ISSN 2616-7433 Vol. 6, Issue 10: 89-96, DOI: 10.25236/FSST.2024.061013

Stakeholder Perspectives on the Carbon Emission Reduction Program in Jiangsu Province: Insights from a Survey-Based Study

Zhiang Yang

University of Southern California, Sol Price School of Public Policy, Los Angeles, California, the United States

Abstract: *In China, carbon emission reduction programs have become a hot topic in academia in recent years, and since the beginning of the 13th Five-Year Plan, they have been greatly strengthened, and it is crucial to explore the impacts of governmental actions on companies. Using a survey methodology, this paper collects results from 76 companies to explore the impacts of environmental protection policies on businesses during the 13th to 14th Five-Year Plan periods in terms of the program's transmissibility, the challenges it poses to businesses, and the reasonableness of the government's behavior when implementing it, respectively. The results show that the program has posed relatively big challenges to firms and that there are some irrationalities in the government's governance. The paper concludes by giving recommendations on the problems of the program.*

Keywords: *Five-year plan, Project evaluation, Carbon eduction, Environemntal protection, China study*

1. Introduction

Jiangsu is an important province on the eastern seaboard of the People's Republic of China, with the second largest economy in China since 2009, after Shanghai, and the largest manufacturing sector in the country. In addition, Jiangsu is the province that has attracted the most international capital[1].

Jiangsu Province was chosen for this study because it is densely industrialized, densely urbanized, and densely populated. It occupies 1.1% of China's land area, hosts 5.8% of China's population, and generates >10% of GDP [2]. In 2023, there were 62,771 industrial business units in Jiangsu Province, with assets totaling 183,165.6 billion yuan. The province's ecological environment system received a total of 78,184 ecological environment letters and reports complaints. Jiangsu Province has a higher total pollutant emission per unit of land area than the national average, a smaller energy resource endowment, a weaker environmental carrying capacity, and a higher per capita energy consumption base. Therefore, Jiangsu Province faces a very serious challenge [3-4].

The Five-Year Plan program originally referred to the Chinese government's five-year plan for the country, which would act as a guideline to influence policies and regulations in each province. Due to the impact of the Paris Agreement and the growing environmental problems, carbon reduction is a very important part of the 13th and 14th Five-Year Plans. This paper discusses the impact of this section on heavily polluting industrial enterprises when it is issued to Jiangsu Province. In the Outline of the Plan, the Government has proposed the need to speed up the improvement of the ecological environment and to step up the comprehensive management of the environment. When this project was issued to Jiangsu Province for implementation, the Jiangsu Provincial Government plans to control total energy consumption within 337.15 million tons of standard coal by 2020, which requires traditional production capacity, especially high-polluting production capacity to achieve transformation and upgrading, at the same time, emerging industries may be valued compared to traditional industries. Carbon emissions declined after the 13th Five-Year Plan, but the rate of decline slowed significantly after 2018, suggesting that the implementation of the policy may have hit a bottleneck[5]. Hence, by 2020, China's carbon reduction project has been strengthened, with the central government deciding that the country needs to be carbon peaked by 2030 and carbon neutral by 2060[6], which is often referred to as the "dual carbon" policy.

As for the monitoring of carbon emissions, the Government's current monitoring methods are mainly divided into three categories, the first of which is an online assessment and monitoring system, the second is to arrange for the relevant city managers of the Government to carry out measurements of the indicators

ISSN 2616-7433 Vol. 6, Issue 10: 89-96, DOI: 10.25236/FSST.2024.061013

in the Industrial Park at regular intervals, and the third is to commission a non-profit organization to issue a report on a yearly basis to conduct an assessment. In the process, companies with substandard or excessive emissions will face the possibility of penalties or closure. If enterprises do not meet the standards, they will receive penalties. Light is a fine, according to the data, Jiangsu Province has more than 30,000 enterprises, the average fine per case is 20,000-30,000 yuan, and the average annual fine reaches 1.5 billion; heavy is shut down, since the 13th Five-Year Plan, Jiangsu Province has shut down a total of 4,454 enterprises[7].

To help Jiangsu Province achieve the carbon peak and neutralization goals, the first thing that should be done is to clarify the trend of carbon emissions in Jiangsu Province, analyze the potential of carbon emission reduction and the feasibility of development, which needs to be combined with the development program of Jiangsu Province, reasonably predict the trend of carbon emission changes under the implementation of various actions and their decoupling trend to provide theoretical basis and decision-making support for the formulation of effective carbon emission reduction targets and policies, and to explore the effective path of carbon emission reduction[8]. Since enterprises are the main actors in the implementation of this program, by focusing on their performance and problems under the Carbon Emission Reduction Program (CERP), it is possible to understand the impacts of the program in a more comprehensive way, to identify opportunities for improving the program, and to promote the balanced development of economic and environmental objectives.

The implementation of these actions and monitoring measures can indeed improve the environmental image of enterprises and promote the adoption of cleaner and more efficient technologies, which will contribute to the sustainable development of enterprises in the long run. However, in the short term, mandatory low-carbon programs and carbon trading actions may lead to a significant increase in business operating costs, especially for energy-intensive or highly polluting enterprises. In such a scenario, what kind of dilemmas are businesses facing, or what kind of businesses are facing greater dilemmas, needs to be assessed. There is the cost, which focuses on capital, market, and labor costs. In the actual operation process, the construction of new projects can not be pushed forward according to the plan, which brings huge financial pressure[9]. The purpose of this study, on the other hand, is to assess the difficulties faced by industrial enterprises in Jiangsu Province in implementing a carbon reduction program and to find solutions.

2. Literature Review

Carbon emissions from the energy industry are one of the main causes of high CO2 levels and an important factor in reducing emissions from the steel industry[10]. China has been the number one producer and the third largest emitter of CO2 for decades (Hu and Lee, 2008). Over time, China has become a large importer of energy, with increased domestic environmental pollution and rapidly rising CO2 emissions [11].China's actions to save energy and reduce emissions have been implemented since a long time ago. Some scholars have found through empirical studies that the large-scale phase-out and upgrading of old, polluting and inefficient combustion facilities under the Clean Air Initiative has facilitated the transformation of China's energy system. Synergistic Benefits of Clean Air Actions China's clean air measures result in net cumulative reductions in CO2 emissions that far outweigh the additional emissions from end-of-pipe facilities.Between 2013 and 2020, China will emit an additional 243 million tonnes of CO2, more than China's total CO2 emissions in 2010 (2.03 Gt CO 2) [12]. However, action to reduce emissions reaches a turning point in 2020 -- In this year, China is proposing a dual-carbon policy in 2020. Included in this basket of policies is the creation of a carbon trading market, which is an important market instrument for growth and CO2 reduction in China's industrial sector(Zhang et al., 2020). The government's "Beautiful China" strategy, launched in 2020, calls for the annual average concentration of PM2.5 (particulate matter with an aerodynamic diameter of less than 2.5 μm) in all Chinese cities to be at or below 35 μg/m³ by 2035. At the same time, China has adopted a series of low-carbon policies to achieve its Nationally Determined Contributions (NDCs) as pledged in the Paris Agreement[13]. Before and after the implementation of the policy, some studies have found that the implementation of the policy has significantly reduced all types of carbon emissions, and that this reduction effect is long-term. Stimulating dynamic carbon to expand supply and demand for carbon allowances is an important way to achieve reductions in carbon emissions[14]. Due to China's vast geographical size and uneven development, achieving this target depends on the performance of each Chinese province, and different factors have different impacts on each Chinese province. The results of the dynamic scenario modelling suggest that most Chinese provinces will achieve their CO2 intensity reduction targets, but that there will be difficulties in achieving the peak CO2 emissions target[15]. There are many different new energy technologies that can reduce carbon emissions, such as the manufacture

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of heterojunction semiconductors with the appropriate energy band arrangement and reasonable morphology for photocatalytic carbon dioxide reduction, but due to financial constraints, among other things, the effect of reducing emissions varies from province to province[16]. Different cities have come up with different strategies, such as the coastal province of Fujian, which proposes to achieve its emissions reduction targets mainly through the development of nuclear power, and coal-rich Anhui, which proposes to achieve its emissions reduction targets by keeping the growth rate of energy consumption lower than the growth rate of GDP[17]. According to the latest research results, the carbon dioxide emission dual control mechanism China's total carbon dioxide emissions have been gradually rebounded, and the decoupling index with economic growth has shown an inverted U-shape trend, most of the provinces and regions are narrowing the gap from the 2020 carbon dioxide intensity control target, the energy intensity has shown a downward trend, and the energy structure has shown fluctuating changes[18]. Additionally, existing literature indicates that the Low-Carbon City Pilot Policy helps improve corporate environmental performance and increases green innovation. However, the policy does not significantly increase the relocation of clean technology enterprises and exacerbates corporate "greenwashing" behavior [19].

3. Analytic Procedure

3.1 Research Questions

The primary research questions for this program evaluation are:

Is the methodology behind the design of government programs rational and widely known to relevant businesses?

How significant are the difficulties that the program presents to the target group?

While the project is underway, how effective was the government in implementing the program?

3.2 Research Methodology

To explore the effectiveness of government governance, questionnaires were crafted, drawing insights from the perspectives of entrepreneurs and business employees.Given the vast diversity within the energy sector, it's impractical to cover every industry. Therefore, our focus narrows to a select group of industries significantly impacted by carbon reduction policies. These sectors will be studied to gauge the extent of their challenges and formulate appropriate strategies in response. Based on findings from the Natural Resources Defense Council and the German Corporation for International Cooperation [20], as well as the People's Republic of China's categorization of industries for national economic activities, this paper considers the following five industries to be the most important in the industrial sector, and at the same time relatively highly polluting. Therefore, our research will concentrate on 1.electricity, heat, gas and water production, 2. manufactoring, 3. metallurgical, 4. mixed industry, 5. supply, as our primary sample.

4. Empirical analysis

4.1 Questionaire Design

Based on the Likert scale, there are seven main questions scattered across the three main sections of the questionnaire, which have been designed to evaluate the program's efficacy. Question 1 “How much do you know about the carbon reduction program implemented in Jiangsu province(which you’re living in)? ” Question 2 “ Has your organization set a decarbonization/net-zero target and timetable?” employed to assess the program's openness and reasonableness by gauging the subjects' knowledge and comprehension of the program. Question 3 “ How much of a challenge do you think low carbon program? ”, Question 4 “Are the costs invested in purchasing new energy/using new technologies after this program proportional to the outputs?”, Question 5“Are there any technical difficulties following the implementation of this program?” used to test the degree of difficulty (both technical and cost) that the program poses for the business. Question 6 “ How aware are you of the introduction of carbon reduction program implementation today? ”, Question 7 “In your opinion, to what extent does the government disclose information on the effectiveness of the implementation of carbon reduction programs (including annual reports on specific governance programs for each industrial park, etc.)? ” used to test the

ISSN 2616-7433 Vol. 6, Issue 10: 89-96, DOI: 10.25236/FSST.2024.061013

legitimacy and transparency of the government's actions while the program was being implemented, Question 8 “Do you think there are problems with the implementation of the current program on carbon reduction?” used to inquire about the effectiveness of government implementation. These questions demonstrate their significance by utilizing a five-point scale, where 1 (Option A) signifies very negative and 5 (Option E) denotes very positive.

4.2 Sample Selection

The questionnaire was distributed via the Credamo platform, where participants were also recruited, while additional subjects were identified through social media platforms. The questionnaire was released on March 23rd and closed on 30th, a total of 8 days to complete the collection. Those who responded and met specific criteria were chosen for further in-depth interviews. To ensure the validity of this survey experiment, 100 subjects from different industrial companies in Jiangsu were recruited on the Credamo platform, and finally, 76 valid data were obtained.

4.3 Modelling Strategy&Results

4.3.1 Likert Scale

The Likert scale is a quantitative assessment tool commonly used in survey questionnaires, proposed by psychologist Rensis Likert in 1932. It presents a series of statements for respondents to choose their level of agreement or intensity of feeling, typically divided into five levels such as "strongly agree" "agree" "neutral" "disagree", and "strongly disagree".

Table 1 : Reliability Test for Likert Scale

Reliability Test

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.780	0.778	8

In this paper, according to table 1, Kronbach's alpha coefficient was used to test the scale reliability in the questionnaire and the monitoring result of 0.78 meets the criteria and passes the test.

4.3.1.1 Knowledge

Table 2: Knowledge

Knowledge			
		How much do you know about the carbon reduction program implemented in Jiangsu province?	Has your organization set a decarbonization/net-zero target and timetable?
N	Valid	76	76
	Missing	1	1
Mean		3.68	3.32
Median		4.00	3.00
Std. Deviation		.697	.867

In the first part of the scale, from table 2, the test is a Likert scale assessment of policy communication and understanding, where a score greater than 3 is considered a pass while the full score is 5. As shown in the graph, the sum of mean scores for these two questions was 3.5. for the question "How much do you know about the carbon reduction program implemented in Jiangsu province (where you reside)?" The average score for this question was 3.68. In comparison, the average score for "Has your organization established a decarbonization/net-zero goal and timeline?" was 3.32.

4.3.1.2 Preliminary Summary for “Knowledge”

This result reflects the relatively high level of government dissemination and business understanding of existing programs, so that the government does not need to spend any more on interpreting the program (e.g., conducting communication sessions to introduce the program itself), but can instead focus on other components (e.g., incentives, evaluating appropriate low-carbon development projects, etc., as explained

ISSN 2616-7433 Vol. 6, Issue 10: 89-96, DOI: 10.25236/FSST.2024.061013

below).

4.3.2 Challenges

Table 3: Challenges

Challenges

		How much of a challenge do you think low carbon program?	Are the costs invested in purchasing new energy/using new technologies after this program proportional to the outputs?	Are there any technical difficulties following the implementation of this program?
N	Valid	76	76	76
	Missing	1	1	1
Mean		1.13	3.05	2.95
Median		2	3.00	3.00
Std. Deviation		.806	.764	.651

According to table 3, the purpose of the second part of the questionnaire's Likert scale panel is to identify the challenges that businesses face in dealing with the program. A scale of 1 to 5 was used, where 1 represents the greatest difficulty/challenge and 5 represents the least difficulty/challenge. In assessing the question"How much of a challenge do you think low carbon program?" the results showed a mean score of 1.13 with a median score of 2, which is significantly lower than the standard; in the question "Are the costs of investing in new energy sources or technologies following this program proportional to the outcomes?", the mean score was 3.05, the median was 3, and a standard deviation greater than 0.7 indicates an outlier. For the question "Are there any technical difficulties following the implementation of this program?", the mean score was 2.95, which is below the standard score of 3.

Since the low scores on more than half of the questions in the Challenges segment suggest that this segment may be an important source of information for arriving at recommendations at a later stage, this paper cross-analyzes the scores of the different types of firms to explore which type faces greater challenges and dilemmas.

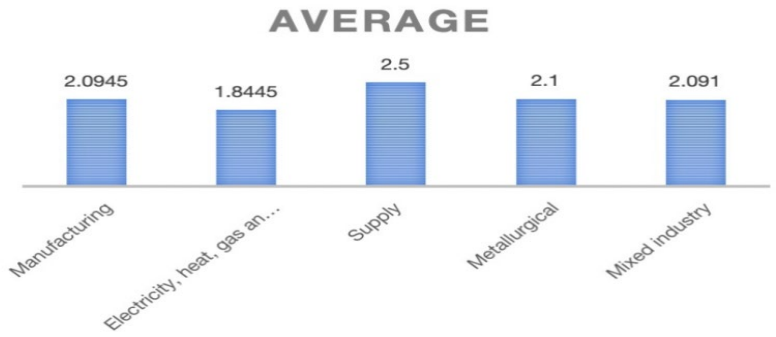

Fig 1: Average for 5 sectors

Table 4: Likert Scale Scores for 5 sectors when doing the cross table test

Business type	How much of a challenge do you think low carbon program?	Are there any technical difficulties following the implementation of this program?	Average
Manufacturing	1.143	3.046	2.0945
Electricity, heat, gas and water production	0.9	2.789	1.8445
Supply	2.143	2.857	2.5
Metallurgical	1.4	2.8	2.1
Mixed industry	1.137	3.045	2.091

As shown in fig1 and table 4, the "Electricity, heat, gas and water production" sector scored the lowest in both questions, indicating that they are the most affected by carbon reduction programs and should be given priority attention. In addition, "Metallurgical" is also facing relatively large technical difficulties, probably due to the high level of chemical expertise involved in smelting metals and the difficulty of replacing the sophisticated equipment used.

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4.3.3 Implementation

Table 5: Implementation

Implementation

		How aware are you of the introduction of carbon reduction program implementation today?	In your opinion, to what extent does the government disclose information on the effectiveness of the implementation of carbon reduction programs (including annual reports on specific governance programs for each industrial park, etc.)?	Do you think there are problems with the implementation of the current program on carbon reduction?
N	Valid	76	76	76
	Missing	1	1	1
Mean		3.39	3.61	2.25
Median		3.50	4.00	2.00

According to table 5, the final part of the scale was designed to assess the effectiveness of the government's actions in the implementation of the program using three Likert scale questions. The question "How aware are you of the current implementation of the carbon reduction program?" was designed to measure the impact of the current program's implementation, with a mean score of 3.39. In "In your opinion, how transparent is the government in disclosing information about the effectiveness of the carbon reduction program's implementation ?" The average score for the question "Do you believe there are issues with the current implementation of the carbon reduction program?" was 3.61. However, the average score for the question "Do you believe there are issues with the current implementation of the carbon reduction program?" was 2.25.

This section has a relatively high degree of variability in the scores of the different questions, with the relatively high scores for the first two questions representing an indication of relatively strong and transparent implementation of the program, but the low results for the last question suggesting that there are concerns about the legitimacy and reasonableness of the program's implementation.

5. Conclusions

The Carbon Emission Reduction Scheme has achieved substantial results in terms of publicity and planning, not only enabling enterprises to fully understand the Scheme and fostering a sense of responsibility but also prompting them to actively formulate relevant plans. At present, enterprises possess relatively comprehensive knowledge. However, perhaps due to technical difficulties, or perhaps due to a lack of practical knowledge, there seems to be a gap between enterprises' motivation to develop plans and their understanding of the knowledge. Secondly, the program posed significant challenges and technical difficulties for firms, mainly due to a lack of guidance and support. By investing in new technologies, firms can generally expect to achieve considerable results. Third, in terms of government enforcement, incentive-based policies outweigh stabilization-based policies, which in turn outweigh punitive regulations. Automatic monitoring is more effective than manual monitoring, which may be subject to problems such as rough enforcement.

There is industrial transformation, for example, chemical plants could use more unmanned cleaning technology to reduce costs instead of manual labor, and manufacturing could try to shift to new energy industries. Of course, this also requires government guidance and support, and the government could do more research to find out what industries are suitable for development in the province that are currently relatively mature in Jiangsu province but have not yet received explicit support. Shenzhen, as mentioned above, chose new energy vehicles because the core development area of the industry is concentrated in the Nanshan District of Shenzhen, so the government seized this point for development. Jiangsu could follow this example by identifying relevant low-carbon industries, creating low-carbon industrial parks, and supporting and investing in them. At the same time, local banks and brokers (especially state-owned enterprises, such as the China Construction Bank) are encouraged to provide "green funds" for companies willing to make the transition to low-carbon industries and to issue "green bonds" to outsiders (e.g., new energy hybrid bonds).

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