Research on the Relationship Between Government Incentives, Carbon Information Index and High-Quality Development of Enterprises Under the Background of Double Carbon: Taking Chemical Raw Materials and Chemical Product Manufacturing as an Example

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Abstract. In September 2020, China clearly proposed the goals of "carbon peaking" in 2030 and "carbon neutrality" in 2060. At present, although the annual carbon dioxide emission of my country's chemical industry is only 500 million tons, in terms of emission intensity, the emission per unit income of the chemical industry is much higher than the average level of the chemical industry; while the chemical raw materials and chemical products manufacturing industry's annual emission of carbon dioxide is 164 million tons, accounting for a relatively high proportion in the entire chemical industry. This paper selects a total of 191 companies in my country's A-share chemical raw materials and chemical product manufacturing industries from 2018 to 2020 as a sample to construct a carbon information index for this industry, and to study the relationship and impact of the carbon information index on the high-quality development of enterprises. The moderating role of carbon information index and high-quality development of enterprises. The results show that the carbon information index has a positive role in promoting the high-quality development of enterprises, and government incentives have a positive regulating effect on the carbon information index and the high-quality development of enterprises. The promotion of quality development is more obvious.

Keywords: double carbon background · Carbon Information Index · government incentives · Chemical raw materials and chemicals · high-quality development

1 Introduction

Climate change is a major challenge the world is facing, and China, as the largest developing country, should shoulder the heavy responsibility of reducing carbon emissions. By analyzing the carbon emissions of various industries in my country, the carbon emissions

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of the chemical industry are far less than the three high-emitting industries of petrochemicals, chemicals, and building materials, but the emission intensity of each sub-industry in the chemical industry is at medium to high intensity. Among them, chemical raw materials and the chemical manufacturing industry ranks second in the chemical industry. The chemical raw material and chemical product manufacturing industry includes seven sub-sectors: basic chemical raw material manufacturing, fertilizer manufacturing, pesticide manufacturing, paint, ink, pigment and similar product manufacturing, synthetic material manufacturing, specialty chemical product manufacturing and household chemical product manufacturing aspects of daily life [1]. In addition, due to the differences in economic structure, energy structure and development level, different regions have different differences, and there is also a lot of pressure in the process of controlling the total emission target and the decomposition process of regional and industry dimensions [2]. Therefore, in some places, the industry is in the carbon Development may not be smooth or even stagnant under emission control. Therefore, enterprises have to do everything possible to upgrade technology, increase innovation, and keep pace with the times for high-quality development, so as to not be eliminated by the industry under the pressure of increasingly strict environmental control. Coupled with the new crown epidemic in recent years, the central government proposed in February 2022 that the high-quality development of Chinese enterprises should adhere to the five new development concepts of innovation, coordination, greenness, openness and sharing, accelerate the digital transformation of enterprises, and build excellence in the new era business and world-class companies. However, as the market competition becomes more and more intense, the cost of raw materials becomes higher and higher, innovation and reform become more and more limited, and it becomes more and more difficult for enterprises to achieve high-quality development. In order to encourage enterprises to actively innovate and achieve carbon emission reduction, the state has issued a series of incentive policies. Government incentives are mainly divided into two aspects: government subsidies and tax incentives. Government subsidies refer to the monetary or non-monetary assets that an enterprise obtains from the government for free, but does not include the capital invested by the government as the owner of the enterprise. Tax incentives refer to the reduction or exemption of tax burdens to a certain part of specific enterprises and tax objects as stipulated in tax laws and administrative regulations by the state using tax policies. However, in order to obtain national carbon emission subsidies, companies must pay attention to the disclosure of their own carbon information [3]. In the context of dual carbon, studying the role of government incentives in the carbon information index and the high-quality development of enterprises can keep pace with the times and conform to the trend of the times, allowing enterprises to adjust their development goals and plans in a timely manner, and re-engineer them according to practical factors. Formulate development strategies and improve the quality of carbon information disclosure, so that enterprises can play their own advantages, make up for their own shortcomings, and develop with high quality.

2 Literature and Review

Most of the research on carbon information disclosure and corporate development focuses on carbon information disclosure and corporate performance. Jin Huiqin (2016)

[5] studied the world's top 500 companies that disclose carbon information, and the results show that carbon emission information has a positive effect on the long-term corporate performance of enterprises. Huang Tianda (2020) [9] took the Shanghai A-share heavy polluting enterprises as the analysis object, and conducted an empirical analysis on the relationship among carbon information disclosure, marketization process, and corporate value. The research results show that the level of carbon information disclosure will promote enterprises to high-quality develop. Chunguang Sheng (2021) [4] constructed a carbon information disclosure index by taking 172 companies with a SynTao Green Finance rating of B or above for four consecutive years as the research object, and used regression analysis to prove that there is a positive correlation between the quality of carbon information disclosure and corporate financial performance. By analyzing and summarizing the research results of scholars, most scholars only study the performance of enterprises or the performance of enterprises in a certain industry. Moreover, in the research of carbon information disclosure framework, there is no unified standard in the end, which provides a basis and new ideas for subsequent scholars' research. Therefore, studying the relationship between carbon information disclosure and the high-quality development of enterprises is to make adequate preparations for the advent of the carbon neutral era, and also lays the foundation for how enterprises can adjust their development strategies under environmental regulation.

3 Theoretical Analysis and Research Assumption

3.1 Carbon Information Disclosure and High-Quality Development of Enterprises

If an enterprise wants to achieve stable development, it must be competitive. If it wants to have a long-term competitive advantage, it must be driven by innovation. To achieve an effective combination of economic and social benefits, only value sharing. Enterprises want high-quality development without competitiveness [8]. A business with good financial performance does not necessarily have to be highly competitive. As for whether it is competitive, it also depends on whether it can achieve a short-term advantage in the severe competition environment of domestic and foreign markets. Most scholars choose total factor productivity as an indicator to measure the high-quality development of enterprises. Total factor productivity is an important concept in macroeconomics and an important tool for analyzing economic growth. Total factor productivity reflects the efficiency of enterprise capital, labor, technology, management, organization and other resource development and utilization [12]. The key to its improvement lies in how to effectively allocate various resources and technological progress. After summarizing the existing literature, it is concluded that the calculation methods of total factor productivity include: OLS method, OP method, LP method, and GMM method, etc. [13]. The most commonly used method by scholars is LP method. Disclosure means that companies disclose their carbon emission reduction strategies, specific carbon emission effects, carbon emission reduction measures, and carbon emission trading to the public, investors, governments and other stakeholders. From the perspective of stakeholders, the more complete and high-quality carbon information disclosure is, the more positive it can show that companies are actively taking responsibility for carbon reduction and taking

measures to achieve carbon reduction in the context of dual carbon., which is conducive to establishing a good image of the enterprise in front of stakeholders, which can be used as intangible assets to create more value for the enterprise and promote the high-quality development of the enterprise [6]. Therefore, the higher the quality of carbon information disclosure of an enterprise, the lower the operating risk and capital cost of the enterprise, the more obvious the competitive advantage, the continuous improvement of enterprise performance, and the ultimate goal of high-quality development. Based on this, the following assumptions are made:

H1: There is a positive correlation between the quality of carbon information disclosure and the high-quality development of enterprises.

3.2 The Moderating Role of Government Incentives in Carbon Information Disclosure and High-Quality Enterprise Development

If an enterprise wants to develop without being affected by environmental regulation, it must open up a path of innovation. When the fierce competition in the environment leads to difficulties in the development of enterprises, government subsidies play an important auxiliary role in the process of enterprise development. Government subsidies can promote the business performance of enterprises and promote the innovation performance of enterprises. The improvement of innovation performance can promote the improvement of business performance, and this effect is the key way to realize the innovation-driven high-quality development of enterprises [10]. When enterprises encounter difficulties in the process of innovation, government subsidies play a pivotal role. When the government selects subsidy objects, it will also look for data on corporate performance, corporate strategy and other data that can illustrate the development prospects of the company from the announcements issued by the company. At this time, high-quality carbon information disclosure is particularly prominent, which will attract the attention of relevant government departments. The higher the quality of carbon information disclosure, the greater the carbon information disclosure index, the more comprehensive the carbon information disclosed, the higher the enthusiasm of enterprises to participate in carbon emission reduction, the more measures they take, and the more responsibility they take for carbon emission reduction. This will make the government feel that the enterprise itself has great potential [1]. Conversely, if the government subsidizes more, companies will disclose carbon information more comprehensively in order to obtain subsidies, thus having the capital for innovation. Therefore, the following assumptions are made:

H2: Government incentives play a positive regulatory role in carbon information disclosure and high-quality enterprise development, that is, the greater the intensity of government incentives, the more obvious the regulatory role.

4 Research and Design and Empirical Analysis

4.1 Sample Selection and Data Sources

This paper selects a total of 191 A-share chemical raw material and chemical products manufacturing companies in China as samples, and excludes companies marked as ST, *ST, and companies that have closed business during the period. After screening, 573 sample data were obtained. The data are mainly obtained from the CSMER database, annual reports, sustainability reports, social responsibility reports, and ESG reports.

4.2 Model Setting

Through Stata software, in order to test the impact of carbon information disclosure on the high-quality development of enterprises, considering the possible nonlinear relationship between the two, the basic regression model is set as follows:

$$TFP_{it} = \alpha_0 + \alpha_1 cid_{it} + \alpha_2 size_{it} + \alpha_3 lev_{it} + \alpha_4 soe_{it} + \alpha_5 gr_{it} + \varepsilon \quad (1)$$

The explained variable is TFP total factor productivity, and the explanatory variable is cid carbon information disclosure index [14]. The sample data used in this paper is an unbalanced panel, which can be regressed by the mixed OLS method. Models (2) and (3) are used to test the moderating role of government incentives in the carbon information index and the high-quality development of enterprises:

$$TFP_{it} = \beta_0 + \beta_1 cid_{it} * zb_{it} + \beta_2 size_{it} + \beta_3 lev_{it} + \beta_4 soe_{it} + \beta_5 gr_{it} + \varepsilon_1 \quad (2)$$

$$TFP_{it} = \gamma_0 + \gamma_1 cid_{it} * ss_{it} + \beta_2 size_{it} + \gamma_3 lev_{it} + \beta_4 soe_{it} + \gamma_5 gr_{it} + \varepsilon_2 \quad (3)$$

Where, zb is the sum of the increase in deferred income and the government subsidies in non-operating income and take the logarithm to the base of ten, and ss represents tax benefits in government incentives, that is the ratio of income tax expense to EBITDA; parameter βi and $\gamma_i (i = 1, 2, 3, 4, 5)$ is the coefficient of the regression model; β_0 and γ_0 are constant terms and ε_i $(i = 1, 2)$ is the random error.

4.3 Variable Selection

4.3.1 Explained Variables

Select the total number of productivity TFP to represent the level of high-quality development of enterprises. Based on the research of scholars, it is decided to use the formula:

$$TFP = lnY - x_1 lnL - x_2 lnK - x_3 lnM.$$

In the LP method, which is the most widely used method for calculating total factor productivity, and calculate the explained variable TFP with the help of Stata. Among them, Y, L, K, and M respectively represent output Y: the main business income of the enterprise; labor L: the number of employees; capital K: the net value of fixed assets and intermediate inputs M: the cash paid for purchasing goods and accepting labor services. Among them, since the main business income includes intermediate inputs, the output of the enterprise cannot be accurately measured. So the company's output Y is chosen to be measured by the enterprise's added value, which is used by most scholars, that is: output Y = enterprise's added value = employee compensation + depreciation of fixed assets + operating profit + taxes.

4.3.2 Explanatory Variables

The explanatory variables are based on the carbon information disclosure quality evaluation system constructed by Sheng Chunguang (2021) [11] Yang Yu qing (2020) [7]. The carbon information disclosure quality evaluation system including both qualitative and quantitative aspects is shown in Table 1. And adopt the content analysis method to evaluate and score the company's annual report, social responsibility report, sustainable development report and ESG report. For qualitative evaluation indicators, "yes" is 1 point, "no" is 0 points; for quantitative evaluation indicators, "with detailed quantitative data of this part" is 3 points, "with quantitative data but not comprehensive" 2 points, "only described in text" is 1 point, and "without any description" is 0 points. After scoring, the company's carbon information disclosure index CID (Carbon Information Disclosure) is calculated by the formula CID = CIDi/TCID, so as to evaluate the quality of the company's carbon information disclosure. Among them, CIDi is the carbon information disclosure score of the i-th company, and TCID is the total carbon information disclosure score of 34 points.

4.3.3 Moderating Variables

Generally speaking, government incentives include two parts: government subsidies and tax incentives. Government subsidies also include two parts from the definition: asset-related and income-related. According to the definition and previous research by scholars, the increase in deferred income in the financial statements is used to represent the government grants related to assets, and the government grants part of non-operating income is used to represent the government grants related to income, and the total government grants are the sum between the two. If the data of government subsidy is missing, the "government subsidy" of "cash paid for purchasing goods and receiving labor services" in the cash flow statement is selected as the supplementary data. Tax incentives refer to the measures taken by the state to reduce or exempt a certain part of the tax burden of specific enterprises and taxpayers by using tax policies in accordance with the provisions of tax laws and administrative regulations. Most of them refer to corporate income tax. Indicates tax benefits. The rest of the control variables are listed in Table 2.

Table 1. Carbon Information Disclosure Evaluation Index System

Qualitative	Quantitative
(1) Whether to incorporate carbon emission reduction into the company's strategy and management system (2) Whether to identify the business risks that future climate change will bring to the enterprise (3) Whether to disclose major environmental problems or sudden environmental problems (4) Whether to bring honor to the enterprise due to energy conservation and emission reduction (5) Whether to take measures to achieve energy conservation and emission reduction (6) Whether to set up a corresponding department to supervise and supervise (7) Whether it has been audited by a third party	(8) Research funds invested in energy conservation and emission reduction (9) Economic benefits from energy saving and emission reduction (10) Carbon emission (11) Direct and indirect carbon emissions (12) Change in carbon emissions (13) Energy consumption (14) Participate in carbon emissions trading (15) Setting clear and effective future carbon reduction targets (16) Current year's carbon emissions target completion

Table 2. Variable Definition

variable type	variable	variable name	calculation method
Explained variable	TFP	full factors production rate	$TFP = \ln Y - x_1 \ln L - x_2 \ln K - x_3 \ln M$
Explanatory variables	CID	Carbon Information Index	The sum of the scores of each enterprise/the total score of carbon information disclosure
Moderator	ZB	Government subsidies	Ln [increase in deferred earnings + "government grants" in non-operating income]
	SS	Tax incentives	Income tax expense/EBIT
control variable	LEV	Asset-liability ratio	Annual average total liabilities/average total assets
	SIZE	Enterprise scale	Natural logarithm of total assets at the end of the period
	SOE	Equity nature	1 for state-owned enterprises, 0 for non-state-owned enterprises
	GR	Growth rate of total operating income	(Total operating income for the current period-Total operating income for the previous period)/Total operating income for the current period
	year	Annual	Dummy variables, controlling for annual factors

5 Analysis of Empirical Results

5.1 Descriptive Statistics

After analyzing the obtained data (see Table 3), it can be seen that the maximum value of total factor productivity (TFP) is 4.988, the minimum value is 2.416, the mean value is 4.230, and the median value is 4.208. This shows that the total factor productivity of the sample enterprises is not very different, the overall development level is relatively average, maintaining a long-term and stable development, and the adjustment of the market structure is not large, indicating that the industry now lacks the leading role of the "leader" and takes the lead Technological innovation to improve the efficiency of resource allocation. The average value of the carbon information disclosure index (CID) is 0.282, the maximum value is 0,884, and the minimum value is 0, which shows that the carbon information disclosure index varies greatly, and the awareness of voluntary carbon information of enterprises is not strong, and there is still a lot of room for improvement. The standard value of government subsidy (ZB) is 0.858, and the difference between the maximum value and the minimum value is large, indicating that the subsidy treatment enjoyed by the sample enterprises is quite different. Combined with the scale of enterprises (SIZE), the standard deviation of the scale of enterprises in this industry is 3.310, indicating that the scale of enterprises is also quite different, and the development space is also very different. The minimum value of tax incentives (SS) is negative, because some companies have negative EBIT, and the smaller the value, the greater the intensity of tax incentives. From the perspective of the minimum value and the maximum value, the industry receives the intensity of tax incentives varies greatly. Other control variables show that most of the sample enterprises are non-state-owned enterprises except for a few state-owned enterprises; and the difference in the growth rate of operating income (GR) is obvious, indicating that the operating conditions and market share capabilities of the sample enterprises are distinct.

Table 3. Descriptive statistics

variable	sample size	mean	Standard Deviation	Min	Median	Max
TFP	573	4.230	0.288	2.416	4.208	4.988
CID	573	0.282	0.136	0.000	0.265	0.884
ZB	573	6.684	0.858	3.301	6.699	8.974
SS	573	0.122	0.355	−4.060	0.130	6.178
SIZE	573	9.507	0.481	7.231	3.313	10.986
LEV	573	4.682	3.310	0.035	20.299	20.299
SOE	573	0.016	0.124	0.000	0.000	1.000
GR	573	0.203	1.294	−0.885	0.080	25.294

Table 4. Correlation analysis

Variable	TFP	CID	ZB	SS	SIZE	LEV	SOE	GR
TFP	1							
CID	0.49***	1						
ZB	0.19***	0.114***	1					
SS	0.159***	0.028	−0.028	1				
SIZE	0.156***	0.011	0.134***	−0.013	1			
LEV	−0.030	−0.039	0.035	0.012	−0.343***	1		
SOE	−0.006	−0.080*	−0.052	0.022	−0.010	0.032	1	
GR	0.074*	0.050	0.009	−0.002	−0.051	0.001	−0.05	1

Note: ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively, the same as in the table below.

5.2 Correlation Analysis

To test the rationality of variable selection, the following correlation analysis was performed (see Table 4). The analysis results show that the correlation coefficient between carbon information disclosure (CID) and total factor productivity (TFP) reaches 0.494, which indicates a significant positive correlation at the 1% level, proving that high-quality carbon information disclosure is conducive to high-quality enterprises development of. Both government subsidies (ZB) and tax incentives (SS) are significantly positively correlated with total factor productivity at the level of 1%, which indicates that government incentives are beneficial to the high-quality development of enterprises to a certain extent, and the greater the intensity of government incentives, the more The higher the level of high-quality development. Both firm size (SIZE) and operating income growth rate (GR) are positively correlated with total factor productivity, but the former is more significant than the latter. The debt-to-equity ratio (LEV) and the nature of equity (SOE) are both negatively and insignificantly related to total factor productivity.

5.3 Regression Analysis

From the regression analysis results, the Adj_R2 value of model 1 is 0.266, and the F value is 42.547, which are significant at the 1% level, indicating that the data in model 1 have a high degree of fit. The construction of Model 1 is reasonable. The regression coefficient value between the carbon information disclosure index CID and total factor productivity TFP is 0.728, which means that there is a significant positive correlation at the 1% level, indicating that the higher the carbon information disclosure index, the more conducive to the high quality of enterprises in this sub-industry development, fully demonstrating that hypothesis 1 is urban. The value of Adj_R2 of model 2 is 0.270, and the value of F is 36.297; the value of Adj_R2 of model 3 is 0.287, and the value of F is 36.297. Comparing the regression results of model 2 and model 3, we can see that model 2 is significant at the 5% level, and model 3 is significant at the 1% level. Both models are reasonably constructed, and model 3 has a higher level of significance than model 2. The regression coefficient between the multiplication term CID*ZB of the carbon information index CID and government subsidy ZB and the total factor productivity TFP is 0.063, indicating that there is a positive correlation between the two, and it is significant at the 10% level; while the carbon information index CID and the regression coefficient between the multiplication term CID*SS of tax preference SS and total factor productivity TFP is 0.473, and it is significant at the 1% level, which proves that both assumptions 2 and 3 are true, that is, government incentives have an impact on carbon emissions. There is a positive moderating effect between information disclosure and high-quality development of enterprises, that is, the greater the intensity of government incentives, the more obvious the positive correlation between carbon information disclosure and high-quality development of enterprises. However, tax incentives have a stronger regulating effect than government subsidies, that is, compared with government subsidies, tax incentives are more significant in encouraging high-quality development of enterprises.

5.4 Robustness Test

In order to ensure the robustness of the research results in this paper, this part adopts the method of replacing the total factor productivity (TFP) of the explained variable to conduct the robustness test, that is, replacing the total factor productivity calculated by the OP method fitting The total factor productivity calculated under the LP method in this paper. Specifically, on the basis of adding dummy variables (whether the enterprise exits the market), the labor capital investment (number of employees), enterprise capital (net value of fixed assets), and enterprise capital investment (investment in fixed assets) of the sample enterprises are selected for the production Multivariate linear regression is carried out on the output (the added value of the enterprise), and its residual is used to represent the total factor productivity of the enterprise. The definitions of the variables used in measuring the total factor productivity of enterprises are consistent with the definitions under the LP method and the control variables remain unchanged. The results show that after changing the measurement method of total factor productivity, the research conclusions consistent with the main test are still obtained (Table 5).

Table 5. Regression analysis

Variables	(1)	(2)	(3)
	model1	model2	model3
cid	0.728***	0.604**	0.966***
	(0.000)	(0.010)	(0.000)
size	0.102***	0.099***	0.101***
	(0.000)	(0.000)	(0.000)
lev	0.004	0.004	0.004
	(0.224)	(0.251)	(0.223)
soe	0.080	0.085	0.070
	(0.337)	(0.308)	(0.391)
gr	0.013	0.013	0.013
	(0.106)	(0.110)	(0.104)
cz		0.063*	
		(0.048)	
cs			0.473***
			(0.000)
_cons	2.947***	2.975***	2.955***
	(0.000)	(0.000)	(0.000)
N	573	573	573
R^2	0.273	0.278	0.295
adj. R^2	0.266	0.270	0.287
F	42.547	36.297	39.425

6 Conclusions

In the context of dual carbon, this paper takes the 2018–2020 data of 191 A-share chemical raw material and chemical product manufacturing companies as the research sample, and draws the conclusion that corporate carbon information disclosure is important to the high-quality development of companies It has a significant positive impact, and government incentives have a positive moderating effect on the relationship between carbon information disclosure and enterprise high quality. The greater the government incentive intensity, the more significant the positive correlation between carbon information disclosure and enterprise high-quality development. The moderating effect of tax incentives is stronger than that of government subsidies. Based on the above conclusions, the following suggestions are put forward:

(1) The analysis and results show that the carbon information disclosure quality of chemical raw material and chemical products manufacturing enterprises is not high, and there are even cases where carbon information is not disclosed. My country is a big

manufacturing country, and the manufacturing industry is also a big carbon emitter. My country should actively promote carbon neutrality according to the process, establish relevant laws and regulations, and include carbon information in its main reports. The Ministry of Finance should also build a unified carbon information disclosure evaluation system as soon as possible, and realize the transition from unwilling disclosure to voluntary disclosure to mandatory disclosure as soon as possible, which is also conducive to the supervision of corporate stakeholders and expands the value of carbon information disclosure.

(2) The Chinese government should increase the intensity of incentives, clarify the incentive mechanism, and not only give heavy polluting industries, but also comprehensively cover the government's incentive policies for every carbon-emitting enterprise, and every enterprise has an inescapable role in reducing carbon emissions. Responsibility. Government incentives can help enterprises to carry out technological innovation and resource allocation from the capital, and then can improve total factor productivity and improve total factor productivity is the source of power for high-quality development. Although it cannot directly generate economic benefits in the short term, in the long run, it will undoubtedly greatly enhance the competitiveness of enterprises in the future. To improve total factor productivity and promote high-quality development, the key is to properly handle the relationship between the government and the market, and to improve the institutional mechanisms and policy measures that are conducive to the optimal allocation of resources.

(3) Shi Yubo, president of the China Energy Research Association, said at the Forum on High-Quality Energy Development that we are now at a critical juncture in energy transition and addressing climate change. What needs to be done is to actively optimize the chemical industry structure and use innovative technologies to achieve energy conservation and emission reduction. To speed up the green and low-carbon transformation of energy, it is necessary to carry out effective digital management of energy, pay attention to low-carbon adoption in terms of adoption, and strengthen the research and development of green energy and products. Write more imaginations to drive the realization of the two-carbon goal. In the process of achieving the carbon neutrality goal, we should "properly handle the relationship between pollution reduction, carbon emission reduction and energy security, industrial chain supply chain security, food security and people's normal life".

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