ATLANTIS PRESS
Advances in Economics, Business and Management Research, volume 217
Proceedings of the 2022 International Conference on Urban Planning and Regional Economy (UPRE 2022)

Do Energy Intensive Companies Prepare for the National Emission Trading Scheme? Evidence from a Nationwide Survey in China

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ABSTRACT
Using the data collected from 420 companies in energy intensive sectors that would be included in the national ETS, this paper examines company preparation for the national ETS in China. The results show that ETS pilot companies have an overall better awareness and higher ability in carbon management. While non-ETS pilot companies seem not be able to prepare properly for the national ETS. They need further training on the basics of an ETS. For all the sampled companies, further training should focus on the MRV method, data quality management, strategic management and advanced low-carbon technology. It is highly likely for the samples to conduct self-mitigation if the carbon price is as high as 2 times of the abatement cost. The analysis provides reference for the smooth introduction and effective implementation of national carbon market in China from the business viewpoint.

Keywords: *Emission trading scheme; national carbon market; company perspective; China*

1. INTRODUCTION

Since 2011, the Chinese government initiated seven ETS pilots in Beijing, Shanghai, Shenzhen, Chongqing, Tianjin, Guangdong and Hubei. In 2016, two non-pilot regions, Fujian and Sichuan, launched their provincial ETS. In December 2017, China ' s National Development and Reform Commission (NDRC) announced the establishment of national ETS with the power generation industry as the starting point. This scheme would gradually extend to the other energy intensive sectors, including petrochemical, chemical, iron & steel, non-ferrous metals, building materials, paper making and aviation industries. At present, some relevant design elements have not been finally determined. For example, the method of cap setting and allowance allocation of the power generation industry is still in the stage of soliciting opinions. The offsetting mechanism, market stabilization mechanism, and measurement, reporting and verification (MRV) system have not been finalized.

In practice, companies are the direct targets of market-based instruments, and their responses and activities determine the actual progress and success of these policies[1][2][3]. For example, the ETS in Korea was inactive during the test period and early compliance years due to the strong resistance from industry[4][5] Currently, the ETS is still viewed relatively unimportant and companies show less enthusiasm for the pilot carbon markets in China. Therefore, policy analysis at the company level is necessary to support the discussion and development of the national ETS. However, quite few empirical researches clarifying the corporate opinions have been conducted in China[6][7].

Aiming to close this research gap, a questionnaire survey was carried out by targeting the companies from energy intensive sectors that would be covered by the national ETS. The specific objectives of this study are to: (i) qualitatively measure the companies' preparations; (ii) estimate the possibility of company conducting self-mitigation.

2. METHODOLOGY

2.1. Possibility of company conducting self-mitigation

In this study, the multi-bounded discrete choice (MBDC) is applied to estimate the possibility of companies to conduct self-mitigation, as shown in Table

1. Companies are presented with an ordered and descending sequence of 15 ratios of carbon price and abatement cost from 500% to 30%, and five choice options from ‘very low’ to ‘very high’ are offered.

Table 1. The MBDC format used in this survey

Allowance market price/abatement cost (%)	The possibility of your company conducting the self-mitigation				
	Very low	Low	Moderate	High	Very high
500	1	2	3	4	5
400	1	2	3	4	5
300	1	2	3	4	5
250	1	2	3	4	5
200	1	2	3	4	5
150	1	2	3	4	5
120	1	2	3	4	5
100	1	2	3	4	5
90	1	2	3	4	5
80	1	2	3	4	5
70	1	2	3	4	5
60	1	2	3	4	5
50	1	2	3	4	5
40	1	2	3	4	5
30	1	2	3	4	5

Questions: In order to fulfill the compliance requirements of national ETS, companies can either choose to conduct self-mitigation, or they can choose to purchase allowances from the carbon market. We want to know the possibility that your company conducts the self-mitigation under different carbon price levels. Please give your choices of self-mitigation possibility under different conditions. (The carbon price level is expressed as a percentage of the allowance market price to abatement cost. For example, ‘500’ means that the allowance market price is 5 times of company’s abatement cost. ‘100’ means that both are the same).

Given a ratio of carbon price and abatement cost (R_{ij}), the probability for the company to conduct self-mitigation will be:

(1)

where i represents different company; j represents different ratio of carbon price and abatement cost; P_{ij} means the possibility of company i conducting self-mitigation under the jth ratio R_{ij}. The value of P_{ij} can be obtained by assigning numerical values to the MBDC verbal answers from Table 1 (the value of very low, low, moderate, high and very high possibility is respectively 0.001, 0.25, 0.5, 0.75 and 0.999)[8]. Therefore, the P_{ij} can be estimated for each company based on equation (1). Suppose that the $F(R_{ij})$ is a normal accumulative distribution, the equation can be written as:

(2)

where R_{ij} is the threshold of the ratio of carbon price and abatement cost; μ_i and σ_i is the mean and standard variance of the normal accumulative distribution; and λ_i is the error term.

2.2. Questionnaire development and data collection

Data was collected in 28 provinces targeting the energy intensive sectors. We sent out 694 invitations and 420 were deemed to be valid, among which 326 are in the ETS pilot areas. Specifically, data was collected in two phases, a pilot survey and a field survey. The questionnaire format mainly consists of four components: company background information; company preparations; the possibility of company conducting self-mitigation; and the prediction of future carbon price.

3. RESULTS AND DISCUSSIONS

3.1. Company carbon management capabilities

Company monitoring and statistical management status of energy use and carbon emissions is shown in Figure 1. A four-point scale is applied for the measurement, with 1=have not yet established monitoring and statistical management system; 2=have a simple system at the company level; 3=have a relatively complete system with key energy equipment being monitored; 4=have a complete system with dedicating department and personnel. Regression analysis was performed to identify the relationship between the company monitoring and statistical management status and its characteristics. Since the dependent variables are rated on an ordinal scale, this analysis chooses the ordinal logistics method to avoid the strong assumption that might be caused by the ordinary least squares method[9][10]. The size, ownership and whether regulated by a ETS pilot have significantly effects on the company monitoring and statistical management status (LR chi2=121.48, Prob > chi2 =0.0000, Pseudo R^2 =0.1110). Overall, the samples have relatively higher capacities of monitoring and statistical management, with a mean of 2.75. Around 57% samples have a relatively complete system with key energy equipment being monitored. The companies with large size, stated-owned ownership and being regulated by a ETS pilot reveal higher carbon management ability. The small and medium companies have lower capacities than the large ones, with about 44% of samples only have a simple system at the company level. The state-owned companies got the highest average score of 3.28, with about 50% samples setting a dedicated

department and personnel. The private companies got the lowest score of 2.22. Nearly 50% of companies only have a simple system at the company level. The companies regulated by a ETS pilot got a higher score of 2.91, which indicates that most companies have a relatively complete system. However, the non-ETS pilot companies got an average score of 2.37, indicating that most of them only have a simple system at the company level.

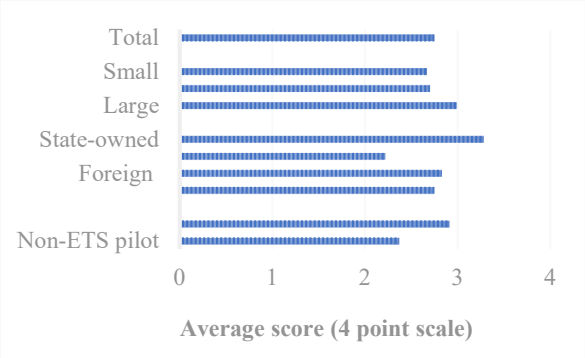

Figure 1 Status of company carbon management

3.2. Company awareness on ETS related polices

In this study, we list nine ETS related policies to examine the company awareness on them, as listed in Table 2. A Five-Likert scale is used for the measurement, with 1=completely unknown; 2=don't know well; 3=moderate awareness; 4= clear; 5=very clear.

Table 2. The policies related to the ETS and their abbreviation

No.	Descriptions	Abbreviation
1	National energy saving targets and relevant policies at different stages	P01
2	National emission reduction targets and relevant policies at different stages	P02
3	Policies and progress of ETS pilots	P03
4	The trading rules, trading volume and price of ETS pilots	P04
5	The development of emission reporting and verification and emission monitoring plan	P05
6	GHG emissions measurement and reporting guideline in your sector	P06
7	National ETS construction plan (Power generation industry)	P07
8	National key energy-saving and low-carbon technology promotion catalog (Energy-saving part)	P08
9	National key energy-saving and low-carbon technology promotion catalog (Low-carbon Part)	P09

The statistics of scores of the listed items are depicted in Figure 2. The results show that the sampled companies are well aware about most relevant policies. In particular, P01, P02, P05 and P06 achieved a mean of nearly 4.00. This implies that the samples are very familiar with the national energy saving and emission reduction targets and related policies and measures at different stages (P01 and P02), and relevant requirements and technical guidelines for measurement, reporting and verification (MRV) of GHG emissions data (P05 and P06). Since the 11th FYP and the 12th FYP, China has successively introduced energy-saving targets and CO2 emission intensity targets. Most of the samples are from the national key emission industries, so they have a good understanding of these targets. So far, the NDRC has issued guidelines of GHG accounting and reporting for 24 sectors, and carried out the reporting and verification of emission data from key emission industries. The samples thus have become more familiar with the policies related to the MRV. Regarding the key technologies, the samples have moderate awareness, with a score of 3.68 (P09 and P10). The result is similar to that of ‘Survey Report on Energy Conservation and Emission Reduction of Chinese Enterprises Since the 13th FYP’. In this survey, most companies hope that the government could promote energy saving and emission reduction technology and information, create an exchange platform, and provide related technical support. On the other hand, the samples have moderate awareness on the relevant progress and trading information of ETS pilots, with a mean of 3.45 and 3.41 (P03 and P04). This is probably becasue the non-ETS pilot surveyed companies presented an average score of 2.82 and 2.85, which lower the average score of the samples as a whole. Meanwhile, the construction plan of national ETS achieved a lower score, with a mean of 3.48 (P08). The reason might be that this plan only focus on the electricity companies which account for only 8.1% of the total samples.

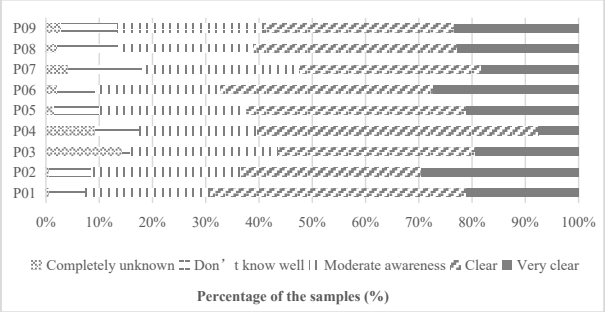

Figure 2 Company distribution by the awareness on ETS related polices

Regression analysis was conducted to identify the relationship between company awareness and its characteristics, including size, ownership, sector, location and whether regulated by a ETS pilot. As mentioned earlier, an ordinal logistics model was used. The sector has no significant impact on all the nine policies. Since more than 90% of the samples come from key emission industries and are covered by ETS pilots, there is no significant difference in the level of awareness on ETS related policies among these industries. The company size has significant effect on the awareness of P01(LR chi2=38.25, Prob > chi2 =0.0008, Pseudo R2 =0.036) and P02 (LR chi2=27.20, Prob > chi2 =0.0271, Pseudo R2 =0.0246). Compared with large companies, small and medium companies have lower awareness of these three policies. This is probably because the national energy saving and emission reduction target aim at the key energy-consuming companies that are usually large companies. The company ownership has significant effect on the awareness of P06 (LR chi2=43.62, Prob > chi2 =0.0001, Pseudo R2 =0.0390). Compared with domestic companies, foreign ones are clearer about the guidance of emissions measurement and reporting. As some developed countries started the carbon pricing mechanism earlier, foreign companies might have more experience in emissions measurement and reporting. Compared with ETS pilot companies, non-ETS pilot companies reveal lower awareness on all the nine polices listed in Table 2. Therefore, it is necessary for the government to strengthen the dissemination of ETS-related information for non-ETS pilot companies. In addition, the location significantly affects the company awareness on P03 (LR chi2=66.19, Prob > chi2 =0.0000, Pseudo R2 =0.0568) and P04 (LR chi2=72.37, Prob > chi2 =0.0000, Pseudo R2 =0.0665). The companies in ETS pilot areas have higher awareness on the related information of ETS pilots. This implies that the training for such companies can focus on other aspects of the carbon market, such as carbon asset management and carbon finance rather than the basic information of ETS.

3.3. Company requirements for further training

This study lists ten issues that companies might need to strengthen in further trainings, as shown in Table 3. A Five-Likert scale is used for the measurement, with 1=not necessary at all; 2=not necessary; 3=moderately necessary; 4= necessary; 5=very necessary.

Table 3 List of issues for companies to strengthen and their abbreviation

No.	Descriptions	Abbreviation
1	Policies and regulations on the ETS	I01
2	Key features, theory and institutional arrangements of the ETS	I02
3	Methods for accounting and reporting of corporate GHG emissions	I03
4	Internal data quality control and management	I04
5	Operation method of data reporting, registration and trading systems	I05
6	Carbon asset management	I06
7	Carbon finance	I07
8	Strategic planning and measures for corporate GHG emission reduction	I08
9	Key technologies for reducing GHG emissions	I09
10	National policies on climate change	I10

The ordinal logistics model was conducted using company evaluation for the listed issues as the dependent variable, and its characteristics. It is found that whether regulated by a ETS pilot significantly affects the company evaluation for I01, I02, I05, I06 and I07. The average scores are depicted in Figure 3. Compared with ETS pilot companies, non-ETS pilot companies have higher need on related knowledge on the I01, I02 and I05, with a mean of 4.05, 3.99 and 3.85, respectively. Although non-ETS pilot companies can conduct carbon trading through the voluntary ETS, the number of these companies is small, and most of them do not have carbon trading experience. Therefore, non-ETS pilot companies more need the basic knowledge on the ETS. On the contrary, ETS pilot companies presented lower scores on I01, I02 and I05, with a mean of 3.42, 3.52 and 3.42, respectively. This implies that ETS pilot companies are familiar with these basic issues through 4 to 7 years of operation of the ETS pilots. The non-ETS companies have lower need on the I06 and I07, with a mean of 3.18

and 3.21 respectively, but ETS pilot companies presented higher need on these two issues, with a mean of 3.63 and 3.69 respectively. This indicates that the ETS pilot companies hope to use carbon market as a tool for investment gains and thus show a certain demand for the knowledge about the carbon asset and carbon finance, while non-ETS pilot companies are not too interested in them. I03 and I04 achieved a mean of nearly 4.00, indicating that the samples are in great need of the method on MRV and data quality management. According to the discussion during the survey, the companies have some technical difficulties in practice. Thus, the respondents suggest that trainings should be conducted targeting the common technical problems encountered by companies, and supplemented by real cases. Companies are in great need in I08, I09 and I10, with a mean of nearly 4.00. This implies that companies hope to further reduce emissions through advanced management and technology in response to more stringent emission reduction targets.

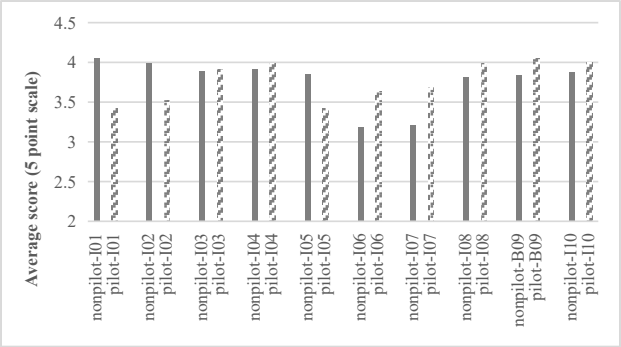

Figure 3 Company requirements for further training

3.4. Possibility of company self-mitigation

This study examines the ability of companies to transfer the increased cost due to the national ETS to their customers. The results show that 3.1% of samples confirm that it is impossible to shift the increased cost to their customers. The share of samples that select a ratio below 10% and 10%-20% is 48.1% and 28.81% respectively. This implies that most companies can transfer a certain percentage of additional carbon costs to their customers due to the implementation of the national ETS. Based on the data collected from the MBDC in Table 1, the statistics of possibility for the samples to conduct emission reduction by themselves in response to a series of ratio of carbon price and abatement cost is presented in Table 4. The number of usable respondents is 301. When the carbon price is 5 times of the abatement cost, 84.05% of the respondents have a high or very high possibility to reduce emissions. When the carbon price is 1.5 times of the abatement cost, the proportion of companies choosing high or very high possibility drops to 42.62%. There are only 20.24% of samples would conduct emission reductions by themselves with a high or very high possibility at the ratio of 100%. As the ratio declines, the possibility of companies conducting self-mitigation gradually decreases. Nearly 50% of respondents have a low or very low possibility for self-mitigation at the ratio of 90%. When the ratio drops to 80%, more than 57% of samples select a low or very low possibility.

Table 4. Statistics of the possibility of company self-mitigation

Allowance market price/abatement cost (%)	The possibility of company self-mitigation					
	Very low (%)	Low (%)	Moderate (%)	High (%)	Very high (%)	Total (%)
500	3.57	3.33	9.05	**19.05**	**65.0**	100.00
400	2.86	5.24	14.52	**32.62**	**44.76**	100.00
300	2.86	6.67	21.43	**39.76**	**29.29**	100.00
250	2.38	11.90	23.81	**44.05**	**17.86**	100.00
200	2.14	11.19	36.67	**42.38**	**7.62**	100.00
150	2.38	18.57	**36.43**	**36.19**	6.43	100.00
120	5.00	24.52	**42.38**	**23.57**	4.52	100.00
100	10.48	28.57	**40.71**	**15.24**	5.00	100.00
90	**14.05**	**32.38**	33.10	13.81	6.67	100.00
80	**17.38**	**40.00**	25.71	12.38	4.52	100.00
70	**21.90**	**40.00**	21.43	9.76	6.90	100.00
60	**31.19**	**33.33**	21.19	8.81	5.48	100.00
50	**45.00**	**25.95**	11.67	9.52	7.86	100.00

40	**51.90**	**22.86**	10.48	9.76	5.00	100.00
30	**58.57**	**18.33**	10.24	6.43	6.43	100.00

Figure 4 presents the results of data listed in the Table 4 and the simulation curves. This study calculated the shares of companies with ‘high probability’ and ‘ very high probability’ and the shares of companies with ‘moderate possibility’ and over. By analyzing the data of these two kinds of samples, the ratio ranges of carbon price and abatement cost to conduct self-mitigation can be estimated. A cumulative normal distribution model was used for the regressions with the shares of the samples as the dependent and the ratios of carbon price and abatement cost as the independent. The R squared for regressions of the two sets of data is 0.9881 and 0.9929, respectively, representing a good fit. The ratio of carbon price and abatement cost on the part of 50% of the samples is 89% and 222% on the two curves, which indicates that the mean of ratios of carbon price and abatement cost for companies to conduct self-mitigation will fall between 89% and 222%.

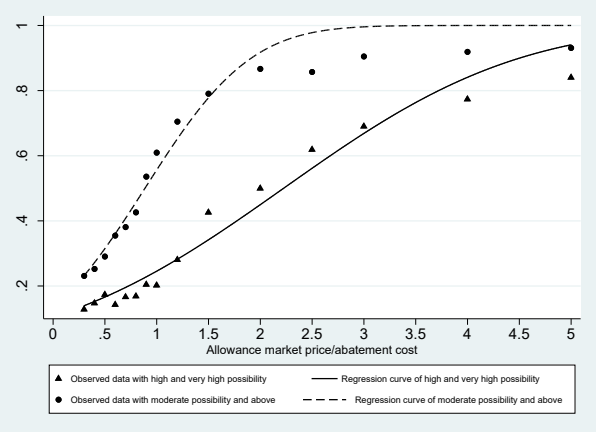

Figure 4 The observed data and regression curve of company possibility to conduct self-mitigation

According to equation (2), the mean ratio of carbon price and abatement cost for each individual company to conduct self-mitigation can be estimated. The relationship between the estimated ratios and company characteristics is examined through the econometric analysis (as shown in Table 5). The results show that company size, ownership, sector category and location have statistically significant effects on the cost ratios for company self-mitigation. Compared with large companies, small and medium ones would conduct self-mitigation at lower ratio of carbon price and abatement cost. Similarly, the state owned and domestically private companies indicate lower ratios than foreign ones for self-mitigation. This is probably because most domestic companies and small and medium ones lag behind foreign and large companies in energy management and energy-saving and low-carbon technologies, and thus have greater emission reduction potential and lower marginal abatement cost. Therefore, they are more likely to conduct self-mitigation for the compliance of the national ETS. Petrochemical and electricity companies have higher ratios for self-mitigation since these two sectors have higher energy intensity and energy cost pressures. The upfront investment needed to carry out emission reductions would bring greater economic burdens to them. Therefore, they are less likely to make self-mitigation compared with the industries with lower energy intensity. Compared with the companies in non-ETS pilot areas, the companies in ETS pilot areas present lower ratios. This is probably because they are located in developed areas, have more financial resources and better understanding of advanced energy saving and emission reduction technologies. They are thus more likely to conduct self-mitigation.

Table 5 Multivariate regression result of company self-mitigation possibility

Company characteristics		Coef.	Std. err.
Size	Small	-0.0088	1.1388
	Medium	-0.2511**	0.1166
	Large	-	-
Ownership	State-owned	-0.3097*	0.1649
	Private	-0.3054*	0.1633
	Foreign	-	-
	Joint-venture	-0.8907	0.1839
	Others	0.0695	0.2498
Sector	Petrochemical	0.4611*	0,2472
	Iron & steel	0.2822	0.2215
	Cement	0.0258	0.2215

	Paper	0.0829	0.2361
	Chemical	0.1821	0.2139
	Electricity	0.6573**	0.2662
	Aluminum	-	-
	Others	0.2346	0.2475
Whether located in ETS pilot areas	Yes	-0.3877***	0.1144
	No	-	-
Whether regulated by ETS pilots	Yes	-	-
	No	-0.0470	02858

*** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level.
F(15,28)=2.73; Prob > F=0.0006; R^2 = 0.0285

4. CONCLUSION AND POLICY IMPLICATIONS

This paper examines company preparation for the national ETS based on a nationwide survey targeting companies from energy intensive sectors that would be included in the national ETS.

First, ETS pilot companies, large and stated-owned companies reveal higher ability of monitoring and statistical management. On the other hand, non-ETS pilot companies are weak in carbon management. Most of them only have a simple monitoring and statistical management system at the company level. Given that most of these companies come from key emission industries that are likely to be included in the national ETS in the future, it is necessary for the government to improve these companies' carbon management ability. Second, companies well know about most relevant policies on ETS, in particular the information on national energy-saving and emission reduction targets at different stage and MRV of emission data. However, half of the samples have lower awareness on the key energy-saving and low-carbon technologies. Compared with ETS pilot companies, non-ETS pilot ones have lower awareness of all the ETS related polices. Third, for all the sampled companies, further training should focus on MRV method and data quality management, advanced strategic management and low-carbon technology, and the latest national climate polices with relevant interpretations. In terms of MRV and data quality management, trainings should focus on the common technical problems encountered by the companies, and supplemented by real cases. For non-ETS pilot companies, the basic information on ETS should be emphasized in the further training, including policies and regulations, key feature, theory, institutional arrangements, data reporting method, registration and trading systems of the ETS. For ETS-pilot companies, further training may focus on the issues of carbon asset management and carbon finance. Forth, it is possible for most companies to pass a certain percentage of cost to their customers due to the implementation of the national ETS. But they have to take most of the cost burden themselves and prefer to self-mitigation for compliance if the carbon price is high. When the ratio of carbon price and abatement cost is over 222%, the companies would conduct emission reductions by themselves with high and very high possibility.

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