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Influencing Factors of Companies' Behavior for Mitigation: A Discussion within the Context of Emission Trading Scheme

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Abstract: China built pilot carbon emission trading schemes in seven regions and established a national carbon trading market in electricity sector in December 2017. This study conducted a questionnaire survey of 570 companies in 29 regions nationwide and found that companies still need to improve mitigation measures regarding fossil fuel combustion, production technology, output adjustment and environmental management. By establishing regression models, influencing factors of carbon emission reduction are identified. Pilot emission trading policy has a significant impact on company emission reduction behaviors. Companies inside or outside the pilot region respond differently to the influencing factors. Companies inside emphasize more on energy price and mitigation potential, while enterprises outside pay more attention to investment and familiarity with technology and policy.

Keywords: emission trading scheme; carbon emission reduction; company behavior; influencing factors

1. Introduction

Faced with global climate change issues, countries need to actively take measures on the mitigation and adaption of climate change; this will reduce the negative effects of anthropogenic interference [1]. Emission trading scheme allows companies to freely trade carbon credits in the carbon market, and is the policy tool with the lowest cost for achieving emission reduction targets [2]. China launched a pilot carbon emissions trading scheme in seven provinces and cities in June 2013, and carried out a national emissions trading system in electricity sector on 19 December 2017 [3,4]. This scheme is expected to cover about 4 billion tons of CO_2 emissions and become the largest one in the world [5]. The carbon emission trading scheme internalizes CO_2 emissions costs of companies which directly reflects in the increase in energy consumption costs.

Several studies focus on the lessons learned from the seven pilot emission trading schemes and compare them with emission trading systems in other countries [6,7]. While equitable allocation among regions, sectors and enterprises is under heated discussion, we cannot neglect that companies are the most direct stakeholders and implementers of carbon market policies [8–10]. According to institutional theory [11], the theory of rational action [12] and the theory of planned behavior [13], perceptions of the outside world and the situation of the company itself will lead to different acceptance of policies, and companies will correspondingly take different actions [14]. A comprehensive understanding of audience perceptions and behavior patterns is important when developing and implementing effective policy [15]. Studying company preference of carbon emission reduction behaviors and identifying influencing factors would provide suggestions on the policy of carbon emission trading scheme and encourage enterprises to make rational mitigation decisions.

Kolk and Pinkse summarize six strategies for company responses to climate change policies including optimizing the production process, supply chain management and developing new products and markets [16]. Some research divides emission reduction choices into several types: no emission reduction measures, carbon emission trading, cleaner production, purification technology, etc. [17,18]. Cadez and Czerny find that companies tend to choose a single strategy rather than a combination of multiple ones [17]. Different influencing factors on companies' behavior are carried out by studies. The primary motivators for enterprises to formulate climate strategy include reducing costs, fulfilling management commitment, achieving company goals and complying with regulations [19,20]. A company's inherent characters such as their type or size, economic sector and mitigation capabilities often decide their climate strategies [21–23]. External environment, for instance, business environment, social culture, carbon exposure, regulations on the energy sector, etc. may also influence the measures taken by companies [22–24]. Based on institutional theory and the resource dependence theory, managers' international experience, business resources and national effects are also important factors [25,26].

Within the context of the upcoming establishment of national carbon emission trading scheme in China, this study explores company behaviors and their influencing factors by developing a nationwide questionnaire survey of enterprises. In Section 2, questionnaire design, data collection and data analysis methods including the selection of independent variables and research hypothesis, will be introduced. Section 3 shows the results of survey and regression on influencing factors. Then, discussions are made based on four types of mitigation behaviors. Finally, the conclusion and limitations of this study are presented.

2. Materials and Methods

2.1. Data Collection and Questionnaire Design

The data were collected via an online questionnaire. From January to April 2016, 1884 questionnaires were distributed among companies in different economic sectors, with different ownership and scales in 29 provinces, among which 570 valid samples were obtained through quality verification. Overall, 292 of them were companies from the seven pilot regions with carbon emission trading scheme, while 278 were from non-pilot regions. In addition, 160 of them were companies directly involved in carbon emission trading, while 410 were not. To ensure the quality of information, respondents were company management tasked with environmental and energy issue, and whose cognition, opinion and attitudes can represent the situation of their companies.

The questionnaire consists of three parts. The first part collected companies' basic information: economic sector, ownership type, business scale, energy type, energy intensity and pressure, competition pressure, investment on energy saving, potential of emission reduction, familiarity of carbon emission reduction technology and emission trading scheme, learning capability and whether it is a pilot company. Secondly, companies' expectations of the national emission trading scheme were investigated based on time and emission reduction size. That is, how soon the company expected to be involved in the national carbon emission trading scheme, and the amount of reduction to be made after entering the market, respectively. Information collected in these two parts was treated as independent and controlling variables, which will be described in detail in Section 2.2.

In the third section, the status of carbon emission reduction behavior of companies is evaluated using a five-level Likert scale. Behaviors were categorized as mitigation from combustion processes, mitigation from production processes, mitigation by reducing yield and strengthening environmental management. Mitigation from combustion processes consisted of six specific behaviors: replacing fossil fuel, improving the efficiency of energy supply, combining heat and power generation, optimizing energy supply structure, using clean fuel, and installing carbon capture and storage equipment. There were seven concrete behaviors for mitigation from production processes: using recyclable materials, replacing manufacturing materials, optimizing product mix, improving producing

process, installing energy-saving equipment, adopting the most applicable technology and controlling the emission of non-CO_2 gases. Reducing output, terminating manufacture and transferring production to other countries were the three possible behaviors for mitigation by reducing yield. Strengthening environmental management was demonstrated by establishing systems for carbon emission monitoring, raising management capability, and improving the education and training of employees. Companies were invited to grade their compliance of each carbon emission reduction behavior from 1 to 5, where 1 means not matched at all and 5 means completely matched. The average value of each type of performances represented the status of each company's behavior.

The quality of the questionnaire was checked for both reliability and validity. The reliability of the questionnaire was only affected by random errors and evaluated through Cronbach's α [27]. Usually, the reliability is good if Cronbach's α is more than 0.9, while it is acceptable if more than 0.7. As shown in Table 1, the result of the reliability test for the overall survey was 0.858 and companies' carbon emission reduction behavior was 0.792, which were both acceptable. Table 2 reflects the result of the validity test of the carbon emission reduction behavior scale via principal component analysis. The Kaiser-Meyer-Olkin (KMO) coefficient was 0.910 and the significance of the Bartlett test is $p < 0.01$, indicating that the questionnaire passed the validity test.

Table 1. Results of the reliability test on the questionnaire.

Dimension	Description	Cronbach's α
Overall	All variables in the survey	0.858
Companies' behavior	Four types of behaviors in combustion, production, yield and environmental management	0.792

Table 2. Result of the validity test on questionnaires regarding the current situation of companies' carbon emission reduction behavior.

Item	Component			
	1	2	3	4
Combustion	0.367	−0.405	0.701	−0.077
Production	0.345	−0.415	0.736	−0.081
Yield	0.181	−0.127	0.499	−0.122
Environmental management	0.338	−0.384	0.700	−0.121
KMO	0.910			
P	0.000			

2.2. Data Analysis

This study uses multiple linear regression models to analyze the influencing factors of companies' carbon emission reduction behaviors which are taken as dependent variables.

2.2.1. Independent Variable Selection and Research Hypothesis

We divide the possible influencing factors into external pressure and internal driving force [28]. Institutional theory is widely used to analyze the influence of policies and social external pressures [11,29]. It states that institutional factors such as governmental regulation, market requirement and social expectations play an important role in companies' behavior. In the socio-political sphere, Liu et al. believe that policies, social pressure and expectations from special stakeholders are often a decisive factor in corporate behavior, while competitors, suppliers and consumers are often the influential factors [28]. Under environmental protection pressure, companies' environmental strategies and management performance are affected by factors such as energy

price [30], market competition [31], the carrying out of order and control policies or those with market incentives [32], regional differences [33], etc.

This study takes three variables that reflect external pressure: energy price, competitive pressure, and whether the company is in the carbon pilot region. If the company believes that the current energy price is too high, it may be reluctant to put more efforts on the use of clean energy to reduce carbon emissions. If the competitive pressure is too large, companies may not be willing to reduce carbon emissions with excessive resources to avoid the increase in costs and guarantee the larger market share. Companies in carbon pilot regions will take more actions, because they may have a better understanding of carbon market policies, show more awareness of the importance of energy-saving and carbon emission reduction and have larger mitigation pressure, compared with other enterprises.

Regarding the external pressure that companies face, the following hypotheses are presented:

Hypothesis 1a (H1a). *The larger the pressure on energy prices, the less companies will engage in carbon reduction behavior.*

Hypothesis 1b (H1b). *The larger the pressure on market competition, the less companies will engage in carbon reduction behavior.*

Hypothesis 1c (H1c). *Companies in pilot region will take more actions on carbon emission reduction compared with others.*

However, institutional theory cannot explain differences in behavior between companies facing the same external pressure [34]. The theory of rational action [12] and the theory of planned behavior [13] state that attitude, subjective norms, and perceived behavioral controls can affect individual behavior. As a result, for companies' decision-making on behavior, instead of external pressure, a company's own resources and capacities [35] as well as its perceived situation for external pressure [14] need to be considered. The greater potential companies have in enhancing energy efficiency and reducing carbon emission, the more room they have to reduce costs brought by climate policies [36]. Companies will act more with clear and accurate expectation on carbon market policies [26].

This study incorporates five variables representing the internal driving forces of companies: the investment in technological transformation projects of energy-saving and carbon emission reduction, the familiarity of mitigation technology, the familiarity of carbon emission trading market policies, the potential for carbon reduction, and the expectation of national carbon market policies. When larger investments are made, it indicates more attention has been paid on environmental management, and more actions will be taken to reduce carbon emission by the company. Companies will do more with a further understanding of technology, policies, and larger mitigation potential. Corporate expectations on the time and scale of the national carbon emission trading scheme reflect the pressures of carbon emission reduction. If they believe the establishment of the scheme is urgent and with high reduction requirements, they may take a variety of measures in advance to ensure a better response.

In terms of companies' internal driving force, the following hypotheses are presented:

Hypothesis 2a (H2a). *As investment are made in improving energy saving and carbon reducing technology, the more inclined companies are to engage carbon reduction behavior.*

Hypothesis 2b (H2b). *As companies become familiar with carbon reducing technology, the more inclined they are to engage carbon reduction behavior.*

Hypothesis 2c (H2c). *As they become familiar with the policies of carbon emission trading scheme, the more inclined they are to engage carbon reduction behavior.*

Hypothesis 2d (H2d). *The larger carbon reduction potential companies have, the more inclined they are to take carbon reduction behavior*.

Hypothesis 2e (H2e). *The sooner companies expect carbon market policies to be put into effect, the more inclined they are to act*.

Hypothesis 2f (H2f). *The larger the expected requirement of carbon reduction, the more inclined companies are to acts*.

Enterprise scale also has great influence on company environmental strategies. The larger the scale of an enterprise, the more equipped it is for pollution control and better environmental performance [33,37]. The scale of companies can be characterized by the number of employees. The industry-effect will also have an impact on the behavior of companies [33]. As most respondents are private enterprises, this study does not take the impact of ownership type into account. A company's scale and economic sector are the two control variables, which reflect the characteristics of the firm.

In terms of control variables, the following hypothesis is made:

Hypothesis 3a (H3a). *The larger a company's scale is, the more inclined they are to act on carbon emission reduction*.

2.2.2. Variable Processing and Assignment

As mentioned above, in the regression analysis, there are four types of companies' carbon emission reduction behaviors: mitigation from combustion processes (*com*), mitigation from production processes (*pro*), mitigation by reducing output (*out*) and strengthening environmental management (*man*). The value of dependent variable is the average score of each type of carbon emission reduction behaviors in the five-level Likert scale.

The name, symbolic representation, description and value of independent variables are shown in Table 3. For example, "*Enprice*" demonstrates the pressure on energy price which is investigated by asking companies to score their evaluation of the economic pressure of energy price from 1 to 4, while 1 means the pressure is low and 4 means high. Continuous variables can be directly put into the regression model. Some categorical variables, including *Enprice*, *Competition*, *Invest*, *Technology*, *Carbonmarket* and *Potential* can be assigned according to the actual meaning and added into the regression model as continuous variables; this simplifies the model. Variables that cannot be assigned based on the meaning, for example $Pilot_{region}$, P_{time}, P_{ratio}, *Sector* and *Size*, are transformed into dummy variables.

Table 3. The name, symbolic representation, description and value of independent variables.

Independent Variables	Symbolic Representation	Description and Value
Pressure on energy price	*Enprice*	Companies' evaluation of the status of energy prices (from 1 to 4, where 1 means the pressure is low and 4 means high)
Competitive pressure	*Competition*	The degree of competition companies is faced with (from 1 to 4, where 1 means limited and 4 means intense)
Whether the company is in the pilot region	$Pilot_{region}$	Whether the company is in the pilot region (1 = yes, 0 = no)
Investment on the mitigation technology	*Invest*	Total company investment in energy-saving and mitigation technology transformation during "the Twelfth Five Year Plan period" (50 = less than 0.5 million Yuan, 275 = 0.5–5 million Yuan, 500 = more than 5 million Yuan)

Table 3. *Cont.*

Independent Variables	Symbolic Representation	Description and Value
Familiarity with mitigation technology	*Technology*	The degree of familiarity with mitigation technology (from 1 to 4, where 1 means low familiarity and 4 means high)
Familiarity with policies on emission trading scheme	*Carbonmarket*	The degree of familiarity with policies (from 1 to 4, where 1 means low familiarity and 4 means high)
Potential of carbon emission reduction	*Potential*	A company's self-evaluation of their potential mitigation capability (from 1 to 4, where 1 means low and 4 means high)
Time expectation	P_{time}	How soon that a company expects to be involved in carbon emission trading schemes (Four categories: 1 = 1–2 years, 2 = 3–4 years, 3 = more than 5 years, 4 = unknown)
Ratio expectation	P_{ratio}	The requirement of proportional CO_2 reduction that companies expect if they get involved in emission trading schemes (Four categories: 1 = 0–0.5%, 2 = 0.5–3%, 3 = more than 3%, 4 = unknown)
Economic sectors	*Sector*	Economic sectors (Three categories: 1 = manufacturing, 2 = electricity/heat, 3 = others)
Company scale	*Size*	Number of company employees (Three categories: 1 = less than 500, 2 = 500–1000, 3 = more than 1000)

2.2.3. Construction of Econometrics Model

The multiple linear regression model on companies' behaviors on carbon emission reduction through the combustion process and its influencing factors, as shown below:

$$\begin{aligned} com_i = \beta_0 + \beta_1 Enprice + \beta_2 Competition + \beta_3 Pilot_{region} + \beta_4 Invest \\ + \beta_5 Technology + \beta_6 Carbonmarket + \beta_7 Potential + \beta_8 P_{time} \\ + \beta_9 P_{ratio} + \beta_{10} Sector + \beta_{11} Size + \varepsilon \end{aligned} \quad (1)$$

where β_i are the coefficients to be estimated, β_0 is constant, and ε is the margin of error.

The multiple regression model demonstrating companies' behavior on carbon emission reduction through production process and its factors are shown here:

$$\begin{aligned} pro_i = \beta_0 + \beta_1 Enprice + \beta_2 Competition + \beta_3 Pilot_{region} + \beta_4 Invest \\ + \beta_5 Technology + \beta_6 Carbonmarket + \beta_7 Potential + \beta_8 P_{time} \\ + \beta_9 P_{ratio} + \beta_{10} Sector + \beta_{11} Size + \varepsilon \end{aligned} \quad (2)$$

The model on output reduction and its factors:

$$\begin{aligned} Out_i = \beta_0 + \beta_1 Enprice + \beta_2 Competition + \beta_3 Pilot_{region} + \beta_4 Invest \\ + \beta_5 Technology + \beta_6 Carbonmarket + \beta_7 Potential + \beta_8 P_{time} \\ + \beta_9 P_{ratio} + \beta_{10} Sector + \beta_{11} Size + \varepsilon \end{aligned} \quad (3)$$

The model on enhancing environmental management and its influencing factors:

$$\begin{aligned} Man_i = \beta_0 + \beta_1 Enprice + \beta_2 Competition + \beta_3 Pilot_{region} + \beta_4 Invest \\ + \beta_5 Technology + \beta_6 Carbonmarket + \beta_7 Potential + \beta_8 P_{time} \\ + \beta_9 P_{ratio} + \beta_{10} Sector + \beta_{11} Size + \varepsilon \end{aligned} \quad (4)$$

3. Results

3.1. Current Situation Regarding Companies' Behavior toward Carbon Emission Reduction

To analyze the impact of pilot carbon emission trading market policies on companies' behavior, all sample companies are categorized according to whether they are in the pilot region and whether they participate in current emission trading scheme. Average score and standard deviation of the four types of companies' carbon emission reduction behaviors are calculated (Table 4).

According to Table 4, the two major behaviors that companies show are reducing carbon emission from production process, which scored 3.663, and strengthening environmental management, which scored 3.660. Less common was mitigation from combustion process, which scored 3.534 and mitigation through reducing output, which scored 2.396. This shows that companies are inclined to take measures through management on energy use and the production process, but they do not intend to reduce output based on economic interests. The behavior of reducing output has a larger standard deviation compared with other types of behavior, indicating that larger difference exists among companies. It is speculated that reducing output is a relatively extreme behavior that companies take when faced with carbon emission reduction pressures.

Table 4. Statistics on current carbon emission reduction behavior of different types of companies.

Statistics		Total	Companies in the Pilot Region	Companies Not in the Pilot Region	Pilot Companies	Non-Pilot Companies
com	Mean	3.534	3.744	3.314	3.945	3.374
	S.D.	0.848	0.757	0.883	0.562	0.886
pro	Mean	3.663	3.870	3.446	3.980	3.539
	S.D.	0.795	0.682	0.845	0.503	0.851
out	Mean	2.396	2.674	2.106	2.873	2.211
	S.D.	1.164	1.236	1.002	1.210	1.090
man	Mean	3.660	3.808	3.504	3.938	3.551
	S.D.	0.829	0.772	0.858	0.587	0.883
sample size		570	292	278	160	410

Comparisons are made between different types of companies regarding each kind of behavior. Both pilot companies and companies in the pilot regions have higher scores than average for all types of behaviors. By comparing the scores of the four kinds of behaviors, we see that behavior preferences for each type of company are similar overall. Mitigation from reducing output is the lowest scoring strategy, but the score of *out* is much higher for pilot companies or firms in pilot regions, indicating that companies have to take unwilling measures such as reducing output or stopping production to meet the carbon emission reduction requirement from emission trading policy.

3.2. Regression of Influencing Factors

Using STATA, multiple linear regression models are used to test the theoretical hypothesis of factors influencing carbon emission reduction behaviors. Four types of behaviors are considered as dependent variables. Table 5 shows the results.

The linear regression model requires that there is no multicollinearity between independent variables, otherwise the variance of estimated coefficients will increase, leading to inaccuracy in the model and lost significance of statistical inference. Variance inflation factor (VIF) is the commonly used indicator for checking multicollinearity. The larger the VIF is, the stronger multicollinearity the variables have. It is generally believed that there is no multicollinearity if VIF is less than 10. As Table 6 shows, the maximum value of VIF of all independent variables is 2.36 and the

minimum is 1.07. This demonstrates there is no multicollinearity between the independent variables of influencing factors.

Table 5. Multiple regression results on different types of carbon emission reduction behaviors.

Independent Variables		Coefficient [1]			
		com	***pro***	***out***	***man***
Enprice		−0.0150	−0.0338	−0.1433 *	−0.0471
Competition		−0.0593	−0.0941 **	−0.0596	−0.0746 *
$Pilot_{region}$		0.2289 ***	0.2525 ***	0.4048 ***	0.1276 **
Invest		0.0005 **	0.0002	5.29×10^{-6}	0.0003
Technology		0.0975 *	0.1055 **	−0.2649 ***	0.1344 **
Carbonmarket		0.1374 ***	0.0847 *	0.2731 ***	0.0563
Potential		0.0897 **	0.0109	−0.1502 **	−0.0496
P_{time}	Less than 2 years	-	-	-	-
	Less than 4 years	−0.0132	0.0167	0.0993	0.0064
	5 or more years	−0.1263	−0.0734	−0.1719	−0.0590
	Unknown	−0.2991 ***	−0.2630 **	−0.0363	−0.1732
P_{ratio}	0–0.5%	-	-	-	-
	0.5–3%	0.3915 ***	0.2896 ***	0.1371	0.2048 **
	More than 3%	0.3198 ***	0.2566 **	0.0516	0.2268 **
	Unknown	−0.1198	−0.1575	−0.3464 *	−0.3802 ***
Sector	Manufacturing	-	-	-	-
	Electricity/heat	−0.0974	0.1730	−0.1594	−0.1299
	Others	−0.0734	−0.0456	−0.0714	−0.0883
Size	Less than 500	-	-	-	-
	500–1000	0.1168	0.1370 *	0.2013	0.0392
	More than 1000	0.0762	0.0622	0.1897	0.0772
F		15.93	13.21	6.38	11.34
R^2		0.329	0.289	0.164	0.259
Sample size		570	570	570	570

[1] *, **, *** represents significance level of 0.1, 0.05 and 0.01 respectively.

Table 6. The result of VIF test.

Name of Independent Variables	VIF	1/VIF
P_{ratio}_4	2.36	0.423
P_{ratio}_2	2.33	0.429
Technology	2.26	0.443
Carbonmarket	2.18	0.458
P_{time}_4	2.16	0.463
P_{ratio}_3	1.88	0.532
Invest	1.58	0.633
Size_3	1.55	0.645
P_{time}_3	1.55	0.647
P_{time}_2	1.49	0.673
Size_2	1.33	0.754
Sector_3	1.19	0.840
Sector_2	1.13	0.888
$Pilot_{region}$	1.11	0.904
Competition	1.11	0.904
Potential	1.08	0.930
Enprice	1.07	0.933
Mean of VIF	1.61	

3.3. Results on the Hypothesis Tests

Table 5 shows the results of multiple regressions on different mitigation behaviors and their influencing factors, where hypotheses in Section 2.2.1 are tested. Table 7 summarizes the result of hypothesis tests. The result of hypothesis tests is slightly different from that of the parameter tests of the multiple regression model, as according to the hypothesis made in Section 2.2.1, these tests are one-tailed tests, while parameter tests are two-tailed. Parameters which are significant in Table 5 may not support the former hypothesis.

Table 7. The result of hypothesis tests.

Type	Hypothesis	Relative Independent Variable	Result [1]			
			com	*pro*	*out*	*man*
External pressure	H1a	*Enprice*	R	R	S	R
	H1b	*Competition*	R	S	R	S
	H1c	$Pilot_{region}$	S	S	S	S
Internal driving force	H2a	*Invest*	S	R	R	R
	H2b	*Technology*	S	S	R	S
	H2c	*Carbonmarket*	S	S	S	R
	H2d	*Potential*	S	R	R	R
	H2e	P_{time}	R	R	R	R
	H2f	P_{ratio}	R	R	R	S
Control	H3a	*Size*	R	R	R	R

[1] R is the abbreviation for reject and S is the abbreviation for support.

Externally, higher energy price only shows significant negative relation to mitigation from output reduction, with no significant influences on mitigation from combustion, production or management improvement. Larger pressure from competition may lead to fewer mitigation actions taken on production and management process. Companies in pilot region will take actions on all four categories compared with other companies outside the region, indicating that external pressure from policy will have comprehensive influences on companies' behavior.

Considering internal driving forces, more investments made in improving energy-saving and carbon reducing technology, the significant enhancements to mitigation from combustion and its influences on *pro*, *out* and *man* are unconvincing. Familiarity with mitigation technology will enhance *com*, *pro* and *man*, and negatively influence *out*. This means that the more familiar with technology companies become, the more mitigating actions from combustion, production, and management taken, and the less companies are willing to reduce output. This result makes senses as more mitigation from combustion, production and management will give options for companies not to choose extreme measures. Similar results imply that companies with more carbon reduction potential will take more mitigation measures on the combustion process, and will not reduce output. Familiarity on carbon market policy will enhance *com*, *pro* and *out*, which supports H2c, but it will not promote mitigation in the management category.

P_{time} and P_{ratio} are dummy variables. As a result, H2e and H2f are true, when the first two coefficients of P_{time} and P_{ratio} are significant, the second one is smaller than the first one for P_{time} and larger for P_{ratio} in Table 5. For P_{time}, only the "unknown" choice is significant and negatively related to *com* and *pro* indicating that companies that expect earlier implementation of carbon market policy do not show greater willingness to implement mitigation strategies. For companies without clear time expectations, they may not take more actions on mitigation from combustion and production. Things are quite different for P_{ratio}. The data show that expectations for larger carbon reduction requirements will lead to more mitigation actions taken in environmental management, but less in the combustion and production processes. With the increase of requirement ratio, mitigation costs from combustion and production processes may also increase, becoming larger than the costs from management. Companies need to balance these costs and show decreasing response to *com* and *pro*.

The "unknown" is also significant with negative coefficients for *out* and *man*, indicating that companies without clear understanding or expectations on carbon emission reduction ratio, are inclined to act less on mitigation by reducing output and improving management.

Control variables in the tests do not show significant effects.

4. Discussion

4.1. Influencing Factors on the Four Mitigation Behaviors

4.1.1. Influencing Factors on Mitigation through Combustion Processes

According to the results shown in Table 5, among all external factors, $Pilot_{region}$ has significant positive relations with carbon emission reduction through the combustion process. Companies in the pilot region have larger pressures on carbon emission reduction when faced with carbon emission reduction requirements in the carbon market. As a result, companies will focus their efforts on the combustion process.

Considering these internal factors, *Invest*, *Technology*, *Carbonmarket* and *Potential* all have significant positive effects on a company's carbon reduction behavior through combustion process. For time expectations, the choice of "unknown" negatively influences company behavior. This means that companies are not willing to act on the combustion process without clear expectations on when the national carbon market will be built up. Companies choosing ratio of carbon reduction at 0.5–3% and more than 3% are more inclined to take measures in the combustion process to deal with carbon reduction pressures.

Economic sector and company size as control variables show little influences on these results.

4.1.2. Influencing Factors on Mitigation from the Production Process

Externally, competitive pressure negatively effects actions taken in the production process. Faced with intense competition, reducing carbon emission during manufacturing usually involves asking the company to use recyclable material and energy saving equipment, which leads to an increase in costs. For economic reasons, companies do not tend to reduce carbon emissions through the production process under these circumstances. Being in a pilot region also has a positive effect on production process.

For internal factors, familiarity with carbon reduction technology and policies have significant positive effects on mitigation through the production process, demonstrating that clear understanding can encourage companies to act with confidence. Similar to the results in the combustion process, no clear time expectations and an anticipation of more than 0.5% carbon emission reduction requirements have a negative influence on company behavior toward production.

For control factors, the size of a company has a significant positive effect on actions taken. This means that larger companies intend to put more effort toward reducing carbon emission through manufacturing.

4.1.3. Influencing Factors on Mitigation by Reducing Output

Pressure on energy prices has a negative effect on carbon emission reduction through cutting back output. When the current energy price is higher than a company's expectations, it will not reduce its output to meet the carbon reduction requirement, as limiting output is an extreme action for any company interested in profit. If a company is in a pilot region, it has a positive effect on output reduction behavior. This means that companies in a pilot region with a larger carbon market requirement are inclined to reduce emissions by reducing output.

For internal factors, familiarity with technology shows a negative effect on mitigation through output reduction. If the company knows more about carbon emission reduction technology, it will take more "positive" actions, for example, mitigation through the combustion process, production

processes, or management; this not only achieves the requirements for carbon control, but also has a minor negative impact on a company's normal operation. A company's carbon emission reduction potential also negatively affects its behavior. Those with larger mitigation potential have more space to reduce emission from energy use, production processes, and effective, scientific management strategies for controlling CO_2 emissions.

Familiarity of policies, which partly indicates the pressure of carbon mitigation on companies, has positive influences on the output reduction behavior. Companies without clear ratio expectations will not plan to reduce production to control emissions, as they face little mitigation pressure.

Control factors have no significant influence on behavior for reducing output.

4.1.4. Influencing Factors on Mitigation by Enhancing Environmental Management

For external factors, competitive pressure has a negative correlation with the company behavior of enhancing its environmental management. When faced with intense competition, for the sake of staying competitive, companies are less likely to invest too much energy or money in environmental management. Whether in pilot region is also a significant factor on behavior of management.

Internally, companies which are familiar with carbon emission reduction technology will analyze the company's development from an environmental perspective and utilize rational, scientific strategies to reduce emissions. Expectation of reduction ratio also has significant influence. Companies with higher expectations of reduction ratios emphasize environmental management, while companies without clear ratio expectations are less likely to take measures through environmental management.

Control factors do not show significant effects on company behavior regarding the enhancement of environmental management.

4.2. Influencing Factors for Company Behavior When in or out of a Pilot Region

As shown in Table 5, whether the company is in a pilot region shows strong significance across all types of behaviors. Influences of different factors are tested on companies in and out of the pilot region separately, as shown in Tables 8 and 9, to provide suggestions for the establishment of national emission trading schemes.

For companies already in a pilot region (Table 8), energy price is the most important external factor. By increasing in energy price pressure, companies will take fewer mitigation actions though the production and management processes. A company's mitigation potential is strongly related to *com*, *pro* and *out*. Larger potential provides companies space to do more in the combustion and production processes, with less impacts on output. P_{time} only shows influence on the combustion process. P_{ratio} shows significant positive effects on *com* and slightly negative impacts on *pro*, which means that a higher expectation of mitigation requirements will lead to more actions taken in the combustion process but has almost no influence on the production process. Companies in a pilot region without clear ratio expectations take fewer measures on *com*, *out* and *man*. The electricity and heat sectors show significant negative impacts on *com*, *pro* and *man*, demonstrating that electricity and heat companies are not willing to take actions compared with companies from other sectors.

The impact of these factors on companies outside of a pilot region is quite different from those on companies inside a pilot region. As shown in Table 9, no external factors show convincing results on the four types of behavior. Companies outside of a pilot region with larger investments in energy-saving and mitigation technology are more active in taking mitigation measures through combustion and production processes. Familiarity of technology will lead to improvement in environmental management, with fewer negative impacts on the output process. Familiarity with carbon market policies may enhance mitigation through combustion, production and output side. Companies outside of a pilot region pay less attention to mitigation potential than companies inside a pilot region. Time expectations have less influences on behaviors. Ratio expectations show less importance on the behaviors of companies outside of a pilot region compared with companies within. Companies from different sectors have a similar understanding regarding mitigation actions.

Table 8. Multiple regression results on different types of carbon emission reduction behaviors for companies in a pilot region.

Independent Variables		Coefficient [1]			
		com	***pro***	***out***	***man***
Enprice		−0.0539	−0.1793 ***	−0.1717	−0.1752 **
Competition		−0.0441	−0.0720	−0.1000	−0.0795
Invest		0.0002	−0.0002	−0.0001	0.0002
Technology		0.0380	0.1007	−0.2301 *	0.0642
Carbonmarket		0.1066	0.0436	0.1417	0.0727
Potential		1.1873 ***	0.1320 **	−0.2449 **	0.0590
P_{time}	Less than 2 years	-	-	-	-
	Less than 4 years	−0.0090	0.0695	0.2507	−0.0372
	5 or more years	−0.2737 ***	−0.0206	−0.2230	−0.0149
	Unknown	−0.4402 **	−0.2977 *	0.2841	−0.2650
P_{ratio}	0–0.5%	-	-	-	-
	0.5–3%	0.2987 ***	0.3229 ***	0.1769	0.1978
	More than 3%	0.3756 ***	0.3226 **	−0.0147	0.2281
	Unknown	−0.4115 **	−0.1723	−0.9076 **	−0.5005 **
Sector	Manufacturing	-	-	-	-
	Electricity/heat	−0.3159 **	−0.4181 ***	−0.2445	−0.3762 **
	Others	−0.0216	−0.0070	−0.1132	−0.0441
Size	Less than 500	-	-	-	-
	500–1000	0.1217	0.1227	−0.0392	0.0501
	More than 1000	0.2133 **	0.0829	0.2623	0.0775
F		12.08	7.16	2.52	6.64
R^2		0.413	0.294	0.128	0.279
Sample size		292	292	292	292

[1] *, **, *** represents significance level of 0.1, 0.05 and 0.01 respectively.

Table 9. Multiple regression results on different types of carbon emission reduction behaviors for companies not in a pilot region.

Independent Variables		Coefficient [1]			
		com	***pro***	***out***	***man***
Enprice		0.0016	0.0483	−0.1318	0.0441
Competition		−0.0672	−0.0940	−0.0106	−0.0487
Invest		0.0008 **	−0.0008 **	0.0003	0.0003
Technology		0.0971	0.0842	−0.3599 ***	0.1667 **
Carbonmarket		0.1958 **	0.1482 **	0.4002 ***	0.0641
Potential		−0.0194	−0.0863	−0.0906	−0.1396 **
P_{time}	Less than 2 years	-	-	-	-
	Less than 4 years	0.0134	−0.0165	−0.1165	0.1187
	5 or more years	0.0229	−0.0696	−0.2546	−0.0118
	Unknown	−0.0867	−0.1901	−0.1954	0.0006
P_{ratio}	0–0.5%	-	-	-	-
	0.5–3%	0.4692 ***	0.2828 **	0.0987	0.2244
	More than 3%	0.2432	0.1975	0.1440	0.2317
	Unknown	0.0251	−0.1310	−0.0940	−0.3251 **
Sector	Manufacturing	-	-	-	-
	Electricity/heat	0.0462	−0.0034	−0.0597	0.0375
	Others	−0.1653	−0.0882	−0.0394	−0.1462
Size	Less than 500	-	-	-	-
	500–1000	0.1114	0.1847	0.4239 ***	0.0431
	More than 1000	−0.0625	0.0059	0.1192	0.0610
F		5.57	5.72	3.14	5.19
R^2		0.255	0.260	0.161	0.241
Sample size		278	278	278	278

[1] *, **, *** represents significance level of 0.1, 0.05 and 0.01 respectively.

5. Conclusions

This study analyzes the behavior of company responses to climate change strategy. Behaviors are divided into four types according to the source of CO_2: reducing carbon emission "from combustion process", "from production process", "by reducing output", and "by strengthening environmental management." The extent of each behavior taken was investigated through a questionnaire sent to 570 companies in 29 different regions of China using a five-level Likert scale. The results compared four types of companies: companies in pilot regions, companies not in pilot regions, and both pilot companies. This showed that Chinese enterprises in general take comprehensive measures to address climate change from different levels.

The behavior differences between each type of company indicated that pilot emission trading policy had a significant impact on company actions; this demonstrated that a company controlled by policy was more inclined to reduce carbon emission by utilizing a wider range of strategies. Ten hypotheses on the impact of external pressure, internal driving force, and controlling variables placed on company behaviors were tested. Only the result of "whether the company is in the pilot region" support all four behaviors. Seven are partly supported by the results: pressure on energy price, competitive pressure, investment in mitigation technology, familiarity with mitigation technology, familiarity with policy, mitigation potential and ratio expectations. The hypotheses on time expectation and company scale are rejected.

Based on whether companies were either in or out of the pilot region, there was quite a different response to the influencing factors. Companies inside the pilot region are influenced more by energy price, mitigation potential, and clear expectation on mitigation ratio requirements, while companies outside emphasized investment, familiarity with technology and policy. Sector differences also show up among companies inside the region. Electricity and heat companies were less willing to take mitigation actions, yet no significant difference appeared among companies not in the pilot region.

As a result, the government may consider less on the time when policy will carry out, but pay more attention to offsetting the differences in understanding emission trading scheme between companies in or out of the pilot region. Clear requirements of mitigation ratio and improvement in company mitigation potential are important for the establishment of national emission trading scheme, especially considering that the four types of carbon behaviors have distinct influencing factors and individual characteristics. Government should take into full account these differences and their specific factors, and adopt appropriate policy guidelines and economic incentive measures; this will promote rational and effective mitigation actions.

In this study, sample data were based on an online questionnaire with relatively high collection efficiency and wide geographical involvement. Although the collected sample data have been strictly controlled and screened, deviation may still exist when compared to reality. Considering the challenge of company investigation, further improvement can be made by combining network research and field study, which will add comparative analysis and improving the quality of questionnaire information collection.

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References

1. UNFCCC United Nations Framework Convention on Climate Change. Available online: http://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf (accessed on 1 September 2016).
2. Harrison, D.; Klevnas, P.; Nichols, A.L.; Radov, D. Using Emissions Trading to Combat Climate Change: Programs and Key Issues. *Environ. Law Rep.* **2008**, *38*, 10367–10384.
3. National Development and Reform Commission. Notice on the Implementation of the National Carbon Emissions Trading Market. Available online: http://www.ndrc.gov.cn/gzdt/201601/t20160122_772150.html (accessed on 20 July 2017). (In Chinese)
4. National Development and Reform Commission. Notice on Pressing the Construction Plan of the National Carbon Emissions Trading Market (Electricity Sector). Available online: http://www.ndrc.gov.cn/zcfb/gfxwj/201712/t20171220_871127.html (accessed on 30 January 2018). (In Chinese)
5. China Electricity Council. China Will Build the World's Largest Carbon Market in 2017. Available online: http://www.cec.org.cn/xiangguanhangye/2016-02-25/149492.html (accessed on 20 July 2017). (In Chinese)
6. Dong, J.; Ma, Y.; Sun, H. From Pilot to the National Emissions Trading Scheme in China: International Practice and Domestic Experiences. *Sustainability* **2016**, *8*, 522. [CrossRef]
7. Zhang, D.; Karplus, V.J.; Cassisa, C.; Zhang, X. Emissions trading in China: Progress and prospects. *Energy Policy* **2014**, *75*, 9–16. [CrossRef]
8. Yang, B.; Liu, C.; Su, Y.; Jing, X. The Allocation of Carbon Intensity Reduction Target by 2020 among Industrial Sectors in China. *Sustainability* **2017**, *9*, 148. [CrossRef]
9. Ye, B.; Jiang, J.; Miao, L.; Li, J.; Peng, Y. Innovative Carbon Allowance Allocation Policy for the Shenzhen Emission Trading Scheme in China. *Sustainability* **2016**, *8*, 3. [CrossRef]
10. Xie, R.; Gao, C.; Zhao, G.; Liu, Y.; Xu, S. Empirical Study of China's Provincial Carbon Responsibility Sharing: Provincial Value Chain Perspective. *Sustainability* **2017**, *9*, 569. [CrossRef]
11. DiMaggio, P.J.; Powell, W.W. The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields. *Am. Sociol. Rev.* **1983**, *48*, 147–160. [CrossRef]
12. Fishbein, M.; Ajzen, I. Belief, Attitude, Intention and Behaviour: An introduction to theory and research. *Philos. Rhetor.* **1975**, *41*, 842–844.
13. Ajzen, I. The theory of planned behavior. *Organ. Behav. Hum. Decis. Process.* **1991**, *50*, 179–211. [CrossRef]
14. Gunningham, N.; Kagan, R.A.; Thornton, D. *Shades of Green: Business, Regulation, and Environment*, 1st ed.; Stanford University Press: Redwood City, CA, USA, 2003.
15. Schipper, L.; Ting, M.; Khrushch, M.; Golove, W. The evolution of carbon dioxide emissions from energy use in industrialized countries: An end-use analysis. *Energy Policy* **1997**, *25*, 651–672. [CrossRef]
16. Kolk, A.; Pinkse, J. Business Responses to Climate Change: Identifying Emergent Strategies. *Calif. Manag. Rev.* **2005**, *47*, 6–20. [CrossRef]
17. Cadez, S.; Czerny, A. Climate change mitigation strategies in carbon-intensive firms. *J. Clean. Prod.* **2016**, *122*, 4132–4143. [CrossRef]
18. Yin, Z.; Wang, X. Modeling Analysis of Different Emission Reduction Measures under the Restriction of Carbon Emission Reduction. *J. Wuhan Univ. Technol.* **2012**, *34*, 86–90. (In Chinese)
19. Jeswani, H.K.; Wehrmeyer, W.; Mulugetta, Y. How warm is the corporate response to climate change? Evidence from Pakistan and the UK. *Bus. Strategy Environ.* **2008**, *17*, 46–60. [CrossRef]
20. Xing, L.; Shi, L. Corporate Response to the "Energy Saving and Pollution Abatement Policy". *Acta Sci. Nat. Univ. Pekin.* **2010**, *46*, 465–470. (In Chinese)
21. Lee, S. Corporate Carbon Strategies in Responding to Climate Change. *Bus. Strategy Environ.* **2012**, *21*, 33–48. [CrossRef]
22. Wahyuni, D.; Ratnatunga, J. Carbon strategies and management practices in an uncertain carbonomic environment—Lessons learned from the coal-face. *J. Clean. Prod.* **2015**, *96*, 397–406. [CrossRef]
23. Liu, Y. An empirical research of awareness, behavior and barriers to enact carbon management of industrial firms in China. *Sci. Total Environ.* **2012**, *425*, 1–8. [CrossRef] [PubMed]
24. Cheng, F.; Shao, S. The Study of Innovation Strategy in the Stage of Active Carbo Reduction Based on Stage Division. *Chin. J. Manag. Sci.* **2016**, *24*, 28–36. (In Chinese)

25. Amran, A.; Ooi, S.K.; Wong, C.Y.; Hashim, F. Business strategy for climate change: An ASEAN perspective. *Corp. Soc. Responsib. Environ. Manag.* **2016**, *23*, 213–227. [CrossRef]
26. Wang, W.; Luo, Y.; Xie, P.; Luo, Z.; Zhao, D. The key elements analysis of Guangdong & Shenzhen ETS & tips for China national ETS construction. *China Popul. Resour. Environ.* **2016**, *14*, 282–291.
27. Cronbach, L.J.; Shavelson, R.J.E. My Current Thoughts on Coefficient Alpha and Successor Procedures. *Educ. Psychol. Meas.* **2004**, *64*, 391–418. [CrossRef]
28. Liu, X.; Liu, B.; Shishime, T.; Yu, Q.; Bi, J.; Fujitsuka, T. An empirical study on the driving mechanism of proactive corporate environmental management in China. *J. Environ. Manag.* **2010**, *91*, 1707–1717. [CrossRef] [PubMed]
29. Oliver, C. Strategic Responses to Institutional Processes. *Acad. Manag. Rev.* **1991**, *16*, 145–179. [CrossRef]
30. Liu, X.; Niu, D.; Bao, C.; Suka, S.; Shishimea, T. A survey study of energy saving activities of industrial companies in Taicang, China. *J. Clean. Prod.* **2012**, *26*, 79–89. [CrossRef]
31. De Groot, H.L.F.; Verhoef, E.T.; Nijkamp, P. Energy saving by firms: Decision-making, barriers and policies. *Energy Econ.* **2001**, *23*, 717–740. [CrossRef]
32. Delmas, M.A. The diffusion of environmental management standards in Europe and in the United States: An institutional perspective. *Policy Sci.* **2002**, *35*, 91–119. [CrossRef]
33. Christmann, P.; Taylor, G. Globalization and the Environment: Determinants of Firm Self-Regulation in China. *J. Int. Bus. Stud.* **2001**, *32*, 439–458. [CrossRef]
34. Prakash, A. *Greening the Firm: The Politics of Corporate Environmentalism*; Cambridge University Press: Cambridge, UK, 2000; p. 16.
35. Christmann, P. Effects of "Best practices" of environmental management on cost advantage: The role of complementary assets. *Acad. Manag. J.* **2000**, *43*, 663–680. [CrossRef]
36. Suk, S.; Liu, X.; Lee, S.; Go, S.; Sudo, K. Affordability of energy cost increases for Korean companies due to market-based climate policies: A survey study by sector. *J. Clean. Prod.* **2014**, *67*, 208–219. [CrossRef]
37. Hettige, H.; Huq, M.; Pargal, S.; Wheeler, D. Determinants of pollution abatement in developing countries: Evidence from South and Southeast Asia. *World Dev.* **1996**, *24*, 1891–1904. [CrossRef]