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Abstract: In order to further mitigate climate change, China, as the world's largest carbon emitter, should make great efforts to improve its carbon emission status. Carbon tax policies (CTP) are widely used worldwide as an important way to reduce energy consumption and emissions. However, the Chinese government has no intention to adopt a carbon tax yet, probably due to doubts about its effectiveness and public acceptance. In this study, the Choice based conjoint analysis method was used to explore the preferences of Shanghai residents for four carbon tax policy attributes. for overall Shanghai residents, the annual cost of carbon tax policy was the most critical CTP attribute with the highest importance (48.87%), followed by transparency of carbon tax policy implementation process (24.72%), use of carbon tax funds (16.68%), and Carbon tax policy implementers (9.73%). Compared to previous studies, the average annual willingness to pay carbon tax of Shanghai residents increased to 1435.28CNY. Furthermore, it is found that increasing the level of public awareness of carbon tax policies can significantly increase their willingness to pay carbon taxes and thus increase carbon tax revenues to further promote the development of low-carbon and new energy technologies. In addition improving the transparency of the carbon tax can significantly increase the WTP and the more people understand the CTP, the more significant the effect is.

Keywords: Carbon tax，Willingness to pay，Transparency，Conjoint analysis

1. Introduction

From 2000 to 2020, China’s carbon emissions have increased from 3405.2 million tons to 9899 million tons, and China has surpassed the European Union and the United States to become the world's largest carbon emitter (Edgar, 2019). In 2020, the Chinese government announced that its carbon emissions will peak by 2030 and China will achieve carbon neutrality by 2060 (Hao J, Gao, Fang, et al., 2022). For a country with such huge carbon emissions, this is such a difficult goal that to achieve it, some adjustments will have to be made to China's various development policies. Whether based on developmental or environmental goals, limiting domestic carbon emissions has become one of the main goals of Chinese policymakers (Chang W Y, Wang, Song, et al., 2022). In order to reduce carbon emissions and eventually achieve carbon neutrality, many methods have been practiced all over the world, but they are mainly divided into two categories: technical means and policy means. Technical means refer to new technical developments such as energy-saving technology, clean energy technology, carbon capture and storage, and new materials. Policy means are a range of government tools at their disposal to control Greenhouse gas (GHG) emissions, including regulations, information programs, innovation policies, environmental subsidies, and taxes. Environmental taxes are highly regarded by the Organization for Economic Cooperation and Development (OECD) due to their important advantages in terms of efficiency, revenue generation and policy transparency (5).

Economists, scientists, and governments have highlighted the important role of carbon pricing, including carbon taxes and emissions trading, in limiting carbon emissions (6, 7, 8). Focusing on carbon taxes, scholars have assessed the practical utility and social implications of carbon taxes

through theoretical and empirical research while targeting different countries. In the research of Williams et al., tax credits and deduction changes to motor fuel taxes were discussed using the US as the example (9). McEldowney and Salter examine environmental taxes in the UK to address the impacts of climate change and provide policy recommendations to support the design of environmental taxes in the UK, taking into account climate change taxes, carbon and energy taxes, transport taxes, congestion taxes, and road taxes (10). Shmelev and Spec investigated an empirical econometric assessment of the effectiveness of Swedish environmental policy on energy and carbon taxes and confirmed the role of environmental taxes as a practical policy tool to effectively reduce carbon emissions (11). Ionescu points out the importance of achieving carbon peaking and carbon neutrality for achieving sustainable development, and explains why carbon taxes, as part of the current environmental tax, are receiving much attention in policy development (12).

However, there are also a number of obstacles to the successful implementation of a carbon tax policy. Opposition from vested interests and their own lobbying efforts among the public will likely prevent successful implementation. Understanding public acceptance of the policy is critical for policy makers to implement environmental policies. Public opposition directly led to the rejection of carbon taxes by vote in Washington State in 2016 and 2018, and violent protests against higher fuel taxes to reduce carbon emissions in France in 2018 (13). Environmental taxation is still a new term to the Chinese public. Rushing into a policy related to a carbon tax without pre-surveying public acceptance would be a dangerous move that would undermine the government's credibility.

Investigating the Chinese public's willingness to pay carbon tax is essential for the implementation of a carbon pricing policy to promote the process of carbon neutrality in China. This paper will design a questionnaire based on a conjoint analysis method and collect data from 1000 respondents to understand the acceptance of carbon tax policies by Chinese people from different backgrounds in order to support carbon tax policy makers.

The structure of this paper is as follows. Section 2 reviews the relevant literature. Section 3 introduces the experimental method and specific process of the conjoint analysis method. The experimental results are discussed in Section 4 and Section 5. The willingness to pay for carbon tax of the Chinese public is discussed and the conclusions of other scholars are discussed. Comparative analysis. We summarize our experimental conclusions and elaborate them in Section 6.

2. Literature Review

In the conventional view, carbon policies or regulations may limit the productivity, profitability or even the growth potential of businesses. On the other hand, governments may believe that implementing carbon regulations will always reduce emissions and promote the use of green technologies, albeit at the expense of business profitability. While these effects may indeed exist, the real social and economic impacts of carbon policies may be more complex (15). A number of studies have confirmed the effectiveness of carbon taxes in achieving goals such as protecting the environment and reducing carbon emissions (16-18). A number of scholars have also pointed out the policy, economic and environmental advantages of carbon tax policies compared to other environmental policies based on similar objectives (19-23).

Willingness to pay (WTP) for carbon tax policy acceptance is a good quantitative tool that has been used in a large number of studies. The reason for its widespread use as Tsang and Burge (24) point out, is that WTP instead reflects people's subjective opinion of the welfare benefits of carbon reduction, which may be higher than its marginal social or abatement costs, implying that there may

also be a positive, or even large consumer surplus (social welfare) if a tax is imposed to pay for the damage caused by carbon emissions.

There is extensive literature describing (25-27) the willingness to pay (WTP) for carbon taxes. For example, Alberini et al. (2018a) show that the average WTP to avoid one ton of CO_2 emission is 94 and 133 euros in the Czech Republic and Italy, respectively. Similarly, Kotchen et al. (28) found that the average U.S. citizen is willing to pay $144 for a fossil fuel tax. Benavente (29) recently concluded that a carbon tax ranging from $13 to $22/t$CO_2$e would reduce carbon emissions in South Africa by 15%, a $23/t$CO_2$e tax would reduce emissions in Australia by 12.4%, and a $27.7/t$CO_2$ e tax would reduce Canada's emissions by 12.5%. WTP varies by study, likely due to differences in countries, payment instruments, methodologies, and survey participant samples. Kotchen et al. (30) find an average WTP of $79 to $89 per year for a 17% reduction in U.S. GHG emissions through a carbon tax by 2020. The Contingent valuation question describes this impact as an increase in the cost of living for U.S. households. In contrast, Kotchen et al. (28) estimate the average WTP of a carbon tax as an increase in household energy bills of $177 per year. In contrast to the popular attitudes in these studies toward spending money for a carbon tax to improve the environment in support of green technology development, there are also a number of different studies that point to some of the factors that might make a carbon tax policy objectionable to the public.

Based on an extensive literature review, Carattini et al. (31) identified five main reasons for public opposition to a carbon tax: excessive personal costs; voters may perceive the government as imposing a carbon tax policy with the goal of increasing revenue; the perception that a carbon tax would affect the broader economy and lead to unemployment; concerns that a carbon tax may not meet stated environmental goals; and without checks and balances, a carbon tax would have a disproportionate negative impacts.

In order to overcome the public's distrust of carbon tax policies, many scholars have improved the attributes of carbon tax policies and tested and analyzed the public's acceptance of different carbon tax schemes. Beuermann and Santarius (32) argue that reassuring the public about the use of carbon taxes can increase the public's acceptance of carbon tax policies. Carattini et al. argue that providing the public with a detailed explanation of the effectiveness of carbon tax policies can also strengthen their confidence in carbon tax policies (33). Hammerle et al. argue that calling them “taxes” may reduce the acceptance of carbon taxes and try to understand whether using different terms with the same meaning can increase the acceptance of carbon tax policies. While there has been a great deal of research on ways to increase the acceptance of carbon taxes, there is a gap in research to achieve this goal by increasing the transparency of the carbon tax policy process.

In comparison with previous studies, our experimental results quantify the specific amount by which increasing the transparency of carbon tax policies can raise the WTP of residents which has important implications for policy makers to weigh the implementation strategies of carbon tax policies.

3. Methodology

A face-to-face survey was designed by Wenjuanxing questionnaire web (https://www.wjx.cn/). All data were acquired from Aug 2022 to Sep 2022. Sawtooth software was utilized to build the mathematical model. Based on the data collected from 800 valid questionnaires in Shanghai, we use Choice Based Conjoint Analysis (CBCA) to investigate and analyze the willingness of Shanghai residents to pay carbon tax, and also to conduct an in-depth study on the preferences of carbon tax policies with different attributes, and for the respondents in particular, for carbon tax policies with

different transparency.

3.1Conjoint analysis method

After the 1970s, conjoint analysis (CA) was widely used in the field of evaluation of consumers' multi-attribute utility functions [34, 35]. The effectiveness of CA for the assessment of individual preferences has made it a common method for market research and scientific studies [36, 37]. CA mimics the trade-off process of real consumers by examining the joint effects of combinations of attributes on respondents. Beggs' work is the first application of conjoint analysis in the environmental domain [38]. Moreover, it has proven effective in assessing non-market values [39]. CA has also been promoted for identifying consumers' willingness to pay for environmental issues [40]. It is inferred that CA can be used to examine the attitudes of residents towards different carbon tax policy attributes.

3.2 Sampling process

In this study, all respondents were from the registered respondents of WJX. Since the primary population of our study is Shanghai residents, we selected respondents according to the distribution of education levels expressed in the latest Chinese census data.

We planned to recruit 50 respondents in the pre-experiment and 1000 respondents in the main experiment of the joint analysis. Web-based questionnaires were designed and distributed to the target respondents, and a total of 805 valid questionnaires were collected at the end of the conjoint analysis experiment.

3.3 Experimental process design.

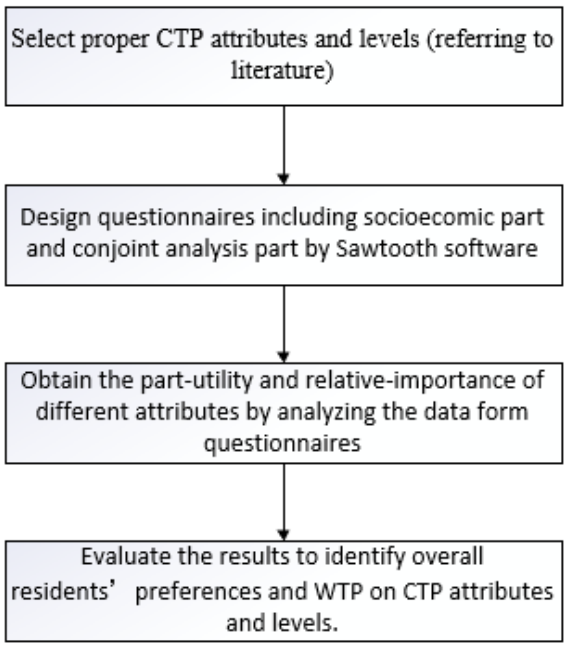

Figure .1 Experimental procedures in detailed

Referring to Figure 1, the CTP properties and levels to be considered for this experiment should be determined in Section 1. Previous literature was used to select the attributes. In Section 2, a questionnaire was designed to examine the respondents' characteristics and socioeconomic information (e.g., gender, age, and education level, etc.) as the first part of the questionnaire (See Table. 2). The second part of the questionnaire was then designed to examine different respondents' preferences for CTP based on a combination of different CTP attributes and levels using Sawtooth software. Table. 1 shows the specific attributes and levels. In the third part, we used the analysis function of Sawtooth software to input the data obtained from the returned questionnaires. Then, during the data process, the questionnaire data were analyzed according to the model built by Sawtooth software. As a result, we obtained results (partial value utility and relative importance) that are representative of the residents' CTP preferences. In the fourth section, we evaluate these results to determine the overall preferences and willingness to pay of residents for CTP attributes.

Table.1 Specific attributes and levels of CBCA experiment

Attributes	Levels
Use of carbon tax funds	General tax budget
	Subsidies/grants for clean energy technology
	Subsidies/grants for low-carbon technologies or CCUS
Carbon tax policy implementers	Bank
	Energy Supplier
	Government
Transparency of carbon tax policy implementation process	No process report
	Report regularly on the official website
	Regularly report on the official website under the supervision of an independent third party
Cost of carbon tax (CNY)	150
	350
	700
	1200
	2000

3.4 Mathematical model & Data processing

The findings of the conjoint process of the survey were analyzed for all of the samples and by complying with 12 different social-demographic and personal variables. A function of Shanghai residents' preference was evaluated from

the CBCA data by multinomial logit function. The function calculated the importance of the respective attribute relative to the other attributes in decision making, as well as the part utility for each level of the attributes.

$$U = \beta_0 + \sum_{k-1}^{n} \beta_n X_n \quad (1)$$

Where β0 represents the constant coefficient of each alternative, β1, β2, β3..., βn denote the coefficients obtained through the logit model, representing the relative weight of the attributes in each alternative. The weights of attributes indicate their importance for respondents' choice making, as well as the preference for all levels within the attribute.

The part-worth utilities denote a value explaining the importance of each attributes' level for the respondents. They are measured on an interval scale of arbitrary origin, so it is meaningless to compare the values of utility at different levels of the attribute. Expressing the utility of partial values in monetary terms is a common way of making them easier to understand. Researchers always set price as a reference attribute in conjoint analysis experiments to calculate how much respondents are willing to pay to improve the level of other attributes. The monetary equivalent of the difference in utility represents the willingness to pay for a unit of utility change. It is considered to be an estimate that helps to evaluate the utility gap at different levels. It is worth noting that the WTP reveals the difference between the two levels, rather than referring to the value of a particular level. The lowest utility level can be set as the baseline value for willingness to pay in the same attribute, and other levels are shown as differences from the baseline value. In addition, relative importance is used to indicate the importance of different attributes to respondents. The value of relative importance is determined by the difference between the highest and lowest utility levels within an attribute.

4. Results and discussions

In this section, the data from the questionnaire and the results from the Sawtooth software analysis process is presented.

4.1 Socioeconomic characteristics of respondents

The data shown in Table 2 consists of the percentage of 805 valid respondents with different socioeconomic characteristics. In order to ensure that the respondents selected for the questionnaire were as close to the reality as possible, we asked WJX to control the proportion of overall respondents according to the proportion of residents with different education levels (high school and below, bachelor and above) obtained from the Shanghai census as much as possible.

It is found that those who believed they are affected by climate change amount to 96.77%, but only 82.61% are aware of the carbon tax policy. This indicates that not all people who are aware of climate change are aware of the details of the carbon tax policy, and there is a need for further dissemination of the carbon tax policy.

Table.2 Percentage of respondents with different socioeconomic characteristics

Socioeconomic characteristics		Percentage
Gender	Male	41.24%
	Female	58.76%
Age	16-30	53.17%
	31-45	42.48%

	46-60	3.85%
	>60	0.50%
Marriage	Married	67.58%
	Single	32.42%
Educational level	Middle school or below	2.48%
	High school	62.86%
	Bachelor	30.93%
	Master or above	3.73%
Family members	1	1.12%
	2	3.73%
	3	39.63%
	4	27.70%
	5	20.50%
	6	5.84%
	>6	1.49%
Residence	Urban	85.84%
	Rural	14.16%
Family disposable income	0-30,000	2.11%
	30,000-50,000	8.70%
	50,000-100,000	19.38%
	100,000-200,000	40.37%
	>200,000	27.08%
	Inconvenient	2.36%
Annual electricity consumption	0-1000	33.17%
	1000-2500	42.24%
	2500-5000	20.99%
	>5000	3.60%
Annual gas consumption	0-800	41.86%
	800-1500	37.14%
	1500-3000	18.14%
	>3000	2.86%
Annual gasoline consumption	0-2500	35.78%
	2500-5000	30.43%
	5000-10000	26.46%
	>10000	7.33%
Climate change impact	None	3.23%
	Little	20.75%
	Some	59.01%
	Huge	17.02%
Understanding of carbon tax	None	17.39%
	Some	67.08%

	Clear	15.53%

4.2 Relative Importance

The result about overall Shanghai residents' CTP preferences is listed in Figure 2(a). According to Figure 2(a), the critical attribute to the respondents is the Annal cost of the carbon tax policy (48.87%). The second critical attribute is transparency of the carbon tax policy implementation process (24.72%), followed by Use of carbon tax funds (16.68%) and Carbon tax policy implementers (9.73%). It is easy to find that among the three non-price attributes the relative importance of transparency to residents is at least 50% more than the other attributes. In other words, improving the transparency of carbon tax policy is the most effective way to increase the acceptance of carbon tax policy by the public.

Fig.4 (b)-(d) appeared that the relative importance of different CTP attributes for residents with different understanding level of CTP. From Fig.4 (b) to Fig.4(d), residents' understanding level of CTP improved from "None" to "Clear". It is revealed that "Use of carbon tax funds" and "Carbon tax policy implementers" have similar relative importance of about 18% and 10%, respectively, among residents with different perceptions of CTP. In contrast to the performance of these two CTP attributes, the relative importance of the other attributes changed as residents' knowledge of CTP increased. The relative importance of "Cost of CTP" (50.45%) was much higher for the group with no knowledge of CTP than for the other two groups with knowledge of CTP. And as the understanding level of CTP improved from "some" to "clear", the relative importance of Cost of CTP decreases from 49.75% to 40.65%. In complete contrast to this trend, the relative importance of "Transparency of carbon tax policy implementation process" rises as the level of understanding of CTP rises. For level from "None" to "Clear", the relative importance is ordered as 20.7%, 24.41% and 29.85%. This result clearly shows that as people's understanding of carbon tax policies increases, their sensitivity to the cost of carbon taxes decreases and their demand for transparency in the implementation of carbon tax policies increases. This may be due to the fact that people are less stingy in spending on carbon taxes because they certainly agree that paying carbon taxes can improve the environment and climate. But accordingly, the demand for various attributes of CTP is bound to increase after people fully understand it, especially transparency. Similar to our results, some scholars have identified a lack of trust in government and its processes as a potential barrier to carbon pricing and other environmental policies (41, 42). Klok et.al. point out that the implementers of a carbon tax should have a better understanding of the effect of the tax, i.e., whether the required carbon dioxide emission reductions are achieved, as well as informing the public about the tax and making it easier to understand (43). Furthermore, Carattini et al. (44) found that public acceptance of carbon taxes increases when there is transparency in the benefits and policy outcomes. Transparency in expected environmental effectiveness can even reduce the need for earmarking, demonstrating that the need for transparency is prioritized over the need for earmarking carbon tax revenues for the population. Based on these results, we propose that policy transparency is the most important CTP attribute and will become even more important in the future as society's understanding of carbon taxes continues to advance.

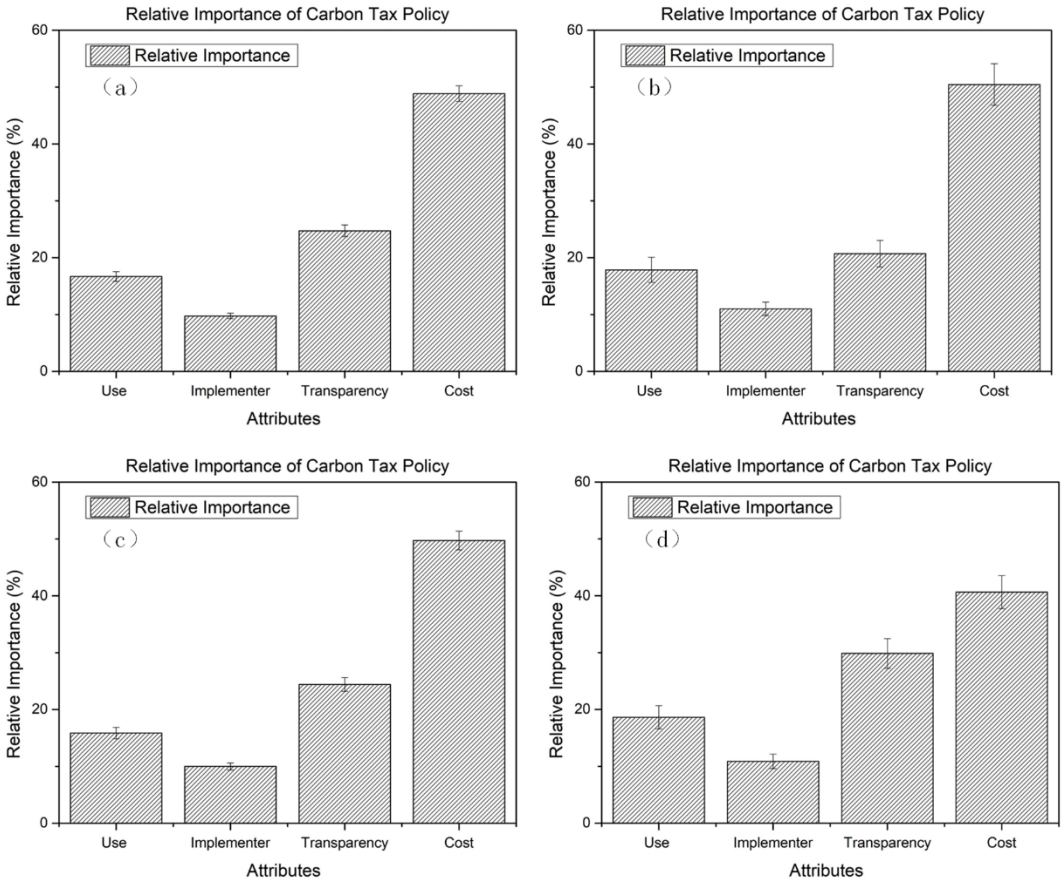

Fig. 4 (a) Relative importance of different CTP attributes for total residents; (b) Relative importance of different CTP attributes for residents without understanding of CTP; (c) Relative importance of different CTP attributes for residents with some understanding of CTP; (d) Relative importance of different CTP attributes for residents with clear understanding of CTP.

4.3 Willingness to pay for CTP

Table.3 reveals the total willingness to pay (WTP) for different levels of the carbon tax policy. Compared with putting carbon tax funds into the General tax budget, respondents in Shanghai are willing to pay more than 500CNY/year to change the use of funds to invest in low-carbon technologies or clean energy technologies. In terms of carbon tax policy transparency, respondents expressed their preference with a WTP of more than 1,000 CNY/year. In other words, people are willing to pay more CNY/year in exchange for reasonable disclosure of the carbon tax collection and use process. In particular, the improvement of the transparency attribute has led to a significant increase in the public's WTP for the carbon tax, which is a testament to the importance of open acceptance in the implementation of the CTP. In addition, it is shown that the government is the best implementer in the residents' opinion.

Since China does not have a carbon tax system in place, many studies have focused on investigating the willingness of the Chinese population to pay a carbon tax to confirm their acceptance of the CTP. A 2009-2010 study of Chinese residents' carbon tax preferences in four regions of China reported that Chinese residents' willingness to pay a carbon tax was about 230 CNY per year(45), while a 2012 study in Suzhou noted that the carbon tax WTP

increased to 396 CNY per year(46). Matthew Winden et.al (47) conducted a comparative study of Chinese and U.S. willingness to pay a carbon tax, showing that Chinese adults' willingness to pay a carbon tax was about 1252.8 CNY, while U.S. adults' willingness to pay a carbon tax was about 4054.97CNY in 2017. According to the findings of these studies, the Chinese population's willingness to pay has been increasing year over year. Assuming that each carbon tax attribute level has an equal chance of being combined into China's carbon tax policies, then the overall mean increase in WTP for carbon tax would be 1435.28 CNY. Our study calculates a mean increase in WTP gained through improved carbon tax policy attributes that is slightly higher than the WTP of Chinese adults on carbon taxes in 2017.

Table.3 Willingness to pay for different levels of all attributes

Attributes	Levels	Annal willingness to pay (CNY)
Use of carbon tax funds	General tax budget	0.00
	Subsidies/grants for clean energy technology	503.90
	Subsidies/grants for low-carbon technologies or CCUS	611.81
Carbon tax policy implementers	Bank	0.00
	Energy Supplier	160.55
	Government	424.81
Transparency of carbon tax policy implementation process	No process report	0.00
	Report regularly on the official website	1122.74
	Regularly report on the official website under the supervision of an independent third party	1482.05
Total	Mean	1435.28

Table. 4 shows the difference in the WTP for Carbon tax for people with different educational levels. In contrast to the findings of previous studies, we find that adults with educational levels below high school are able to obtain a higher WTP for carbon tax (1652CNY) after improving their understanding of carbon tax attributes. It is not difficult to find that the reason for their larger average WTP increase than those with higher educational levels is their enthusiasm for using carbon tax funds to support low carbon and clean energy technologies. But the more important factor remains the transparency attribute of the carbon tax policy, which is regarded as the most desirable attribute by people with any level of education which is demonstrated by improving the level of WTP of this attribute.

Table.4 Willingness to pay for different levels of all attributes (respondents with different educational level)

Attributes	Levels	Willingness to pay		
		Educational level (CNY)		
		High school	Bachelor's degree	Master's degree or above
Use of carbon tax funds	General tax budget	0.00	0.00	76.72
	Subsidies/grants for clean energy technology	698.28	297.40	0.00
	Subsidies/grants for low-carbon technologies or CCUS	743.72	443.06	392.44
Carbon tax policy implementers	Bank	0.00	0.00	0.00
	Energy Supplier	163.26	119.92	65.99
	Government	495.88	338.70	283.56
Transparency of carbon tax policy implementation process	No process report	0.00	0.00	0.00
	Report regularly on the official website	1246.08	977.76	1521.10
	Regularly report on the official website under the supervision of an independent third party	1608.80	1344.60	2033.16
Total	Mean	1652.00	1173.81	1457.65

Table.5 shows that residents with different family disposable income have different performance on the WTP for improving the carbon tax attributes. It shows that members of households with an annual disposable household income between 30,000 and 50,000CNY show a greater interest in

investing carbon tax revenues in areas related to low carbon and new energy technologies. In addition, we analyzed the WTP composition of other groups and found that improving the transparency of carbon tax policies is still the most effective means of increasing residents' WTP because that improved transparency yields the greatest increase in WTP.

Table.5 Willingness to pay for different levels of all attributes (respondents with family disposable income)

Attributes	Levels	Willingness to pay			
		Family disposable income per year (CNY)			
		0-30,000	30,000-50,000	100,000-200,000	>200,000
Use of carbon tax funds	General tax budget	108.95	0.00	0.00	0.00
	Subsidies/grants for clean energy technology	0.00	1070.62	501.02	472.23
	Subsidies/grants for low-carbon technologies or CCUS	118.10	1320.41	541.81	681.99
Carbon tax policy implementers	Bank	0.00	0.00	0.00	0.00
	Energy Supplier	188.23	385.03	183.64	43.75
	Government	470.71	441.62	387.75	395.71
Transparency of carbon tax policy implementation process	No process report	0.00	0.00	0.00	0.00
	Report regularly on the official website	456.71	907.38	1067.22	1489.62
	Regularly report on the official website under the supervision of an independent third party	575.60	1064.44	1333.90	2048.86
Total	Mean	639.43	1729.83	1338.45	1710.72

Table 6 shows the WTP of residents with different understanding levels of CTP. It is found that

when the residents' Understanding level of CTP is raised from "None" to "Some", the mean WTP will increase from 1072.16 CNY to and the "Clear" level corresponds to the highest WTP (3246.18CNY). This proves that increasing the public's awareness of the carbon tax policy can significantly increase their willingness to pay the carbon tax and thus increase the carbon tax revenue to further promote the development of low carbon and new energy technologies. This positive stimulus is significant for carbon tax policies. Similar to our results, a study of Chinese university students found that environmental concern and support for carbon tax policies were positively correlated. In addition, Table 4 reveals that the increase in willingness to pay for carbon tax is mainly concentrated on the attributes "Use of carbon tax revenue" and "Transparency of CTP implementation process". At the same time, the higher the level of understanding of carbon tax, the greater the increase in WTP with the improvement of carbon tax attributes, especially the increase of "Transparency" from "No process report" to "Report regularly on the official process". This part of the data shows that improving the transparency of the carbon taxation process significantly increases the WTP and the effect is more pronounced for people with a higher level of understanding of the CTP. Similarly, studies have shown that improving the transparency of fees in solid waste recycling in Africa is effective in increasing confidence and willingness to pay (48), and Capasso (49) shows that improving Fiscal transparency increases Tax morale. Furthermore, Sun et al. (50) suggest that the new Chinese government should establish some mechanisms to improve the transparency of environmental governance. It can promote residents' support for environmental issues. Compared with these studies, our findings further quantify the environmental and economic benefits that can be gained by improving the transparency of CTP and raising the population's understanding level of CTP which will enhance the determination of policymakers to combat environmental problems through carbon tax policies.

Table.6 Willingness to pay for different levels of all attributes (respondents with different understanding of carbon tax)

Attributes	Levels	Willingness to pay		
		Understanding of carbon tax (CNY)		
		None	Some	Clear
Use of carbon tax funds	General tax budget	0	0	0
	Subsidies/grants for clean energy technology	442.13	455.66	979.07
	Subsidies/grants for low-carbon technologies or CCUS	342.12	554.78	1749.54
Carbon tax policy implementers	Bank	0.00	0.00	0.00
	Energy Supplier	123.40	158.68	86.41
	Government	335.19	420.21	478.93
	No process report	0.00	0.00	0.00

Transparency of carbon tax policy implementation process	Report regularly on the official website	850.72	1010.37	2847.26
	Regularly report on the official website under the supervision of an independent third party	1122.91	1342.81	3597.32
Total	Mean	1072.16	1314.17	3246.18

5. Conclusion and Suggestions

In this study, we utilized the conjoint analysis method to examine the importance of CTP attributes for Shanghai residents with different understanding level of CTP. The overall and different groups' WTP for different attribute levels of CTP were also calculated and analyzed.

Data on CTP preferences was collected via questionnaires. Then, a mathematical model was created within Sawtooth software to analyze the obtained data. The primary conclusions of this study are as follows:

1) It is found that 96.77% of people believe they are affected by climate change, but only 82.61% are aware of the carbon tax policy. There is still upside potential for carbon tax policy awareness.

2) For overall Shanghai residents, annal cost of carbon tax policy was the most critical CTP attribute with the highest importance (48.87%), followed by transparency of carbon tax policy implementation process (24.72%), Use of carbon tax funds (16.68%), and Carbon tax policy implementers (9.73%).

3) It demonstrates that increasing the level of public awareness of carbon tax policies can significantly increase their willingness to pay carbon taxes and thus increase carbon tax revenues to further promote the development of low-carbon and new energy technologies.

4) We find that the residents with a lower educational level do not have absolutely lower WTP for carbon tax than the group with a higher education level. Shanghai residents with a high school education have a strong preference for investing carbon tax funds in low carbon and new energy technology support.

5) As residents' household disposable income increases, the WTP for improving transparency of CTP increases rapidly.

6) It appeared that raising "Transparency" from "No progress report" to "Report regularly on the official website" could increase the WTP by 2847.26CNY. It showed that improving the transparency of the carbon tax can significantly increase the WTP and the more people understand the CTP, the more significant the effect is.

In this study, we discussed which CTP attribute levels are preferred by Chinese. In particular,

WTP can help policymakers estimate the benefits of improving the attributes of carbon tax policies and thus benefit them to optimize the most It should be noted that improving the attributes of carbon tax policies should be accompanied by enhanced public awareness of carbon tax policies.

In the future, several problems still require further examination, primarily including the following: the higher economic level and education of Shanghai residents may differ somewhat from the national population's CTP preferences. We hope to add some preference surveys for residents in other regions of China to our future work.

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