification Guidelines, (2) ST enterprises and observations with missing data are excluded, (3) samples for which text information cannot be extracted due to report formatting problems are excluded, (4) missing samples for annual report disclosure years are excluded.

3.2 Methods

This section specifically refers to Cahill et al (2020) [14] using the event analysis method, in which the normal return $R_{i,t}$ of the stock is represented by the "daily stock return without cash dividend reinvestment" according to the CSMAR database, the impact of the disclosure of green and low carbon transformation words in the annual report on the stock price is important. In order to examine the impact of the disclosure of the green transformation term on the

share price of listed enterprises, this section also requires the calculation of abnormal returns according to Equation (1).

$$AR_{i,t} = R_{i,t} - \alpha_i - \beta_{i,t}(R_{m,t}) \quad (1)$$

where $AR_{i,t}$ is the abnormal return, denoting the abnormal return of firm i on day t .

$R_{i,t}$ is the actual return of firm i , and $R_{m,t}$ is the main board market return. Here the main board index is selected as the SSE index, and later in the robustness test section, the Shenzhen index, GEM index, CSI 500 index will be selected instead of the SSE index in this paper. β_i is obtained based on fitting individual stock i with the pre-event window t . As for the pre-event window, this paper selects [-210, -30] days before the disclosure date of listed enterprises' annual reports to calculate. In this paper, abnormal returns (AR_s) represent the returns of firm i on the event date, and cumulative abnormal returns (CARs) represent the pre-announcement window port [-20, -2], event window [-1, 1], [-2, 2], [-3, 3], [-5, 5], [-10, 10], [-15, 15], [-20, 20], and the cumulative abnormal returns for the post-event window [2, 20], respectively. For each firm i , the CARs for the event interval $[T_1, T_2]$ are calculated as shown in Equation (2).

$$CAR_{i;T_1,T_2} = \sum_{t=T_1}^{T_2} AR_{i,t} \quad (2)$$

Table 1. CARs of Green Low-carbon transformation

Index	SZI	GEI	SME	ZZ500	SZI	GEI	SME	ZZ500
Time	[-1,1]				[-2,2]			
Sample	-0.006***	-0.006***	-0.006***	-0.004***	-0.006***	-0.008***	-0.005***	-0.002
Year	SZI	GEI	SME	ZZ500	SZI	GEI	SME	ZZ500
2019	-0.013***	-0.014***	-0.017***	-0.008***	-0.018***	-0.019***	-0.023***	-0.010***
2018	-0.009***	-0.009***	-0.006***	-0.004*	-0.009***	-0.010***	-0.005**	0.000
2017	0.001	-0.005***	0.003	-0.001	0.004	-0.005**	0.007***	0.001
2016	-0.007***	-0.005**	-0.008***	-0.004*	-0.008***	-0.006**	-0.010***	-0.004
2015	-0.000	0.001	0.001	-0.001	0.001	0.003	0.003	0.000
2014	-0.002	-0.000	-0.000	-0.004	0.008*	0.006	0.009*	0.002
2013	-0.011***	-0.000	-0.001	-0.003	-0.012***	0.006	0.002	-0.001
2012	0.003	-0.006**	0.002	0.002	0.011***	-0.007**	0.008*	0.007**
SOEs	-0.003**	-0.003*	-0.002	-0.001	-0.002	-0.003	-0.001	0.000
Non-SOEs	-0.007***	-0.008***	-0.007***	-0.004***	-0.007***	-0.009***	-0.006***	-0.003**

Finally, the annual report disclosure date is selected as the event date in this section, and the corresponding t-value is calculated according to the event analysis method, where the denominator part is the standard deviation of cumulative abnormal returns, and if the t-value is significant, it proves that the event has a significant effect on firm i , and vice versa, there is no significant effect.

4 Empirical results and analysis

4.1 Cumulative abnormal returns

Table 1 calculates the cumulative abnormal returns CARs for different intervals based on Equation 2. It is evident that throughout the table, the green low carbon transformation has a different impact on all event windows. The first row of Table 1 shows the calculated cumulative abnormal returns for the entire sample. For the 3-day trading window [-1, 1] before and after the announcement, the green transformation causes a significant decrease of 0.623% in the cumulative abnormal returns of firms; for the 5-day trading window [-2, 2] interval and the 7-day trading window [-3, 3] interval, the green transformation causes a significant decrease in the cumulative abnormal returns of firms by half 0.557% and 0.557%. In the medium-term window, the cumulative abnormal returns of listed enterprises start to gradually turn from negative to positive in the 11-trading-day interval [-5, 5] and the 21-trading-day interval [-10, 10], while in the long-term window, the cumulative abnormal returns reverse significantly and are positive in the 31-trading-day interval [-15, 15] and the 41-trading-day interval [-20, 20], all of which prove that the disclosure of green low-carbon transformation in annual reports affects the stock price of enterprises significantly and negatively in the short term and turns positive in the long term. And according to the counterfactual test, the cumulative abnormal

return calculated by selecting the pre-disclosure window [-20, -2] interval is 1.225%, which is positively significant, which may be related to the existence of the pre-disclosure impact of the firm's performance. In contrast, the cumulative abnormal return in the post-annual report disclosure window [2, 20] is significantly positive, with the cumulative abnormal return increasing by 0.669% and significant at the 1% level, but with the pre-event disclosure window, the cumulative abnormal return is significantly lower. This proves that many firms in the sample experienced significant stock price declines before and after the disclosure of the green low-carbon transformation in their annual reports, and the market reacted significantly and negatively to the green low-carbon transformation firms, and Hypothesis 1 is proved.

Table 2. CARs of green low carbon transformation in different main board markets

Window	[-20,-2]	[-1,1]	[-2,2]	[-3,3]	[-5,5]	[-10,10]	[-15,15]	[-20,20]	[2,20]
Sample	0.012***	-0.006***	-0.006***	-0.005***	-0.003*	0.0002	0.006**	0.011***	0.007***
Year	[-20,-2]	[-1,1]	[-2,2]	[-3,3]	[-5,5]	[-10,10]	[-15,15]	[-20,20]	[2,20]
2019	0.001	-0.011***	-0.014***	-0.013***	-0.010***	-0.007*	-0.008	-0.007	0.002
2018	0.013***	-0.010***	-0.011***	-0.013***	-0.013***	-0.006	0.003	0.0015	-0.000
2017	0.042***	0.002	0.005**	0.006*	0.009**	0.013***	0.018***	0.041***	-0.003
2016	-0.028***	-0.007***	-0.008***	-0.008**	-0.010**	-0.027***	-0.036***	-0.047***	-0.019**
2015	0.041***	0.000	0.002	0.003	0.017***	0.039***	0.068***	0.078***	0.042***
2014	0.031***	-0.008**	-0.001	0.003	0.009**	0.003	0.017	0.044***	0.039***
2013	-0.015***	-0.001***	-0.010**	-0.013***	-0.012***	-0.012*	-0.014*	-0.028***	0.001
2012	0.015**	0.003	0.012***	0.013***	0.016***	0.017***	0.030***	0.050***	0.036***
SOEs	0.009**	-0.003*	-0.002	-0.001	0.002	0.000	0.005	0.004	-0.009*
Non-SOEs	0.013***	-0.007***	-0.007***	-0.007***	-0.004*	0.001	0.008**	0.016***	0.013***

In addition, CARs differ significantly depending on the year of annual report disclosure and the nature of equity. Table 1 shows that the cumulative abnormal returns of the sample of enterprises disclosing green low-carbon transformation in their 2012 annual reports are significantly positive, which may be related to the release of the "12th Five-Year Plan for Green Low-Carbon transformation Technology Development" by the Ministry of Science and Technology of China since 2012, which strongly promotes the development of green low-carbon transformation, while the 2016 The cumulative abnormal return of the sample of enterprises disclosing green low-carbon transformation in the statement is significantly negative, which may be related to the high density of green low-carbon transformation policies in 2016. Meanwhile, this section verifies the CARs of SOEs and non-SOEs. According to Table 2, it can be found that in the comparison between SOEs and non-SOEs, the cumulative abnormal return rate of the non-SOE sample is more significant during the disclosure event window, i.e., the impact of disclosing green low-carbon transformation is more significant for non-SOEs.

4.2 Robustness test

Similar to the method of obtaining abnormal returns calculated by the SSE index returns in Equation 1, this section attempts to test the stability of the results in Table 1 by calculating different abnormal returns based on different market indices. For this purpose, this section selects Shenzhen index, GEM index, SME index and CSI 500 index as proxy variables of SSE index based on CSMAR database, and the event windows are selected as [-1, 1] and [-2, 2]. The results are shown in Table 2. It can be found that the cumulative abnormal returns calculated based on different market indices are basically consistent with the results in Table 1, both in terms of sign and significance. The CARs calculated based on the four major indices are -0.626%, -0.623%, -0.0557% and -0.0365% for the three trading windows before and after the announcement of the annual report for green low-carbon transformation enterprises, which are all negative and significant. The CARs calculated based on the equity classification criteria are the same as those in Table 2, and the robustness tests are passed.

4.3 Policies impact

From Table 1, it is known that the introduction of green low carbon transformation policies in 2012 and several green low carbon transformation policies in 2016 have a significant impact on the share prices of firms, so how do specific policies related to green low carbon transformation affect the market performance of green low carbon transformation firms? In this section, this chapter examines the impact of policies on the share prices of green low-carbon transformation firms. To this end, this section specifically examines the 2015 Fifth Plenary Session of the 18th Central Committee(see Column1), which elevated green low-carbon transformation to a national strategy for the first time, the 2016 Opinions on Establishing a Unified Green Product Standard(see Column2), Certification and Labeling System (the "Green Product Opinions",see Column3), and the "Industrial Product Opinions" "Industrial Green Development Plan (2016-2020)"(see Column4), "Notice on the Development of Green Low-carbon transformation System"(see

Column5), the first batch of green low-carbon transformation list announced by the Ministry of Industry and Information Technology in 2017(see Column6), the third batch of green low-carbon transformation list announced by the Ministry of Industry and Information Technology in 2018(see Column7). the third batch of green low-carbon transformation list announced in 2018 and the fourth batch of green low-carbon transformation list announced in 2019(see Column8) are set as policy shock events, and the impact of the green low-carbon transformation policy on the share price of enterprises is determined specifically through the event analysis method. Considering that the policy has a time lag, this paper selects [-5,5] as the event window, and the empirical results are shown in Table 3. For the entire sample, this section finds that Made in China 2025 has a large impact on the green low-carbon transformation stock price, and the CARs coefficient calculated for the 11-day trading window is positive and significant at the 1% level. However, the results of the policy into 2016 show that the impact of the green low carbon transformation policy on the share price of green low carbon transformation enterprises is negative and decreasing in significance, which shows that, as the number of policies increases, the average impact of the policy not only does not increase but gradually weakens, and the impact of the policy on for the share price of green low carbon transformation enterprises changes from significant to insignificant. However, in 2017, the state began to publicize and select the list of green low-carbon transformation enterprises, which has a significant impact on the share price of green low-carbon transformation enterprises, and this impact is more significant as time progresses, because according to the behavioral signal theory, when the market receives the policy signal transmission, investors can screen through the signal to identify enterprises that substantially implement green low-carbon transformation and give positive feedback.

Table 3. Different policy impacts

Column	1	2	3	4	5	6	7	8
Date	26/10/2015	30/06/2016	03/09/2016	07/12/2016	31/05/2017	03/09/2017	31/07/2018	14/09/2019
CARs	0.027***	-0.003	-0.005	-0.011**	-0.035***	0.031***	-0.016***	0.016***

5 Further study

Based on Table 1 above, it is clear that the market reacts negatively in the short term to firms that adopt green low-carbon transformation, so what other factors affect green low-carbon transformation firms besides policy factors that affect their profitability, resulting in significant changes in their profitability.

Table 4. Profitability and CARs of Green low-carbon transformation

Y	CARs[-1,1]				CARs[-2,2]				CARs[-3,3]			
Cost	0.002*** (2.67)				0.003*** (3.00)				0.002** (2.33)			
ROA		0.060*** (3.26)				0.108*** (5.36)				0.153*** (6.86)		
ROE			0.027*** (3.38)				0.043*** (4.73)				0.055*** (4.58)	
Tobinq				0.001 (0.46)				0.001 (0.83)				0.002 (1.34)
Control	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Constant	0.042*** (-2.65)	-0.005 (-1.03)	-0.004 (-0.76)	-0.005 (-1.03)	0.053*** (-2.81)	-0.006 (-0.88)	-0.003 (-0.43)	-0.006 (-0.88)	-0.052** (-2.36)	-0.011 (-1.52)	-0.007 (-0.93)	-0.011 (-1.52)
YEAR	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
INDUSTRY	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
N	3651	3651	3651	3651	3651	3651	3651	3651	3651	3651	3651	3651

Given that there is a strong relationship between firms' technological innovation and their profitability, the improvement of firms' profitability can support firms' technological innovation, which in turn will bring firms' technological accumulation, improve their competitiveness, and eventually achieve the improvement of their profitability. Therefore, this section is to calculate the cumulative abnormal returns CARs of enterprises obtained from the [-1,1] event window based on Equation 1, and test the relationship between the cumulative abnormal returns of enterprises and their profitability obtained through Equation (1) by constructing a regression model . The specific formula is as follows Equation (3).

$$\hat{CARs}_{i,t} = \beta_0 + \beta_1 Performance_{i,t} + \sum X_{i,t} + \mu_t + \mu_i + \varepsilon \quad (3)$$

Where $Performance_{i,t}$ is the enterprise profitability variable, this section selects the enterprise profitability indicators in the CSMAR database, specifically including the average return on total assets (ROA), average return on net assets (ROE) and TobinQ value (TobinQ) value. To explain the effect of firm's performance on cumulative abnormal returns, $X_{i,t}$ are control variables, specifically the dummy variables DUA for separation of two offices, NUM for board size, SHARE for equity concentration, and other corporate governance variables.

The empirical results are shown in Table 4. Short-term performance ROE has a significant positive effect on cumulative abnormal returns with ROA, and both are significant at the 1% level, while long-term performance TobinQ has a positive but insignificant effect on firm profitability. This indicates that firm profitability is an important factor affecting the cumulative abnormal returns of green low-carbon transformation firms, and Hypothesis 3 is proved. In addition, corporate input is also a key factor affecting the cumulative abnormal returns of green low-carbon transformation firms, and the greater the corporate input the greater the impact of the implementation of green low-carbon transformation on the stock price shock.

6 Conclusion

Under the situation that the country emphasizes vigorously developing innovative technologies such as green low-carbon transformation, green low-carbon transformation has been widely disclosed in the annual reports of enterprises since 2012 to show the environmental responsibility of enterprises, and green low-carbon transformation has become an important factor in studying the behavior of enterprises. This chapter examines the reactions in the market of enterprises implementing green low-carbon transformation through textual data of listed enterprises' annual reports, where the short- and long-term impacts are different after the disclosure of their annual reports, showing a negative and significant shock in the short term and a reversal in the medium and long term, showing a positive and significant shock. This chapter further finds that this reversal stems from the level of profitability of firms in the current year, and firms with poorer profitability in the current year are more willing to implement a green low-carbon transformation, suggesting that a green low-carbon transformation is significantly associated with low performance. In addition, this section explores the role of national policy news for firms with green low-carbon transformations.

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