Enterprise Low-Carbon Behavior, Financial Performance and Economic Transformation—Data from Listed Companies in China

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Abstract. The low-carbon development of enterprises is an important breakthrough in Chinese economic transformation and the optimization and upgrading of the industrial structure. Based on a sample of Chinese listed companies involved in the low-carbon industry from 2010 to 2018, this paper empirically analyzes the correlation between the low carbon behavior, economic transformation and financial performance of listed companies. The results show that a company’s carbon intensity and financial performance are negatively related, and this relation is more significant when the financial performance is measured using the ROA (return on asset) of listed companies. The level of economic transformation in places where enterprises are located can significantly strengthen the positive relationship between enterprise low-carbon behavior and financial performance, including in central and western areas, where positive relationships are strengthened, and areas with heavy polluting industries, where positive relationships are weakened. Therefore, it is necessary to strengthen carbon emission supervision for non-heavy polluting industries and enterprises in the central and western regions.

1 Introduction

Improving the environment and achieving high-quality development are important issues in today's world. Enterprises are the backbone of the national economy. A series of measures, such as transforming the economic development mode, optimizing and upgrading the industrial structure, and realizing the transformation from "extensive" to "intensive", are closely related to enterprise strategy, behavior and performance. A low-carbon economy is a new direction of traditional industrial civilization, and the "three low" (low energy consumption, low pollution, and low emissions) pattern of economic development fits the theme of world economic transformation. Exploring the regulatory role of the regional economic transformation on the enterprises’ low carbon behavior and financial performance has important implications for the formulation of macroeconomic policy.

2 Literature Review and Hypothesis Proposal

2.1 Analysis of the impact of enterprise low-carbon behavior on financial performance

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As the green demand of governments and clients is getting stronger day by day, the industrial enterprises in North America, Europe, Japan, and other developed countries have adopted the strategy of active environmental management, and have taken it as an important component to maintain their international competitiveness. Some investors, financial institutions and international trade partners have shown more concern about the relevance of financial performance and environmental responsibility [4]. From the perspective of internal conditions, based on relevant data of Britain, Japan and other countries, Pratima (2000) indicated that competitiveness, legitimacy, and the sense of ecological responsibility were the deep motives of listed companies to conduct environmental management; and they were affected by the degree of industrial saturation, the seriousness of problems, and leader characteristics [5].

Secondly, environmental performance is good for alleviating the principal-agent problems caused by information asymmetry. In this theory, since it is acknowledged that environmental problems have the feature of hysteresis, owners must pay attention to financial performance and environmental performance simultaneously to avoid adverse selection risks. After all, these two can influence each other. A high-quality environmental report of an enterprise is an effective way for investors to avoid risks caused by information asymmetry, and is also a perfect signal to illustrate the enormous potentiality and lofty morality of an enterprise, which is good for reducing financing costs. Such signals are even more radical in the market of creditor's rights. Clarkson (2011) found a positive relationship between environmental performance and voluntary climate change disclosure [6]. The fact that the capital market is paying increasingly more attention to enterprise environmental information indicates that enterprises are becoming the core strength to build a "low-carbon China".

In earlier studies, because of the influence of the relatively high estimated rate of cash flow increase or the political economy problems left over from British history, Yan (2014) thought that environmental information disclosure had no significant correlation with company value [8]. Some scholars also believe that corporate social responsibility negatively affects corporate performance [9]. Eva (2010) pointed out that when a researcher did not use an advanced measuring instrument or did not study investment portfolios, the conclusion of a negative correlation between the two was apt to be obtained, and a study that considered the hysteretic nature of environmental problems was more likely to find a positive correlation between the two [10]. Elisabeth (2013) found that environmental performance had a positive correlation with financial performance, but it would be influenced by factors such as the elected indicators for financial and environmental performance, regional differences, operating departments, and the length of the period [11]. Chen (2016) [14] found that for building materials companies, the environmental protection measures that targeted reducing pollution and emissions were good for optimizing both the short and long term financial performance; however, in the financial industry, the situation was the opposite, i.e., a financial service company with relatively low environmental costs had better financial performance. Compared with the situation in non-developed countries, the act of reducing environmental costs had a direct and significant influence on the performance of the financial service enterprises in developed countries [15]. Abraham (2012) thought that environmental expenditures were an important part of costs, and pointed out that the ROA and Tobin’s-Q had significant negative correlations with enterprise environmental performance, but environmental expenditures had a significant positive correlation with the amount of R&D investment. Therefore, it may result in extra value for enterprises [16].

Finally, enterprise low-carbon behavior is the best practice according to low-carbon ecological economy theory. At present, most enterprises in China lack quantitative descriptions, and their willingness to disclose is weak. Nicola (2015) found that the carbon emissions level of an enterprise had a non-linear relationship with Tobin’s-Q; on the other hand, only an enterprise with good performance in terms of their amounts of emissions and reductions could achieve a high level of retained profits. After decades of theoretical and empirical study, a final conclusion has not been reached yet, and this has made some scholars think [17]. Karen found that companies announcing membership in EPA’s Climate Leaders, a program targeting reductions in greenhouse gas emissions, experience significantly negative abnormal stock returns [18]. Busch also found a negative correlation between voluntary carbon management and financial performance [19]. For this reason, hypothesis H1 is hereby proposed:

H1: Quantified low-carbon behavior has a positive correlation with financial performance.

However, the correlation between enterprise environmental performance and financial performance can be influenced by industry characteristics. James (2016) pointed out that energy enterprises with good environmental performance had better financial performance, and the same had been proved in both the service industry and textile industry [20]. However, this conclusion was disproved in the food industry [23]. Research on the Japanese manufacturing industry indicated that the correlation between environmental performance and financial performance depended on the selected substitute variables for environmental protection. For example, the amount of waste emissions had no significant correlation with financial performance, but the reduction of greenhouse gas emissions had a significant positive correlation with financial performance, and the degree of correlation was related to the growth rate of the enterprise [24]. For heavy polluting industries, Halit (2017) thought that the environmental protection performance had no influence on financial performance [25]. For this reason, hypothesis H2 is hereby proposed:

H2: In high polluting industries, quantified low-carbon behavior has a positive correlation with financial performance.
Since it is influenced by the level of local economic development and the degree of completeness of the legal framework and national policies, the correlation between enterprise low-carbon behavior and financial performance may vary from region to region. A Bangladeshi study indicated that in the past decade, only 19% of enterprises in the country mentioned environmental problems. Compared with the disclosures made by enterprises in other parts of the world, the grade and degree of disclosure made by Bangladeshi enterprises were very little [26]. It was similar to a Malaysian study in which Nik (2013) found that 49 building materials enterprises gave positive descriptions of their environmental performance, which were narrative, unverifiable, and did not disclose environmental problems [27] as required by the relevant regulations. In Europe, the situation is quite the opposite. After the EU’s Energy Performance Directive and Pollutant Release Register were released in succession [28], in order to relieve the system pressure and maintain the advantage of green competition, Elisabeth (2014) found that in the past 15 years, 55 French industrial companies added the content of environmental information to their annual reports, which was accurate because of the application of technical methods [29]. Apparently, the system of environmental information disclosure in developed countries is more complete, and the low-carbon concept is more deeply rooted among the people. Therefore, it is highly likely that it may affect the correlation between enterprise environmental performance and financial performance. Will the correlation between Chinese enterprise environmental performance and financial performance vary from region to region? Tian (2017) pointed out that in China, the cities with a mayor who has a relatively long tenure and a doctorate degree may disclose more environmental information. In addition, the number of Internet users, the distance to Hong Kong, the urban unemployment rate, and the local legal system would all affect the level of environmental information disclosure. Furthermore, there were regional differences in all the aforesaid indicators [30]. For this reason, hypothesis H3 is hereby proposed:

H3: In the central and western regions, quantified low-carbon behavior has a positive correlation with financial performance.

### 2.2 Analysis of the regulating effect of economic transformation

The influence of the low-carbon economy has directly driven the global adjustment of the industrial structure and energy structure, and changed the economic development patterns of different countries. The resource-saving and environmental-friendly economic development pattern has been approved all over the world. Jänicke (1997) pointed out that with the economic development and income growth, the service industry's share increased while the industry's share decreased, and the industrial structure shifted to less polluting sectors to improve the environmental quality, revealing the relationship between industrial structure upgrades and pollutant emissions [31]. Enterprise low-carbon behavior is not only an act of shouldering social responsibility, but is also the key power that enables China to have the right to speak in the field and maintain its international competitiveness. It will stimulate the potential of each listed company in terms of low-carbon development and promote enterprises to actively conduct low-carbon transformation. Su (2014) pointed out that the industrial structure and energy efficiency are two important factors that determine the regional differences in China's carbon emissions intensity [32]. Scholars have come to different conclusions when studying the impact of economic structural changes on carbon emissions performance. One view is that economic transformation (from "extensive" to "intensive") is an important way to solve problems such as rising corporate costs and insufficient domestic demand. The decline in the energy consumption intensity is the main driving force for China's lower carbon emissions intensity, especially the decline in the energy consumption intensity of the secondary industry; and the low carbonization of the energy structure can contribute to the decline in the carbon emissions intensity. Therefore, to reduce the carbon emissions intensity, we must focus on reducing the energy consumption intensity and optimizing the structure. However, Zhang (2009) believes that the economic scale effect has the largest contribution to the changes in carbon emissions, and the energy intensity effect has the largest positive effect on the reduction of China's carbon emissions. The effects of the carbon intensity and industrial structure are small and vary by industry. There are also opinions that changes in the energy structure will vary by period in China's carbon emissions reduction work, and changes in the industrial structure will have a negative effect on the carbon emissions reduction work. Therefore, on the basis of analyzing the influence of listed companies’ low-carbon behavior on financial performance, the regulating effect of the regional economic transformation intensity is also considered in this paper. For this reason, hypothesis H4 is hereby proposed:

H4: The intensity of the regional economic transformation will enhance the positive correlation between enterprise low-carbon behavior and financial performance.

It is of great significance to study the relationship between enterprises' low-carbon behavior, financial performance and economic transformation. To separate the low-carbon information from the original environmental information disclosure or environmental information research, taking the micro subject as the research object meets the current hot topics of global research, and is conducive to the implementation of global green and low-carbon behavior. This can include changing the method of selecting qualitative variables to study environmental information; analyzing the relationship between enterprises' low-carbon behaviors and financial performance from the perspective of the heterogeneity of companies such as the degree of economic transformation in industries, regions and places.
where enterprises belong; and providing direction for enterprises to formulate corporate strategies.

3 Research Design

3.1 Sample selection and data sources

The relevant data of all the listed companies involved in low-carbon industries in China’s 27 industry segments for the period of 2010-2018 were included in this paper. Since the aim of a listed company’s low-carbon behavior is to reduce the greenhouse gas emissions, it is beneficial to the series of measures formed under the overall pattern of “three in one” (low-carbon energy, low-carbon technology and low-carbon industrial system). Therefore, the selected samples should be those from high-carbon industries or some high-tech (low-carbon) enterprises. In 2010, the China Energy Conservation Industry Network listed five industries with high carbon emissions, i.e., the electricity and heat manufacturing and supply industry, the oil processing industry, coking and nuclear fuel processing, the ferrous metal smelting and rolling industry, the non-metallic mineral product industry, and the chemical raw materials and product manufacturing industry. In 2016, the China Carbon Emission Exchange Network added the construction industry and transportation industry to the list. The amount of carbon emissions of these two accounted for one-third of the total in that year. Therefore, according to the 66 industry segments listed by CSMAR, all the listed companies involved in low-carbon industries in the 27 segments were selected. Such companies are involved in coal mining, oil field exploitation, excavating services, basic chemistry, chemical products, chemical synthesis materials, new chemical materials, steel, nonferrous metallurgy and processing, building materials, semi-conductors and elements, optics and photo electronics, finished automobiles, communication equipment, computer equipment, paper making, chemical pharmacy, biological products, communication services, electric power, ports and shipping, road and railway transportation, public transportation, airport and air transportation, logistics, real estate development, and new materials.

The process of sorting the data includes the following steps: (1) eliminating ST/PT companies, (2) eliminating the companies with missing data, and (3) eliminating the companies that did not have continuous data over the 9 year period. After sorting out the data in the preliminary stage, 72 listed companies were selected, and a balanced panel consisting of data collected over a 9 year period was obtained. In order to avoid the influence of extreme values, some continuous variables were winsorized at the 1% level. The low-carbon information in this paper was sourced from corporate social responsibility reports, enterprises’ official websites and the statistical yearbooks of the provinces (cities) involved; and the financial information was sourced from CSMAR. The data processing and statistical analysis were conducted using Stata15.0.

3.2 Model building and variable definitions

The static panel model was adopted. Its general form is as follows:

$$y_{it} = \alpha + \beta^T x_{it} + \mu_i + \epsilon_{it}$$ (1)

The dependent variable $x_{it}$ was a k×1 dimensional vector, $\beta_i$ was a 1×k dimensional vector, and $\mu_i$ was a random disturbance term. According to whether there was any change in the intercept and slope, the model was classified as a variable coefficient model, a variable intercept model or a mixed model. Subscripts i and t were the two dimensions of the panel data, which represented the cross section and time series natures, respectively. Since the individual effect and time effect were fully considered, it can be extensively applied to microscopic studies, and even macroscopic studies. Combined with the general form of the static panel data model and the relationship between enterprises’ low-carbon behavior and financial performance, four sets of regression model formulas were established to test the four hypotheses, respectively. Quantitative variables were adopted to measure enterprise low-carbon behavior. (In previous studies, researchers gave special emphasis to qualitative variables. Examples include if the enterprise had been approved by ISO140001, if the enterprise has been punished by environmental protection departments, etc.) According to the industry and region, the degree of economic transformation of the place where each company belongs is added, and enterprise heterogeneity is more comprehensively considered. The latest enterprise low-carbon and financial data was used, which could provide a basis for the construction of the country’s ecological civilization.

To test hypotheses 1-3, we build the following model:

$$ROA_{jt}(\text{TOBINQ}_{jt}) = \alpha + \alpha_{\text{LC}_{jt}} + \alpha_{\text{SIZE}_{jt}} + \alpha_{\text{LEV}_{jt}} + \alpha_{\text{CFO}_{jt}} + \alpha_{\text{TURN}_{jt}} + \alpha_{\text{GROWTH}_{jt}} + \alpha_{\text{SHARE}_{jt}} + \beta + \delta + \mu_{jt}$$ (2)

To test hypotheses 4, we build the following model:

$$ROA_{jt}(\text{TOBINQ}_{jt}) = \alpha + \alpha_{\text{LC}_{jt}} + \alpha_{\text{TRANSFORM}_{jt}} + \alpha_{\text{LC} \times \text{TRANSFORM}_{jt}} + \alpha_{\text{SIZE}_{jt}} + \alpha_{\text{LEV}_{jt}} + \alpha_{\text{CFO}_{jt}} + \alpha_{\text{TURN}_{jt}} + \alpha_{\text{GROWTH}_{jt}} + \alpha_{\text{SHARE}_{jt}} + \eta + \delta + \mu_{jt}$$ (3)

The dependent variables $ROA_{jt}$ and $\text{TOBINQ}_{jt}$ are the proxy variables for financial performance, which respectively represent the accounting income and circulation market value achieved by the unit assets of each listed company in the tth year. We use dummy variables (whether companies disclose quantified low-carbon behaviors) as proxy variables for the low-carbon behaviors of listed companies. $\text{LC}^{*}$ represents whether companies quantify and disclose their greenhouse gas emissions such as carbon dioxide in the tth year. INDUSTRY and EASTERN represent the industry characteristics and regional difference of each listed company, respectively. Economic transformation (TRANSFORM) is a regulated variable. In order to measure their influence on company value comprehensively, based on the existing research results, company size (SIZE), debt paying ability (LEV), growth
ability (GROWTH), turnover ratio (TURNOVER), cash flow ratio (CFO) and capacity for governance (SHARE) are taken as control variables. In the model, \( \eta_i \) is the unobservable individual effect, \( \delta_t \) is the time effect, and \( \mu_z \) is a random disturbance item. It is noted that Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan are included in the eastern region, referring to Table 1 for the calculations and definitions of the above-mentioned variables.

### Table 1 Main Variables and Definitions

| Variable symbol | Variable name       | Variable definition                                                                 |
|-----------------|---------------------|-------------------------------------------------------------------------------------|
| ROA             | Return on total assets | Net profit/period-end total assets                                                  |
| TOBINQ          | Circulation market value | Year-end circulation market value/period-end total assets                         |
| LC              | Disclosure nature | If the company quantifies its low-carbon behavior, it is 1; if not, it is 0. |
| SIZE            | Enterprise size | The natural logarithm of the company’s year-end total assets.                       |
| LEV             | Debt paying ability | Total indebtedness/total assets                                                    |
| GROWTH          | Growth ability      | (Operating revenue for the year - operating revenue for the previous year)/operating revenue for the previous year/period-end total assets |
| TURNOVER        | Operation ability   | Operating revenue/period-end total assets                                           |
| CFO             | Cash flow adequacy ratio | Net cash flow of operating activities/period-end total assets                     |
| SHARE           | Capacity for governance | Ratio of the shares held by the largest shareholder                                |
| QUANTIFY        | Disclosure nature | If a company quantifies its low-carbon behavior, it is 1; if not, it is 0.       |
| INDUSTRY        | Industry nature     | -If a company belongs to a heavy polluting industry, it is 1; if not, it is 0.  |
| EASTERN         | Region nature       | If a company is located in the eastern region, it is 1; if not, it is 0.         |
| TRANSFORM       | Economic transformation | The tertiary industry proportion of the province (municipality directly under the Central Government) where the company is located in the current period. |

### 4 Empirical Test and Results Analysis

#### 4.1 Descriptive statistics

Based on the descriptive statistics of the variables in Table 2, the following can be concluded. (1) The average value of LC is 0.3056. (It indicates whether the selected sample has recorded the amounts of their greenhouse gas emissions in detail, i.e., whether it has disclosed and quantified its low-carbon behavior). Among all the selected samples, almost 30% of the companies have published and quantified their low-carbon behavior, and 70% enterprises still gave qualitative descriptions. (2) As for the financial performance (TOBINQ and ROA) of the selected samples, the average values are 1.5385 and 0.0368, respectively, which are about ten times (one-tenth) of the maximum value (minimum value). They indicate that the performance levels of the selected samples vary, and there may be extreme values. (3) As for the dichotomous variables—INDUSTRY and EASTERN—most of the selected samples were in the non-heavy polluting industries and eastern regions.

### Table 2 Descriptive Statistics of Variables

| Variable | mean     | sd       | p25  | p50  | p75  | min    | max    |
|----------|----------|----------|------|------|------|--------|--------|
| TOBINQ   | 1.5385   | 1.1406   | 0.7685 | 1.1607 | 8.5715 | 0.6992 | 11.4217 |
| ROA      | 0.0368   | 0.0454   | -0.2612 | 0.0297 | 0.2109 | -0.2612 | 0.2699 |
| LC       | 0.3056   | 0.4610   | 0     | 0    | 1    | 0      | 1      |
| SIZE     | 23.6020  | 1.3906   | 20.31 | 23.65 | 27.1 | 20.18 | 27.39  |
| LEV      | 0.5156   | 0.2008   | 0.0462 | 0.5356 | 0.8919 | 0.0341 | 0.9293 |
| CFO      | 0.05655  | 0.0719   | -0.1546 | 0.0603 | 0.2487 | -0.2244 | 0.5526 |
| SHARE    | 0.4132   | 0.1493   | 0.1165 | 0.4057 | 0.7546 | 0.1165 | 0.7631 |
| INDUSTRY | 0.3472   | 0.4765   | -0.6320 | 0.0531 | 9.7333 | -2.4255 | 78.5187 |
| EASTERN  | 0.7083   | 0.4549   | 0     | 1    | 0    | 1      | 1      |
| GROWTH   | 0.5356   | 3.3569   | -0.6320 | 0.0531 | 9.7333 | -2.4255 | 78.5187 |
| TRANSFORM | 0.4982  | 0.1350   | 0.3914 | 0.4466 | 0.5213 | 0.2862 | 0.8100 |

#### 4.2 Multiple regression analysis

Descriptive statistics analysis can only show the average value, maximum, minimum, and general distribution of each indicator of the selected samples; and it cannot prove the correlation between enterprise carbon emissions intensity and financial performance. Meanwhile, under the influence of industrial and regional heterogeneity, we must ask whether the correlation between the two will change. After introducing industrial and regional virtual variables, what is the direction of the regulating effect and the significance level? Under the background of the green and low-carbon strategy of the country and the global economic transformation, how will the industrial structure of the place where a listed company is located influence the correlation between the two? Is there any difference in the current period and the period that lags behind in terms of the regulating effect? All of these need to be interpreted using the multiple linear regression method. Refer to Table 3, Table 4, and Table 5 for the detailed regression results.

### Table 3 Low-carbon Behavior and Financial Performance of enterprises in different industries

| Dependent variable: ROA | Dependent variable: TOBINQ |
|-------------------------|---------------------------|
| 0.4982 0.1350 0.3914    | 0.4466 0.5213 0.2862 0.8100 |
significant at the 10%, 5%, and 1% level, respectively. Note: *, **, and *** indicate that the correlation is significant at the 10%, 5%, and 1% level, respectively.

TURNOV

Table 4 Low-carbon Behavior and Financial Performance of enterprises in different regions

| Dependent variable: ROA | Dependent variable: TOBINQ |
|-------------------------|---------------------------|
| Eastern region          | Eastern region            |
| LC                      | -0.00856                  |
| Non-polluting industry  | -0.02011**                |
| Non-polluting industry  | -0.0306                   |
| Full sample             | -0.04499                  |
| Non-polluting industry  | -0.05653                  |
| Full sample             | -0.04750                  |
| Non-polluting industry  |                         |

| Observed value | Model selection |
|----------------|-----------------|
| 576            | 200             |
| 376            | 200             |
| 459            | 189             |
| 459            | 189             |

| R2             | 0.2978          |
|                | 0.3583          |

Note: *, **, and *** indicate that the correlation is significant at the 10%, 5%, and 1% level, respectively.

Table 5 The Regulating Effect of the Degree of Regional Economic Transformation

| Dependent variable: ROA | Dependent variable: TOBINQ |
|-------------------------|---------------------------|
| Eastern region          | Eastern region            |
| LC                      | -0.01768                  |
| Non-polluting industry  | -0.02362                  |
| Non-polluting industry  | -0.45                     |
| Full sample             |                           |
| Non-polluting industry  |                           |

| Observed value | Model selection |
|----------------|-----------------|
| 648            | RE              |
| 648            | RE              |
| 459            | Yes             |
| 189            | Yes             |
| 459            | Yes             |
| 189            | Yes             |
| R2             | 0.2978          |
|                | 0.3583          |

Note: *, **, and *** indicate that the correlation is significant at the 10%, 5%, and 1% level, respectively.

4.2.1 Regression analysis of enterprise low-carbon behavior and financial performance

As shown in Table 3, the regression results of enterprise low-carbon behavior and financial performance indicates that no matter which dependent variable, ROA or TOBINQ, is used in formula (1), LC has a negative correlation with it, i.e., carbon emissions intensity has a negative correlation with financial performance, and the correlation was significant at the 10% level in the case of ROA. Because ROA reflects the performance of an enterprise, it is easier to use it to directly reflect the book value. TOBINQ stands for the circulation market value of each asset. It symbolizes the future investment value of an enterprise, which is lagging behind; and therefore enterprise low-carbon behavior is more apt to find favor in the eyes of investors, creditors, and other stakeholders (Yan Qiu et al., 2014). The good news is that the significance level has improved in the past decade. This indicates that environmental information has attracted the attention of increasingly more market participants. Enterprises, as the core component of building a “low-carbon city” and “low-carbon society”, will closely combine their development with ecological environmental protection. There is no doubt that they will function using their unique features for the promotion of the low-carbon economy.

4.2.2 The regression analysis of low-carbon behavior and financial performance in high-polluting industries

According to the grouping results, in the high-polluting industries, LC had a significant negative correlation with ROA. The carbon emissions intensity in high-carbon industries has a negative relationship with ROA. The correlation with TOBINQ was negative but not significant. In low-polluting industries, LC is not
significantly related with ROA and TOBINQ, and the correlations are far lower than those in high-polluting industries. It can be shown that the low-carbon behavior of high-polluting industries has a more significant positive impact on financial performance. The state should increase its low-carbon subsidy policy for enterprises in high-polluting industries; gradually build and improve the low-carbon industrial chain; increase subsidies for listed companies that actively develop low-carbon energy sources and develop low-carbon technologies; and further take measures to cut overcapacity in industries such as steel and cement, which have high energy and capital consumption. In this policy context, the growth of highly polluting industries will be further suppressed. In addition, as for the control variables, SIZE has a positive correlation with ROA (the coefficient is 0.00419), and a significant negative correlation with TOBINQ (the coefficient is -0.22965). This seemingly indicates that listed companies have indeed reaped better accounting values by expanding at the expense of the environment over the past nine years. However, in the long run, the way of “quenching a thirst with poison” will bring about unimaginable negative effects (the regression coefficient of the latter was 55 times that of the former). The author hopes that enterprise senior executives and the people concerned will pay attention to the issue.

4.2.3 The regression analysis of enterprise low-carbon behavior and financial performance in the central and western regions

As shown in table 4, the LC of enterprises in the central and western regions is negatively correlated with ROA and TOBINQ, i.e., enterprises' low-carbon behaviors play positive roles in promoting financial performance, which reflects that the correlation between the low-carbon performance and financial performance of the listed companies in central and western China has been strengthened in recent years. This discovery conforms to the conclusion drawn above. However, there was no significant correlation between the carbon emissions of enterprises in the eastern region and enterprise performance. At present, in China's domestic carbon flow, the carbon flow from the west to the east has fallen sharply; and production and consumption in the eastern coastal provinces have caused large amounts of carbon emissions in the central and western regions. Relying on low-end products with high energy consumption, high emissions, and low value added imported from the Midwest, the eastern provinces produce and export high-end products with low energy consumption, low emissions, and high value added. In addition, some less developed regions (such as the southwestern region) have changed from net carbon output areas to net carbon input areas. This is mainly due to the rapid growth of per capita consumption in these regions. Due to the correct implementation of the western development strategy, as well as the "ecological rule of law", "lifelong accountability system", "ecological red line" and other policy documents, the environmental information disclosure mechanism has become more complete, and punishment has become increasingly more severe, which made those in business in the central and western regions with the idea of “development based upon pollution” decrease its use.

4.2.4 The regulating effect of the regional economic transformation on enterprise low-carbon behavior and financial performance

Considering local areas, enterprise low-carbon behavior and financial performance may be influenced by the degree of local economic transformation. Table 5 of the empirical results shows that the economic transformation of the place where an enterprise is located will have a significant regulating effect on enterprise low-carbon behavior and financial performance. The regression results indicate that when the dependent variable is ROA, the coefficient of LC*TRANSFORM is 0.09084, and this indicates that regional economic transformation can suppress the positive impact of low-carbon behavior on financial performance in the current period. That is probably because ROA is calculated following enterprise accounting principles, and it reflects the financial conditions and operating results of an enterprise in the past year. In addition, the benefit period of environmental investment is lagging, and so it is difficult to represent the financial performance in the current period.

Furthermore, the coefficient of LC*TRANSFORMt-1 is negative, which indicates that the delayed economic transformation could strengthen the positive correlation between the low-carbon behavior and financial performance of listed companies. When the dependent variable is TOBINQ, LC*TRANSFORM is significantly negative, indicating that the economic transformation can strengthen the positive relationship between low-carbon behavior and financial performance. TOBINQ stands for the market value of shares. It shows the degree of the capital market’s reaction towards the low-carbon behavior of a listed company, and it is also an in-depth representation of the future value of a company. The coefficient of LC*TRANSFORMt-1 is positive, indicating that the lagged economic transformation into the next period will weaken the positive correlation between the low-carbon behavior and financial performance of listed companies. The regulating effect between the two is still reflected in the economic transformation effect in the current period.

5 Robustness checks

Net profits (RPO) and year-end aggregate market value (MV) are used to replace ROA and TOBINQ in the study model, and the carbon emission intensity indicator is changed, i.e., “the total amount of carbon dioxide emission of the year” (LC′) and “the total amount of carbon dioxide emission of the year/total operating revenue of the year” (LC") are used to replace LC. A new panel multiple regression is conducted for all samples, including heavy polluting samples, non-heavy polluting samples, eastern region samples, and central and western
region samples. The regression results still support the existing research hypothesis. For the results, refer to Table 6, Table 7 (when the explanatory variable is LC') and Table 8 (when the explanatory variable is LC''), which verify the relationship between enterprises' low-carbon behaviors and financial performance and the regulating effect of economic transformation on them. Note that since some listed companies did not disclose their amounts of carbon dioxide emissions, the calculation is made based on the standard that one ton of standard coal releases 2.62 tons of CO2 and 0.0085 ton of SO2.

Table 6 Test of Enterprise Low-carbon Behavior and Financial Performance in different industries

| Dependent variable: | Full sample | High polluting industry | Non polluting industry | Full sample | High polluting industry | Non polluting industry |
|---------------------|-------------|-------------------------|------------------------|-------------|-------------------------|------------------------|
| LC'                 | -4.9315**   | -5.0872***              | -3.1433**              | -0.00274**  | -0.00249**              | 0.04830**              |
| SIZE                | 10.1101**   | 12.7648**               | 2.9172**               | 0.08290**   | 0.07362**               | 0.10881**              |
| LEV                 | -43.9181*** | -65.0069***             | -6.56490**             | -0.34487*** | -0.33137***             | -0.73155**             |
| CFO                 | 15.45189**  | 17.52046**              | 3.80189**              | -0.10011**  | -0.12886**              | 0.06866**              |
| TURNOVER            | -190.922*** | -235.753***             | -61.3874*              | -1.49862**  | -1.24433**              | -2.21315**             |

Note: *, **, and *** indicate that the correlation is significant at the 10%, 5%, and 1% level, respectively.

Table 7 Test of Enterprise Low-carbon Behavior and Financial Performance in different regions

| Dependent variable: | Eastern region | Midwest region | Dependent variable: | MV | Eastern region | Midwest region |
|---------------------|----------------|---------------|---------------------|-----|---------------|---------------|
| LC'                 | -0.00093**    | 0.00407**     | -0.00485**          | 0.15294** |
| SIZE                | 0.00392       | 0.00157       | 0.04949**           | 0.15949*** |
| LEV                 | -0.015441**   | 0.00542**     | -0.41303**          | -0.20059** |
| CFO                 | 0.09230       | -0.00074**    | 0.05430**           | 0.63566*** |
| TURNOVER            | -0.02841**    | -0.01654**    | -0.24053**          | -0.06038** |
| CONS                | -0.05109**    | 0.00602**     | -0.57678**          | -3.42009** |
| Observed value      | 230           | 130           | 230                 | 130   |
| Model selection     | FE            | FE            | FE                  | FE    |
| Year                | YES           | YES           | YES                 | YES   |

Note: *, **, and *** indicate that the correlation is significant at the 10%, 5%, and 1% level, respectively.

Table 8 Test of the Regulating Effect of Economic Transformation

| Dependent variable: | ROA | Year-end aggregate market value |
|---------------------|-----|--------------------------------|
| Regression coefficient | Z value | Regression coefficient | T value |
| LC''                | 0.432** | 0.04 | -2.6025 | -1.02 |
| TRANSFORM           | 1.73   | 0.17 | 1.69    | 0.64  |
| TRTRANSFORM         | 10253.53 | 0.11 | -42982.08* | -1.85 |

Note: *, **, and *** indicate that the correlation is significant at the 10%, 5%, and 1% level, respectively.

6 Conclusion and Suggestions

Though the relevant data samples of all A shares in China’s 27 industry segments involving low-carbon industries in the period of 2010-2018, this paper has conducted an empirical analysis on the relation between enterprise low-carbon behavior, financial performance and economic transformation. The following is found. 1. The carbon emissions intensity has a negative relation with financial performance. This fully indicates the objective fact that the capital market is paying increasingly more attention to low-carbon information. Meanwhile, at the 1% significance level, the negative relationship of the two still has upside potential. 2. The positive relationship between corporate low-carbon performance and financial performance is more significant in highly polluting industries. This being significant at the 5% level reflects that carbon emission intensity is still the core power for the traditional fossil energy segment to obtain economic benefits. 3. The positive effect of low-carbon behavior on financial performance is more significant in the central and western regions. Enterprises in the central and western regions are paying increasingly more attention to environmental protection and environmental information disclosure, which is especially manifested in the classification and quantification of environmental information. The stronger the positive effect of this behavior on enterprise financial performance is, the more room there is for enterprises in the central and western regions to improve their low-carbon behaviors. The local governments and companies themselves should focus on the long-term benefits of low-carbon activities and implement targeted measures. In order to integrate the influence of local factors, after further introducing moderating variables, it was found that the current level of economic transformation of the listed company's place of ownership can significantly strengthen the positive relation between its low-carbon behavior and financial performance.

Through the robustness test, the following was also concluded. 1. After changing the explanatory variable and the explained variable, carbon emissions intensity has a negative relation with financial performance, which is more significant for the net profits directly reflected in the book value. 2. The regulatory effect of geographical location has changed greatly and there was no significant difference between the Midwest and the east. This...
indicates that the purchase of traditional fossil energy, the transformation and renovation of fixed assets, the expansion of production lines, and other operating investments not only increase enterprise accounting income, but also are good for sending good signals to the share circulation market, thereby promoting the increase of the share price. After entering the economic new normal, although the overall direction of the carbon flow is still from west to east, the amount of carbon flow has fallen sharply, and the gap between the east and west has narrowed. Meanwhile, the insignificant coefficient value also reflects that the country's determination to strengthen pollution control and prevention and build a green and low-carbon society has achieved some results in the capital market, and the process of ecological civilization has been accelerated. The regulatory effect of the economic transformation on enterprise low-carbon behavior and financial performance is more obvious in the current period, which conforms to the previous hypothesis.

Therefore, the following is suggested. Firstly, the low-carbon education of enterprise senior executives should be deepened, and the awareness of environmental protection should be raised among all parties. Enterprises should take a long-term view, fulfill social obligations, take the initiative to implement green financial policies, improve green financial mechanisms, and promote sustainable development. Enterprises should be gradually guided to take the right path of green and low-carbon development. They should enhance the awareness of green and environmental protection of all parties involved, make full use of various channels and media to publicize low-carbon knowledge, and cultivate people's financial literacy and thinking modes. Furthermore, they should carry out targeted education for citizens, pay attention to the cultivation of interdisciplinary comprehensive talents, conduct comprehensive quality inspections when employees are introduced, and pay attention to the assessment of employees' awareness and knowledge of green environmental protection. Secondly, a quantitative control mechanism for environmental performance should be implemented as soon as possible. For high-carbon industries, the external supervision system should be further strengthened and the efficiency of environmental policies should be improved. They should establish information disclosure platforms to solve the problem of information asymmetry; strengthen post-loan monitoring reviews; establish risk monitoring, early warning mechanisms and risk statistical monitoring indicator evaluation methods; and conduct performance and quality evaluations according to each indicator established in the later stage of the project. In addition, a risk transfer and compensation mechanism should be established to standardize the measures to deal with various risks and solve risk problems in order of importance so as to minimize the losses caused by risks. Thirdly, relevant decision-making departments should have a profound understanding that for the traditional energy-intensive industry, its inherent industry attributes determine the close relationship between the carbon emission intensity and financial performance. Therefore, in order to build a “low carbon economy”, we must adjust the ratio of clean energy applications, overcome the technology challenges of new energy development, speed up the pace of economic transformation, increase the proportion of the tertiary industry, and realize the optimization and upgrading of the industrial structure. Fourthly, the management method for the low-carbon performance in high-tech low-carbon industries should be optimized, and the performance appraisal indicators of environmental performance should be diversified. Fifthly, the supervision in central and western regions, especially in remote areas, should be enhanced. Meanwhile, “the Internet plus” environment monitoring system should be established and perfected.

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