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Government Environmental Pressure and Market Response to Carbon Disclosure: A Study of the Early Chinese ETS Implementation

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Abstract: We studied how companies' carbon disclosures affect the cost of capital under the Chinese government's introduction of the Emissions Trading Scheme (ETS) regulation. We also tested how much the effect varied between state-owned and private enterprises, and between polluting and non-polluting industries. Since, at its early stage, the market may perceive signals and implementations of environmental regulation as a cost burden, the effect of environmental disclosure, which is traditionally known to reduce the cost of capital, may be different. Using a comprehensive index through content analysis and targeting companies in China's pilot ETS regions between 2011 and 2016, our study showed the following test results. First, for the companies in regions where the ETS regulation was introduced, while carbon disclosure was below a certain level, disclosure raised the cost of capital, and after carbon disclosure was sufficiently high, disclosure decreased the cost of capital. Second, this inverted-U-shaped relationship appeared in non-state-owned enterprises only, and state-owned enterprises showed a traditional linear relationship that disclosure lowers the cost of capital. Third, this non-linear relationship was statistically significant only in the non-heavy pollution industries. This study contributes to the literature in that there are limited studies on the market effects of China's early introduction of the ETS regulation.

Keywords: government pressure; carbon disclosure; cost of equity capital; state-owned enterprise; heavy pollution industry

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1. Introduction

The global environmental crisis has pushed global policymakers to make political and legally binding agreements among participants during the period of the Kyoto agreement in 1995, the Copenhagen accord in 2009, and the Paris agreement in 2015 [1,2]. After Copenhagen, Chinese policymakers decided to establish their own carbon trading markets in 2010, and by 2013 they launched their initial trading markets in seven pilot provinces [3–6].

Studies have shown that regulation is one of the most important factors influencing a company's environmental policy [7–9], and it is also the case in China [2,10,11]. As the market response to an environmental regulation may vary with the timing of the market and the regulation [2,4], studying the initial market reaction to China's regulatory initiative related to climate change may be worth exploring. Moreover, China's institutional uniqueness can provide a more pronounced effect than other countries on the influence of regulations [12–15]. Therefore, a study on the impact of the Chinese government's launch of its carbon markets in 2013 can offer an important implication given that the markets for carbon in many countries are still in their infancy.

Although information disclosure and the cost of equity has been studied widely [16–19], relatively few studies have focused on the relationship between carbon disclosures and the cost of capital and generally showed a relationship where carbon disclosure reduces the cost of capital, i.e., a positive market response [20–23]. However, as stringent environmental regulation can be perceived as an increase in corporate burden and therefore may lead to an adverse market reaction [24–28], the relationship between carbon disclosure and cost of capital may change after the government's regulatory actions.

This study investigated how the effect of carbon emission disclosure on the cost of capital appeared under the influence of the introduction of the Emissions Trading Scheme (ETS) regulation in China. We also examined whether this relationship could vary depending on the company's ownership structure and industry characteristics. Based on multiple resources available, including annual reports and sustainability reports, we performed content analysis to construct a carbon disclosure index similar to the Carbon Disclosure Project (CDP) index. We analyzed the 2011-2016 six-year period of Chinese firms listed on the Shanghai and Shenzhen Exchanges, which are part of the pilot ETS regions.

Our empirical test results are as follows. First, we discovered an inverted-U-shaped relationship between carbon disclosure and the cost of capital for our sample companies located in regions where pilot ETS has been announced since 2011 and implemented since 2013. It appears that, below a certain disclosure level, the market predicted that the coercive pressure caused by the initial ETS implementation would increase the cost burden on companies and increase potential short-term risks. However, the non-linear result of this study showed that when the disclosure exceeds a certain level, the negative effect of regulatory pressure is overcome, and the traditional positive effect of disclosure appears.

Second, such a non-linear relationship for the ETS-regulated companies appeared only in non-state-owned enterprises (non-SOEs). For state-owned enterprises (SOEs), we found a linear relationship consistent with the previous studies [20–23], indicating that the market is not concerned about the regulatory effects on SOEs. Unlike developed countries, in China, social pressure is not enough, and governmental influence is relatively strong [12,15], making political legitimacy more critical for businesses. SOEs which have already secured political legitimacy may be less likely to be affected by regulatory pressures [13].

Our final tests revealed that the inverted-U relationship between carbon disclosure and the cost of capital appears only in non-heavy pollution industries (non-HPI). The test result for the heavy pollution industries (HPI) is statistically insignificant. Since the polluting industry's active disclosure efforts partially offset the negative impact from regulations, the various responses of information users may have been the cause of failure to obtain a significant result. Unlike SOEs, which showed a significantly negative coefficient, the market reaction for HPI might be interpreted as relatively mixed.

This study is one of the rare empirical studies investigating the effect of the mandatory ETS implementation of the Chinese government on the relationship between carbon disclosures and the cost of equity capital. So far, there have been only a few studies on carbon disclosure-cost of capital using samples from the United States, China, and South Africa [20–23]. They are all common in that they rely on content analysis of CDP questionnaires to measure carbon disclosure. If we ignore the comparability issue essential in content analysis, the difference between studies can be regarded due to the differences of test samples and study designs. Among them, only Li et al. [21,22] studied Chinese data. However, their research has a limitation in that the number of evaluated items measuring carbon disclosure is relatively simplified, and their research interests, such as the effect of media reporting or marketization, are different from ours. Considering the relatively massive size of the ETS markets in China, studying Chinese's early experiences is meaningful in carrying out the ETS-related policies in other countries, including countries in the Third World. We believe that our study contributes to the literature in that it found complex relationships among variables, which is worth further research.

The remaining sections are organized as follows. The following section covers literature review and hypotheses developments. Section 3 presents the research design and

samples selection. The results of descriptive statistics and regression analyses are provided in Section 4. Finally, Section 5 summarizes this paper and discusses implications of the findings of this study.

2. Literature Review and Hypothesis Development

2.1. Chinese Climate Change Action and Its Iinfluence

During the 1990s and 2010s, international consultations to cope with the climate crisis reached an agreement among countries, and China decided to create a carbon credit market after the Copenhagen conference in 2009, although until Copenhagen agreements were not binding [3–6]. Since July 2010, China's National Development and Reform Commission (NDRC) has launched national low-carbon provincial and municipal pilot projects in seven provinces and eighty-one cities, exploring low-carbon development models and effective paths for reducing carbon emissions. In October 2011, China issued the "Notice on The Pilot Phase Work of Carbon Emission Trading" and became one of the early initiators who implemented the Emission Trading Scheme, in specific zones including Beijing, Shanghai, Shenzhen, Tianjin, Guangzhou, Chongqing, and Hubei' [3,29]. The first ETS pilot phase had been set from 2013 to 2014, and Shenzhen took the lead in launching the carbon emission trading market in 2013. The seven pilot carbon markets had been gradually active since the launch, with the trading volume increasing gradually. The Chinese pilot ETS regions account for a quarter of the Chinese economy. About 2,000 companies participated, with 123 million dollars of carbon allowances auctioned off by 2015 [3]. During this period, companies and investors in the Chinese market faced signals and implementations of a newly imposed government environmental regulation, as shown in Table 1.

Studies have generally pointed out that government regulation is one of the most critical factors influencing corporate environmental policies [2,7–11,14,15,26,30–35]. For example, in an analysis of EU CDP data by Sakhel [33], companies were mostly exposed to regulatory risk than disaster or market risk, among the risks related to climate change. In Abreu et al. [9]'s survey on Canada's oil and gas industry, respondents perceived government pressure as the most important, and the pressure had the most significant influence on the company's proactive strategy. Grauel and Gotthardt [7] suggested that the government's environmental regulations lead to an increase in voluntary corporate environmental disclosures for various reasons such as: learning regulations in advance, exempting from stricter regulations, saving money to meet tougher future regulations by investing in advance; and gaining legitimacy from stakeholders and society. Hsueh [35] also showed the positive relationship between a new regulation and more carbon disclosure. Conversely, according to Cadez et al. [8], regulatory uncertainty about when and how regulations will be implemented reduces firms' climate action by deferring the relevant investments.

Studies on China have the same conclusion. In a Walker et al. [14]'s study, regulatory pressure positively influences both environmental behavior and reporting. According to Liu et al. [34], coercive pressure of government regulation significantly affects corporate carbon management initiation behavior. Chen et al. [15] and Shen [11] also have discovered a significant and positive effect of regulatory pressure on the carbon policies of the business. Accordingly, we predict that government regulations will have a substantial impact on corporate carbon-related strategies, activities, disclosures, and related responses.

Aside from the impact of government regulations on a company's behaviors or disclosures, the market response to a regulation may not necessarily be positive. This is because the regulatory implementation can mean an increase in corporate costs and a decrease in revenues. Shane [24] showed that the value of regulated companies decreased as the environmental disclosure requirement of pollution control performance and related costs were strengthened. Blacconiere and Northcut [25]'s study showed a similar decline in value as a result of the introduction of stricter regulations. According to Ramiah et al. [26], a series of regulatory signaling related to climate change has caused a decrease in value in some industries.

Table 1. China's Environment Events around and after the launch of pilot ETS.

Date	Event
9 July 2010	Circular on the Implementation of low-carbon Pilot projects in Provinces and Cities
23 October 2011	"Notice on The Pilot Work of Carbon Emission Trading"
22 November 2011	White Paper on "China's Policies and Actions on Climate Change 2011"
27 January 2012	Notice of the State Council on the issuance of the Work Plan for controlling Greenhouse gas Emissions during the 12th Five-Year Plan Period
17 June 2013	The First National Low-carbon Day
8 June 2013	Launch Shenzhen ETS pilot phase
26 November 2013	Launch Shanghai ETS pilot phase
28 November 2013	Launch Beijing ETS pilot phase
19 December 2013	Launch Guangdong ETS pilot phase
26 December 2013	Launch Tianjin ETS pilot phase
2 April 2014	Launch Hubei ETS pilot phase
19 June 2014	Launch Chongqing ETS pilot phase
27 May 2014	Notice of the General Office of the State Council on the issuance of the Action Plan for Energy Conservation, Emission Reduction and Low-carbon Development for 2014-2015
1 January 2015	New Environmental Protection Law
18 December 2017	Construction plan of national carbon emission trading market
1 January 2018	Environmental Protection Tax Law of People's Republic of China
19 April 2019	Notice of the State Council on the issuance of the Work Plan for controlling Greenhouse gas Emissions during the 13th Five-Year Plan Period
16 July 2021	National Carbon Exchange listing

2.2. The Effect of Environmental Disclosure on the Cost of Capital

Prior studies have reported a negative association between financial disclosure and the cost of capital [16–19]. As for CSR, environmental and social performance is related to the cost of capital, credit ratings, and accessibility to finance [36–39], and environmental, social disclosure influences capital costs by affecting investor preferences, reducing information asymmetry, and allowing lower estimated risks [40–42]. The consensus of the empirical studies is that environmental and social disclosure reduce the cost of capital [42–45]. For example, using data from North America and Europe, Orens et al. [43] reported that web-based non-financial disclosures are negatively related to the implied cost of equity capital. Dhaliwal et al. [42] supported this by showing that voluntary CSR disclosure decreased the future cost of equity capital. Other studies, including Reverte [44]'s Spanish study and Chauhan and Kumar [45]'s Indian study, showed consistent results.

Unfortunately, limited studies have dealt with the relationship between disclosure of carbon emission information and the cost of capital [20–23]. He et al. [20]'s research on the S&P 500 firms, which answered the CDP survey, showed that carbon disclosure decreases the cost of capital, implied that the capital market rewards a firm's carbon transparency. Using a small Chinese sample, Li et al. [21] discovered that media reporting moderates the negative relationship between carbon information disclosures and the cost of equity financing. Using a sample similar to Li et al. [21], Li et al. [22]'s research claimed that both financial and non-financial carbon disclosures decrease the cost of capital. Lemma et al. [23]'s South African study also reported a negative relationship between voluntary carbon disclosure and the cost of capital.

2.3. The Effect of Carbon Disclosure on the Cost of Equity under Government Pressure

As shown above, the market reaction to the disclosure is more often positive, but the market may not always respond positively to environmental regulation. One reason is that companies may not have been proactive in responding to regulatory signals. For example, in Liu [10]'s study using Chinese data, perceived governmental pressure negatively influenced firms' environmental behaviors. This is because, until they are actually implemented, regulations are understood as obstacles to corporate goals, triggering negative emotions and making companies understand regulations as negative pressures, thus creating managers' passive behaviors [10,46]. Companies may start to act environmentally only after environmental regulations are defined as threats instead of opportunities [47]. In this case, regulation is understood more often as a cost to companies, and carbon management may not be implemented before the actual regulatory shock arrives, resulting in a lump-sum compliance cost and impairing short-term performance.

The second reason is that the market may also understand a company's environmental burden as a cost [48–50]. Of course, empirical results have not reported that the market moves consistently in the negative direction that predicts cost increases and revenue declines. According to Ramiah et al. [26], investors in Australia had various reactions to the government's signals of green policies depending on the industry the company is in. The market returns on various signals related to climate change before and after Obama's election as investigated by Ramiah et al. [51], or during the Trump administration by Nerger et al. [52] were also mixed.

However, as firms postpone decisions under high uncertainty of the initial stage of environmental regulation [53–55], the market cannot see their proactive creation of competitive advantage, thus leaving only concerns about cost burden, because the immediate effect of regulations can mostly be the imposition of various costs which decrease productivity and revenues [26,56–58], resulting in some value decrease [24,25].

Chapple et al. [59] focused on the Australian ETS-related signals during 2006 and 2009 and discovered that the market responded negatively to the news of ETS implementation and positively to the ETS delay. The time surrounding the Copenhagen Accord can also be such a period. Both of Matsumura et al. [27]'s S&P 500 CDP data from 2006 to 2008 and Lee et al. [28]'s Korean CDP data from 2008 to 2009 had negative market responses, implying that during the period the carbon emission information was accepted more often as an increase in future costs.

Jiang and Luo [2]'s Chinese data from 2009 to 2011 showed some positive market responses to regulatory signals related to climate change; however, the authors argued that most of the signals were related to regulatory delays and that the market responded positively to the delays, implying that in China between 2009 and 2011 environmental signals failed to stimulate companies to develop proactive environmental strategies.

Moreover, the impact of government environmental regulations in China may be more substantial than that of other countries. In China, civil pressure and institutional environment are insufficient to induce companies to respond to environmental issues proactively [12,14,15], complemented by the increased government influence and policy competition among government agencies [12,13].

Therefore, we expect that the Chinese market will react more strongly to the introduction of environmental regulations, and we predict that the market response to environmental disclosures will also be affected by the advent of regulations. Considering the complex and potentially adverse short-term effects of regulations [24–26,51,52,56–58], the market's positive response that previous studies have observed [42–45] may not necessarily be the same when China's ETS initiation is considered. What we are dealing with is initial regulatory shock, which can be more complex depending on the extent to which companies respond [49,50]. Therefore, we propose Hypothesis 1 as follows, without predicting the direction.

Hypothesis 1: *Under the influence of the implementation of the Chinese pilot ETS, a company's carbon emission disclosure differentially affects the cost of capital.*

2.4. The Effect of Carbon Disclosure on the Cost of Equity under Corporate Governamce

Government regulatory pressures may be perceived differently depending on the governance of a company. Differences in the degree of dependence on government among firms may lead to differences in their responses to government signals [13]. Li and Zhang [60]'s 2007 data showed that the percentage of state-owned among listed companies in China was 63%, while the average for Western countries such as the UK, Germany, and France was between 0.08 and 6.3%. Therefore, to study Chinese companies, it is worth investigating the differential effect of governmental ownership.

State-owned enterprises (SOEs) and their stakeholders may be more sensitive to government signals about environmental regulations because of their increased monitoring from the governmental participants who came in according to the government's shareholdings. In China, some of the SOEs' managers are appointed by the government [61]. As a result, SOEs have led the CSR reporting of Chinese companies during the period between 2001 and 2018 [62]. Moreover, better access to resources using a special relationship with the government [63] provides businesses easier access to government subsidies and external funding [64–67], resulting in increased profitability [68] and lower levels of cost of capital despite their possible inefficiency, in which case the market may not need to be sensitive to the impacts on SOEs, even in a situation where harsh regulations are introduced. Chinese studies have reported that government ownership relieves financial constraints during the financial crisis [69] and improves corporate performance [70,71].

Conversely, private companies and their stakeholders may be more sensitive to government regulation. According to Wang et al. [72], unlike SOEs, firstly, non-SOEs did not secure political legitimacy; secondly, because the government had a relatively lower influence on governance, non-SOEs did not have acted in advance reflecting the will of the government; and thirdly, their access to capital and government benefits are less robust than those of SOEs. Therefore, Wang et al. [72] suggested that the corporate response to the government's environmental initiation can be more pronounced in non-SOEs. Some studies have argued that SOEs in China have suffered inefficiency, resulting in a higher cost of capital [73,74]. SOEs may underperform due to policy burdens generally aimed at not company value but social value [75]. Some other studies have reported that China's non-SOEs respond better to environmental issues [76–78] and show higher efficiency than SOEs [79–82]. Studies also report that good CSR disclosure leads to good CSR performance [83,84]. Therefore, if private companies are more actively responding to environmental regulations and have managed their resources efficiently, the market will not be concerned about their carbon emission information, even considering the existence of newly tightened regulations.

However, the reality may be a little bit more complicated. Marquis and Qian [13] suggest that as SOEs already obtain political legitimacy, they have easier access to governmental resources, making them not respond sensitively to governmental signals. However, they also prove that greater government monitoring due to increased networking with government officials increases firms' responsiveness to governmental signals. We conjecture that if companies—whether SOEs or not—are not prepared for regulation or fail to secure legitimacy, they may receive more severe regulatory shocks, and it is unclear whether the impact will be more substantial in SOEs or non-SOEs. Therefore, we provide our hypothesis as implying no direction as below.

Hypothesis 2: *Chinese companies' carbon emission disclosure differentially affects their cost of capital between state-owned and non-state-owned enterprises.*

2.5. The Effect of Carbon Disclosure on the Cost of Equity in Polluted/Non-Polluting Industries

Since environmental regulations will most affect industries with high environmental pollution, and since large-scale capital investment is preceded in such industries, making it difficult to respond flexibly and preemptively to regulations compared to other industries, the market's response to environmental disclosures may also be the greatest. In a Engau and Hoffmann [85]'s research on regulatory uncertainty after the Kyoto Protocol, the chemical industry focused on avoidance strategies such as stopping investment and moving out of the regulated area, instead of a strategy to respond to regulatory uncertainty flexibly.

Conversely, suppose the industry has preemptively prepared for environmental regulations; a tightened regulation is not really new news, concerns about additional cost increase may be lower, and the market response may not be significant. Some studies have reported an increase in related disclosures from companies involved in environmental and social incidents [86,87]. Peng et al. [88] reported that firms in high-pollution industries disclosed more carbon information. Jaggi et al. [89]'s study showed that the positive influence of corporate governance on carbon disclosure was intensified in the highly polluting industries. Moreover, companies in high-pollution industries tend to report more substantial than symbolic information [90]. Possible explanations of the increased quantity and quality of disclosure when a firm encounters environmental issues include facing strong public pressure [91], gaining and maintaining legitimacy from the society [86,90,92] and obtaining differentiation against competitors by disclosing their environmental efforts [93]. Chinese studies reported higher environmental expenditures [78] and a greater impact of environmental activities on corporate performance [82] in polluting industries. As noted previously, more disclosure can in itself induce positive market reactions [42–45].

Shane [24]'s paper showed that the negative market effect of new environmental regulation was decreased for the already highly regulated industries, indicating that the market expects that regulators will act to mitigate the negative impact on those industries. In a study of chemical companies under a strengthened environmental regulation, Blacconiere and Northcut [25] reported that the negative effect was decreased for the firms with extensive environmental disclosures. It may imply that the market's negative response to an introduction of stronger regulations may not be more significant for the companies of a direct hit as long as they are prepared.

However, some other studies have reported a basically negative market reaction to the polluting industries. For example, studies on the Toxics Release Inventory disclosure regulation in the United States in 1989 reported a decline in stock prices [94,95]. According to Nguyen [96], after the ratification of the Kyoto Protocol, the polluting industries suffered a decline in Tobin Q in addition to a decrease in financial performance. What makes our prediction difficult is that the effect of disclosure on environmental violations is lower in China than in other countries [97]. Moreover, recent studies on China's polluting industries report that good CSR performance [98,99] or political connection [100] has the effect of easing the market reaction.

If companies in polluting industries are those directly hit by the new environmental regulations, and if these companies tend to make more disclosures, the differential preparation of polluting industries such as more disclosures can lead to different market responses in times of regulatory pressure. However, as it is not clear a priori whether China's polluting industry has been proactive and substantially preparing for environmental regulations, and it is unclear how the Chinese market will react, Hypothesis 3 is presented as follows without predicting the direction in the same way as Hypotheses 1 and 2.

Hypothesis 3: *Chinese company's carbon emission disclosure differentially affects their cost of capital between high-pollution and non-high-pollution industries.*

3. Research Design

3.1. Carbon Information Disclosure

We collected carbon disclosure data from annual reports and corporate social responsibility reports. The contents are quantified by a self-developed index based on the Carbon Disclosure Project questionnaire (the CDP index). CDP is a comprehensive index that considers various factors: governance mechanisms, opportunities and carbon risks, carbon strategies and targets, carbon actions and processes, carbon reporting and emissions, carbon emissions trading and offsetting, carbon engagement and communications, and others [101].

Companies' carbon disclosures consist of financial and non-financial carbon information [21,22]. Financial carbon information comprises low-carbon research investments and achievements, resource utilization, government reward, carbon emission trading revenues, and development issues. Non-financial carbon information contains low-carbon development strategies and the establishment of a low-carbon management department, as shown in Table 2. The score was scaled to 0, 1, and 2 points. A score of 0 means that no information is provided, and a score 1 is given for the general non-quantitative information. A score 2 means detailed quantitative information, including quantitative emission reduction targets, completeness of the targets, and the types of gases, among others. The total maximum score for a high disclosure level is 30 points. Overall, our disclosure index contains five categories with 18 items, and scores are converted into percentages. This index is more specified than the indexes used by previous studies such as He et al. [20] and Li et al. [21].

Table 2. Specifications of the Self-Constructed Carbon Information Disclosure Index.

Categories	No.	Details	Score
Financial Information	A1	(1) Government reward for energy conservation, carbon emissions trading revenue and other income information	0, 1, 2
	A2	(2) R & D expenditures, investment in technical assets and other expenditures	0, 1, 2
Corxporate Governance	B1	(1) Set up special management agency positions	0, 1
	B2	(2) Employee incentives for low carbon metrics	0, 1
	B3	(3) Build a sound management framework	0, 1
Corporate Strategy	C1	(1) Awareness of low-carbon forms	0, 1
	C2	(2) Corporate Strategy	0, 1, 2
	C3	(3) Low-carbon external communication	0, 1, 2
Low Carbon Target and Take Measures	D1	(1) Goals of Low-carbon, energy-saving, emissions reduction	0, 1, 2
	D2	(2) Methods by which to save energy and low-carbon measures	0, 1, 2
	D3	(3) Energy-savings and environmental protection achieved	0, 1, 2
	D4	(4) Awareness of the environmental system	0, 1
	D5	(5) Energy-saving emission and reduction incentives	0, 1
Emissions	E1	(1) Method of greenhouse gas emissions	0, 1, 2
	E2	(2) Emissions data	0, 1, 2
	E3	(3) Energy consumption type and energy amount	0, 1, 2
	E4	(4) Third party examines emission data	0, 1, 2
	E5	(5) Carbon emission permits trade mechanism	0, 1, 2

3.2. Research Model

Following Hail and Leuz [102] and Dhaliwal et al. [42], we used measures of the implied cost of equity capital proposed by Easton [103], modified-PEG ratio estimation (*COE*). *COE* is calculated from the changes in long-range earnings forecasts scaled by the stock price. The model is described below.

$$COE = \frac{\left[DPS_{t+1} + \sqrt{DPS_{t+1}^2 + 4 \times P_t \times (FEPS_{t+2} - FEPS_{t+1})}\right]}{2Price_t} \quad (1)$$

COE is the cost of equity financing; $FEPS_{t+1}$ is the earnings per share during year t+1; $FEPS_{t+2}$ is the earnings per share during year t+2; DPS_{t+1} is the dividend per share during year t+1; Pricet is the stock closing price at the end of year t.

We employed the following regression model (2) to test our hypotheses. The cost of equity (COE) is the dependent variable, and the carbon information disclosure (CID) is the independent variable. We employed a lead-lag approach in which the dependent variable is t+1 while the independent variables are at time t, to reduce endogenous problems.

$$COE_{it+1} = \beta_0 + \beta_1 CID_{it} + \beta_2 CID_{it}^2 + \beta_3 SIZE_{it} + \beta_4 LEV_{it} + \beta_5 MTB_{it} + \beta_6 OCF_{it} + \beta_7 OWN_{it} + \beta_8 IND + \beta_9 YEAR + \varepsilon_{it} \quad (2)$$

We included the following control variables. $SIZE$ is the natural logarithm of the market value of common equity at the beginning of year t. $SIZE$ captures various factors such as public pressure or financial resources, which influence the disclose of carbon information [104]. MTB is the market-to-book ratio, defined as the market value of equity divided by the book value of equity at the end of year t. Given that debt holders demand greater disclosure to monitor a firm's financial and operational activities [105], we include the debt ratio (LEV). We had operating cash flow (OCF) in our model because OCF captures financial resources that affect the cost of capital. OWN is the natural logarithm of the largest shareholder ratio. The ownership structure is one of the essential factors related to managerial decisions. Finally, year and industry dummies specify the time and industry in which the observations were made.

3.3. Sample Selection

Our data included 914 Chinese public firm-years from 2011 to 2016 available from various sources, including Chinese Stock Market and Accounting Research (CSMAR) and RESSET databases. Panel A of Table 3 indicates the distribution of sampled firms by year. The number of carbon disclosure firms increased over time, from 130 in 2011 to 174 in 2016. Although the possible top score of each firm is 30, Part A shows that the actual carbon information disclosure scores range from 1 to 19, implying that the general disclosure level is not high. The average score is less than 13, which is only about 40 percent of the total score.

Table 3. Sample Distributions.

Part A: Sample Distribution and Carbon Information Disclosure Score						
Year	**N**	**Percentage (%)**	**Mean**	**Standard Deviation**	**Min**	**Max**
2011	130	14.22	6.29	3.42	1	15
2012	149	16.30	6.41	3.48	1	15
2013	151	16.52	6.8	3.95	1	18
2014	154	16.85	7.06	3.86	1	19
2015	156	17.07	7.55	4.03	1	17
2016	174	19.04	7.41	4.18	1	18
total	914	100				

Part B: Industry Distribution		
Industries	**N**	**Percentage (%)**
Transportation	65	7.11
Mining and Quarrying	33	3.61
Manufacturing	442	48.35
Electricity, Gas, Steam and Water Supply	56	6.13
Construction	72	7.88
Wholesale and Retail Trade	58	6.35
Real Estate Activities and Leasing	76	8.32
Professional, Scientific and Technical Activities	112	12.25
Total	914	100

Part B of Table 3 presents the number of firms that disclose carbon information by industry. The most significant number of firm-year observations in the sample is from the manufacturing industry (442 firm-years), followed by Professional, Scientific and Technical Activities (112 firm-years), and the Real Estate Activities and Leasing (76 firm-years).

4. Empirical Results

Table 4 presents the descriptive statistics of the variables used in this study. The table shows that the mean of *COE* and *CID* are 0.114 and 0.22. The average size of companies (23.416) is slightly larger than that seen in the general samples, suggesting that the company disclosing carbon issues is likely to be more successful than the average company. The means of *HPI* and *SOE* are 0.561 and 0.130, respectively, indicating that more than half of our total sample firms are from high pollution industries, and the government controls only thirteen percent of our sample firms. Among the companies of carbon emission disclosure in the ETS regions, it can be said that the proportion of SOEs is tiny compared to the Chinese average (Li and Zhang [60], about 60%).

Table 4. Descriptive Statistics.

Variables	N	Mean	Median	Standard Deviation	Min	Max
COE	914	0.114	0.109	0.040	0.001	0.276
CID	914	0.220	0.219	0.121	0.031	0.594
SIZE	914	23.416	23.072	1.672	20.185	28.509
LEV	914	0.492	0.511	0.201	0.009	0.892
MTB	914	1.903	1.530	1.143	0.711	9.109
OCF	914	0.063	0.063	0.081	−0.274	0.484
OWN	914	3.566	3.715	0.549	1.286	4.484
SOE	914	0.130	0	0.337	0	1
HPI	914	0.561	1	0.497	0	1

Table 5 presents the correlation matrix of the test variables. The table shows no statistically significant relationship between *CID* and *COE*. This is contrary to the prediction from the literature that the two will deliver a negative relationship [20–23,42–45] and suggests the possibility that the relationships in both directions overlaps in our data.

The second point to look at is the relationship between *CID* and *SOE*. *CID* has a statistically insignificant but negative relationship with *SOE*, which supports the possibility that SOEs are negligent in disclosure and therefore did not have responded preemptively and proactively to regulatory initiatives. However, we do not know how the market will respond because SOE's delayed response to regulations can result in a more significant regulatory impact, or conversely, it may mean that SOEs do not need to be proactive, and the market does not need to worry about them.

Finally, *CID* showed a statistically insignificant negative relationship with *HPI*. Contrary to the observations of some previous studies [86–90], the test result in Table 5 can be interpreted that the polluting industries have less disclosure, and if less disclosure is understood as a lack of preparation for the regulation, we can predict that the regulatory impact and adverse market reaction will more substantial in the pollution industries.

However, correlation analysis can show a superficial relationship between the two variables because other factors that affect them are not considered. Therefore, to investigate the causal relationship, in the next section we will attempt regression analyses controlling influencing factors.

Table 5. Correlation Matrix.

Variable	COE	CID	SIZE	LEV	MTB	OCF	OWN	SOE	HPI
CID	0.001	1							
	(0.976)								
SIZE	0.135 ***	0.283 ***	1						
	(0.000)	(0.000)							
LEV	0.236 ***	0.194 ***	0.628 ***	1					
	(0.000)	(0.000)	(0.000)						
MTB	−0.226 ***	−0.170 ***	−0.564 ***	−0.516 ***	1				
	(0.000)	(0.000)	(0.000)	(0.000)					
OCF	−0.110 ***	0.101 ***	−0.042	−0.242 ***	0.159 ***	1			
	(0.001)	(0.002)	(0.210)	(0.000)	(0.000)				
OWN	−0.068 **	0.033	0.320 ***	0.172 ***	−0.218 ***	0.058 *	1		
	(0.040)	(0.317)	(0.000)	(0.000)	(0.000)	(0.082)			
SOE	−0.018	−0.024	0.003	0.027	−0.115 ***	−0.028	0.125 ***	1	
	(0.589)	(0.475)	(0.931)	(0.418)	(0.000)	(0.398)	(0.000)		
HPI	−0.021	−0.087	−0.128 ***	0.011	0.151 ***	−0.141 ***	0.018	−0.018	1
	(0.536)	(0.610)	(0.000)	(0.749)	(0.000)	(0.000)	(0.580)	(0.581)	

Note: *, **, *** denote significant at $p < 0.01$, < 0.05, and < 0.01, respectively.

Regression test results for Hypothesis 1 are in Table 6 model 1. Since the coefficient of CID^2 is statistically significant at the 1% level, *CID* forms an inverted-U relationship with *COE*. This may be because the market is concerned about cost increase to respond to new regulations. However, if the level of environmental disclosure exceeds a certain level, it indicates that the cost effect will be dispersed into the past because sufficient responses from the company are already in place. Thus, the traditional negative relationship—more disclosure lowers the cost of capital—appears. *LEV* is positive at a significance level of 1%, suggesting that high-leverage firms are perceived to have more risk. The negative relationship between *OWN* and *COE* implies that concentrated firms are regarded as having lower risks.

Table 6. Regression Results.

Variables	Model1	Model2	Model3	Model4	Model5
Dependent	*COE*	*COE*	*COE*	*COE*	*COE*
moderator		*SOE*	*Non-SOE*	*HPI*	*Non-HPI*
Independent					
CID	0.087 **	−0.203 *	0.124 ***	0.078	0.102 **
	(2.255)	(−1.851)	(2.996)	(1.286)	(1.970)
CID^2	−0.253 **	0.498	−0.358 ***	−0.264	−0.262 *
	(−2.293)	(1.649)	(−2.993)	(−1.553)	(−1.723)
SIZE	0.000	0.003	−0.000	0.002	−0.002
	(0.065)	(0.884)	(−0.330)	(1.461)	(−1.009)
LEV	0.030 ***	0.022	0.030 ***	0.022 **	0.029 **
	(3.632)	(1.070)	(3.285)	(1.992)	(2.356)
MTB	−0.003 **	−0.008	−0.003 **	−0.002	−0.006 **
	(−2.201)	(−1.096)	(−2.190)	(−1.099)	(−2.154)
OCF	−0.006	−0.046	0.003	0.014	−0.044 *
	(−0.419)	(−1.307)	(0.197)	(0.729)	(−1.728)
OWN	−0.011 ***	−0.011	−0.011 ***	−0.009 ***	−0.011 ***
	(−4.934)	(−1.278)	(−4.612)	(−3.041)	(−3.271)
Intercept	0.161 ***	0.127	0.167 ***	0.115 ***	0.187 ***
	(6.791)	(1.433)	(6.682)	(3.375)	(4.997)
IND&YEAR	Included	Included	Included	Included	Included
Observation	914	119	795	513	401
Adj. R^2	0.244	0.223	0.250	0.358	0.125
F	19.40 ***	3.259 ***	17.51 ***	18.87 ***	5.416 ***

Note: *, **, *** denote significant at $p < 0.01$, < 0.05, and < 0.01, respectively.

Table 6 model 2 and 3 report our test results for Hypothesis 2. The estimated coefficients of *CID* and CID^2 are statistically significant at the 1% level only with non-SOEs samples. For SOEs, *CID* shows a traditional linear relationship to COE, although the significance level is just 10%. Our interpretation is that the group most affected by the introduction of the ETS regulation is non-SOEs, and the market is not concerned about the regulatory impact on SOEs. This may be because the market did not worry about the possibility of short-term performance decrease due to regulatory shocks because SOEs had already acquired legitimacy and resource accessibility through establishing a connection with the government [13,63].

The test results for Hypothesis 3 are presented in Models 4 and 5. The estimated coefficients of *CID* and CID^2 are statistically significant at the 5% and 10% levels only with Non-HPI firms. One possible interpretation is that the market was relatively more mixed with concerns about cost increases for which *HPIs* has no reason to be less, and assurances from *HPI's* proactive response to the regulations, resulting in no significant results.

Next, to control for any potential endogeneity around a firm's disclosure decision in our topic [106], we employed a two-stage least squares (2SLS) model [107]. In this model, we used two instrument variables: The Pollution Information Transparency Index (*PITI*) variable and the industry—year mean of the carbon information disclosure (*CID_IND*) variable based on the researches [38,107,108]. The Pollution Transparency Information Disclosure Index (*PITI*) evaluates pollution levels, violation records, environmental audits, and overall corporate environmental behaviors of the major cities of China, provided by the China Institute of Public and Environmental Affairs (IPE) and the Natural Resources Defense Council (NRDC).

Table 7 shows the second stage results, which showed increased coefficient values in all models and almost consistent results with Table 6, except model 5 where the significance of *CID* disappeared. Therefore, the 2SLS results show that most of the conclusions from Table 6 are maintained even after endogeneity is controlled.

Table 7. Endogeneity-Controlled Regression Results.

Variables	Model1	Model2	Model3	Model4	Model5
Dependent	*COE*	*COE*	*COE*	*COE*	*COE*
moderator		*SOE*	*Non-SOE*	*HPI*	*Non-HPI*
Independent					
CIDFIT	0.400 **	−1.337 *	0.379 *	0.149	1.630
	(2.133)	(−1.934)	(1.880)	(0.620)	(1.496)
$CIDFIT^2$	−0.920 ***	1.969	−0.883 **	−0.418	−2.697 *
	(−2.698)	(1.358)	(−2.383)	(−0.848)	(−1.808)
SIZE	−0.000	0.005	−0.001	0.005 ***	0.000
	(−0.271)	(1.397)	(−0.595)	(3.407)	(0.136)
LEV	0.034 ***	0.027	0.036 ***	0.032 ***	0.030 **
	(3.916)	(1.019)	(3.702)	(2.918)	(2.407)
MTB	−0.007 ***	−0.007	−0.007 ***	−0.000	−0.006 **
	(−4.738)	(−0.972)	(−4.556)	(−0.294)	(−2.159)
OCF	−0.009	−0.015	−0.001	−0.002	−0.028
	(−0.531)	(−0.522)	(−0.063)	(−0.119)	(−1.098)
OWN	−0.000 ***	−0.000 *	−0.000 ***	−0.000 ***	−0.000 ***
	(−2.977)	(−1.886)	(−2.970)	(−2.792)	(−3.090)
Intercept	0.088 **	0.170	0.101 ***	0.021	−0.069
	(2.488)	(1.455)	(2.651)	(0.489)	(−0.399)
IND&YEAR	Included	Included	Included	Included	Included
Observation	914	119	795	513	401
Adj. R^2	0.091	0.307	0.089	0.321	0.145
F	14.03 ***	2.374 ***	12.06 ***	21.18 ***	6.673 ***

Note: *, **, *** Denote significant at $p < 0.01$, < 0.05, and < 0.01, respectively. *CIDFIT*: The fitted value of *CID* from the first-stage regression.

5. Conclusions and Discussion

In this study, we investigated the effect of corporate carbon disclosure under the new regulatory environment, the mandatory Emissions Trading Scheme (ETS) implementation, on the cost of capital of Chinese companies from 2011 to 2016. Specifically, we first examined the impact of a company's CIP disclosure on the cost of capital. Next, we tested how this relationship between carbon disclosure and cost of capital differed between state-owned and non-state-owned firms and, finally, between high pollution–non-high pollution industries.

Our empirical results were as follows. First, we discovered that around the implementation of ETS Chinese market's response to carbon disclosure was non-linear. Instead of the uniformly diminishing effect of corporate carbon disclosures on the cost of capital, we found an increasing effect for the disclosures of less than a certain quality, and from disclosure over a certain quality, carbon disclosure diminished the cost of capital. We conjecture that at a time of high uncertainty, such as the early stage of a strengthened regulation, the market may show concerns about cost increase from corporate carbon information revealed in carbon disclosures. A net effect due to disclosure may appear in a decreasing direction from disclosing a certain quality or higher.

This may be because faithful disclosure is understood as a signal to the company's regulatory readiness. The market may judge high carbon disclosure quality as a signal that a company responds sufficiently to carbon regulations. In such a company, the cost increases due to the introduction of regulations related to carbon emission may not be sudden, and the cost can be distributed in the past, present, and future, thereby reducing the side effects of short-term cost increase. In that case, the long-term cost reduction effect such as securing legitimacy and reducing future regulatory implementation costs and related costs such as fines and litigation will be dominant.

It can be theoretically explained that the initial period of regulation has a different impact from the rest. Companies initially experience fluctuations such as cost increases but soon respond by changing how resources are used through innovation and efficiency [49,50]. In an event study of EU ETS by Brouwers et al. [48], the market showed a significant response only in 2006 and 2009, the first years of each regulatory phase. A time of transition like our study's period, when external conditions become stringent and many companies are unprepared, can be when the difference between prepared and not becomes clear. The nonlinearity of this study may be a differential result between the prepared and the unprepared.

Regulation induces companies to create innovations, thus gaining a competitive advantage [109,110]. Conversely, in other conditions, regulation can have side effects contrary to the regulator's intent [111,112]. Some studies of the financial impact of social performance have reported non-linearities in which financial benefits only occurred when large social investments were made, and the cost effect was greater in the middle investment group, implying that companies that achieve a comparative advantage through successful innovation are limited to those prepared through sufficient investment [113,114]. In short, regulation can bless those who are prepared and curse the unprepared in the name of cost and risk.

Our second test result is that the inverted-U relationship appears in the non-SOEs, whereas the traditional negative linear relationship appears in the SOEs. Our interpretation is that for SOEs, the market was less concerned about regulatory shocks. Since Chinese SOEs are directly affected by the government's policies due to their high share and direct dispatch of government personnel, it is likely that the Chinese government's environmental policy-related will is also being implemented in the SOEs. In this case, the effect of sudden cost increases from regulatory shocks may be low. The opposite interpretation is also possible. Since Chinese SOEs have already formed networks with the government and secured legitimacy, they can pay less for regulatory non-compliance. Under any interpretation that reflects China's unique characteristics, the market's less concern about SOEs in our data seems to be explainable.

Our final analysis is that the main findings of this study did not appear in the high-pollution industries, but rather the test result was statistically significant only in the non-pollution industries. Although the polluting industries are those that suffer the most from environmental regulations, some of them may have a higher level of disclosure, so the factor of an increase in the cost of capital due to regulatory shock and the factor of a decrease due to the partial increase in disclosure quality can be intertwined. On the other hand, the non-polluting industries were shocked by the regulation because there was no reason to prepare in advance, unlike the polluting industries, where regulation can become a fatal problem. Therefore, a proactive response is required.

This study looked at the market response of China's carbon emission-related disclosures through the cost of capital in the early stages of the ETS regulation. Considering the importance of Chinese experience of the ETS implementation, especially in terms of the size of their carbon market, which is the largest outside the EU and the US, and the accumulation of experience leading among third world countries, our study has a contribution in terms of how companies will be impacted when the ETS system is implemented.

Moreover, as regulations tighten, ETS systems are in place, and carbon emissions become a major strategic choice for companies, all stakeholders, including investors, financial analysts, regulators, and even researchers, will be responding to management decisions related to carbon emission-related issues because the information usefulness of related information will increase. This study, which showed that carbon emission disclosures can affect corporate financing in a complex way, will be helpful to all stakeholders who need corporate information. The results of this study will have certain implications for information users because it shows that a disclosure does not mean that everyone gets the same fruit, and that a strategically well-designed approach is needed to obtain it. However, our study could not sample all the listed companies in the ETS regions due to limitations in the cost of capital data, and although our disclosure variable through content analysis is richer than in the previous studies, the problem of comparability may be pointed out. Therefore, there are certain limitations in terms of generalization, and we ask the reader's attention.

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