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China's Ability to Alleviate the Problem Associated with Carbon Tax Through Conditional Cash Transfers
A Case Study of Shanghai

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ABSTRACT
Nowadays, to alleviate the problems caused by carbon dioxide, governments distribute kinds of carbon tax policies. Conditional Cash Transfers (CCTs) are a critical component of the distributional effects around carbon taxes and contribute significantly to their alleviation. Recent studies related to CCTs have shown that research on the application of CCTs in carbon tax redistribution is concentrated in developed countries and some developing countries but not in China. To fill the gap, this paper aims to ascertain whether China can alleviate the problem associated with carbon tax through CCTs. This paper first did a literature review for CCTs and then further developed the calculation of the total distributional effect around carbon taxes by converging its total distributional effect of each income group to the mean, and takes Shanghai as a case study. The household income classifications of the existing CCTs in China and international standards are combined into a new household income group. This paper concludes that the four categories of the new household income group, including the Lowest, Low, Middle, and Higher, results in grant amounts of $466.032, $718.466, and the remaining two $0 per year. Thus, the case study of Shanghai demonstrates China's ability to mitigate the problems associated with carbon taxes through CCTs.

Keywords: *Conditional Cash Transfers, China, Poverty, Redistributing, Carbon Revenues, Carbon Tax*

1. INTRODUCTION

Recent increased focus on global warming and the evolution of climate change into a political issue have led many to conclude that the world's economy may lose up to 10% of its value by the middle of the century if climate change continues on its present course. Failure to meet these goals would doom the Paris Climate Agreement and the hope of net-zero global emissions by 2050 [1]. Thus, measures such as carbon taxes on consumers of carbon have been used by many countries to reduce CO2 emissions. On the one hand, carbon-depended fossil fuel consumers would shift their demand to alternative energy sources that release less carbon in order to balance their tax burdens if they are taxed on the quantity of carbon produced during production and consumption [2]. A carbon tax, on the other hand, could result in increased energy and food costs. This is likely to have contributed to a widespread belief that carbon taxes and the economic burden on the poor are positively correlated. According to this view, carbon taxes always widen the scale of poverty, and only the distribution of carbon revenues slows its relentless course. Therefore, the distributional effects of carbon taxes are widely discussed [3-8]. Related literature demonstrates that cash transfer is the primary way carbon revenues are distributed today and in the recent past [9-11]. Among them, the use of existing conditional cash transfer policies to cope with the economic burden of carbon taxes is more generalizable [3]. However, these studies have mainly focused on developed countries and some developing countries, and there are almost no studies for China. In particular, Asia has the greatest risk of carbon pricing adoption [1]. To this end, China, as one of the three most significant carbon emitters (28 percent of total global carbon effects come from China, 15 percent from the US, and 7 percent from India), China’s exploration of CCTs in mitigating the side effects of carbon taxes is urgent. It has lessons for other Asian countries that also rely on coal production [1]. Different countries have their CCTs, such as the PROGRESA program in Mexico, the Opportunity New York program in the United States, and Brazil's Education and Health Program [12].

Nevertheless, what is known about CCTs in China is based mainly on rural middle and high schools, which are not universal [13]. Therefore, it is urgent to identify CCTs that benefit the whole country and are unique to China. Then, according to the core of CCTs, "providing cash incentives to stimulate the use of public services by low-income groups," CCTs in China are equivalent to Targeted Poverty Alleviation strategies (TPA) [14-17]. Therefore, this paper selects CCTs, also known as China-specific TPA, as the subject to investigate the distribution of carbon income throughout China.

The theory of CCTs has recently been presented [3]. Nonetheless, several practical questions arise when dealing with China's ability to alleviate the carbon tax problem through CCTs. It is vital to find China's existing conditional cash transfer policy and its application to carbon income redistribution and apply it to Shanghai. To answer all these questions, the paper presents an original approach that equates Existing conditional cash transfer policies in China with Targeted Poverty Alleviation. Even though the application of cash transfers to carbon income distribution has improved in recent years, most improvements have been achieved through unconditional cash transfers. No research has been directed at improving targeting based on existing CCTs in China. Nonetheless, it is feasible to significantly decrease the carbon tax's economic impact on the poor by using China's current conditional cash transfer system (Targeted Poverty Alleviation). With this goal, this work explores whether China can mitigate the problems associated with carbon taxes through CCTs?

Based on the approach presented in a case study of Shanghai, this study aims to propose China's ability to alleviate the problem associated with carbon tax through CCTs. To achieve this objective, a hypothesis is suggested that "the Chinese government can trade-off the target and the amount of compensation through existing CCTs, which are also equivalent to TPA, and thus mitigate the side effects of the carbon tax." It is also concluded how many yuan per household of different incomes will be compensated with carbon income per year. The derivation of this conclusion is based on three main steps: first, the shares of per capita taxes and tax revenues in the expenditures of direct and indirect effects are derived. Second, the direct and indirect effects are added to obtain the carbon tax's total distributional effect. Third, the subsidy amount is allocated to move the value of the total distributional effect for each income group closer to the mean. This paper is organized in the following structure. The literature review part examines pertinent literature about CCTs and unconditional cash transfers (unCCTs) and case studies, among others. The Case Study part describes a case study of Shanghai. The Results and Discussion part discusses China's ability to alleviate the carbon tax problem through CCTs. Conclusions and policy implications are addressed in the Conclusion part.

2. LITERATURE REVIEW

Over the past decade, most of the research in climate change economics pays particular attention to redistribute tax revenue by using cash transfer and other methods. Cash transfers encompass both CCTs and unCCTs. CCTs have gotten a lot of attention for offering financial incentives to encourage low-income populations to participate in public services. Still, they have been applied primarily in education and health rather than carbon revenue allocation. The carbon income distribution field has focused more on unconditional cash transfer approaches. Few scholars have applied China's CCTs to carbon income allocation. In many developed countries, CCTs are often used to distribute carbon revenues in the form of case studies. However, only a few developing countries have implemented relevant case studies in some regions, even less so in China. Case studies in some Chinese provinces have solely discussed where carbon revenues go rather than the application of CCTs in carbon revenue allocation. Therefore, taking CCTs in China as the research objective and theory and analyzing whether some Chinese provinces can mitigate carbon tax-related problems through CCTs using case studies would fill this literature gap.

2.1. Conditional Cash Transfer

In the literature, there are a surprising number of CCTs. Yet, few studies have been published on China's CCTs, let alone applying China's CCTs to carbon income distribution. In the early 1990s, some basic research was conducted on the distributional effect around carbon tax [3-8]. Since then, it has been proven that carbon taxes have distributional effects, but handling these effects has not been completely addressed. In his seminal article on cash transfer, Vogt-Schilb and Adrien show that cash transfer programs can facilitate the distribution of carbon revenues to compensate the poor while devoting most of the financial resources to fund other priorities [9]. As a result, cash transfers have gradually been widely used for carbon revenue allocation [10, 11]. Renner and Sebastian question whether unconditional and CCTs can combine to reduce the harmful effects of a carbon tax. [3]. They focus on how existing conditional cash transfer policies such as Progresa in Mexico, which are mainly targeted at education and health, can be applied in carbon revenue allocation [12]. Cash transfers, unconditional, and CCTs have been widely associated with carbon tax redistribution, particularly in Netherlands and UK [4, 5]. In light of this, researchers have become increasingly interested in applying CCTs in some areas of developing countries, such as the

Caribbean and nations in Latin America [3, 7, 9]. Li and Fan's study of CCTs in China affirm the need for CCTs for student enrollment in rural high schools in China [13]. Nevertheless, the CCTs here are limited to rural high schools and thus are not universal and not suitable for permanent application in carbon income distribution. Meanwhile, several studies have been performed on China's Targeted Poverty Alleviation strategy (TPA) [14-17]. TPA has been shown to develop detailed and targeted poverty alleviation measures for policymakers [15]. It makes poor groups more willing to use resources such as education and health. Because TPAs satisfy the core of CCTs in providing cash incentives to stimulate public services by low-income groups, TPAs are equated with CCTs in China. Much work on the distributional effects in China has been carried out, yet there is still a large gap in applying TPA as CCTs in China for carbon tax allocation, which will be the focus of this paper [18, 19].

2.2. Application of Conditional Cash Transfers

As demonstrated by the development of case studies in many areas, CCTs and other methods have been theorized to address the issue connected with a carbon tax in industrialized and some developing nations. Nevertheless, very little is known about case studies in Chinese provinces. For developed countries, in the initial work in this field of 2010, Feng and Kuishuang utilize a case study in the United Kingdom to examine the distributional effects regarding climate change taxes on families with varying incomes [5]. A comparison is made between the impact of a CO2 tax and the impact of various GHG taxes in the United Kingdom, emphasizing distributional effects and cost-efficiency. For developing countries, the first systematic report on a case study on the application of CCTs in carbon income distribution throughout the Caribbean and Latin America was conducted in 2019 by Vogt-Schilb and Adrien [9]. This case study is divided into three main steps: first, the impact of carbon income redistribution on household expenditures is explored. Then, the net contributor/beneficiary ratio is calculated. Finally, the proportion of income needed to compensate for the lowest two quintiles of carbon costs is found. In addition to developed and some developing countries, a growing body of literature has investigated selected provinces in China through case studies to alleviate the problem associated with carbon tax through CCTs [3-5, 7, 9, 18, 19]. These case studies are divided into two main steps: first, the direct and indirect effects are derived for the per capita and the share of the tax in expenditures. Second, direct effect + indirect effect = total distributional effect around the carbon tax. Vogt-Schilb and Adrien's case study can precisely identify poor households but needs international criteria for household income classification [9]. However, the case study of Yan and others only completes the computation of the total distributional effect around the carbon tax but leaves out the carbon revenue distribution percentage [18, 19]. Therefore, this paper combines China's existing conditional cash transfer criteria with international standards to classify households with different incomes. It also proposes the hypothesis of allocating the number of subsidies to move the value of the total distributional effect of each income group closer to the mean. As for selecting the case study provinces, data on CO2 emission inventories of 30 provinces will be referenced [20, 21].

Overall, several theories and methods have been proposed to explore the ability of different regions to address carbon tax-related issues through CCTs, some focusing on CCTs theories, others on case study methods. An essential question associated with the conditional cash transfer in China is that the Targeted Poverty Alleviation strategy (TPA) is a CCTs policy with universal applicability. Nonetheless, applying CCTs in China to carbon income distribution is a critical gap that is still not discussed in the literature. In addition, CCTs are widely used in carbon income allocation through case studies in some regions of developed and some developing countries. However, there is still a gap in case studies of Chinese provinces. Therefore, this study contributes to the literature by filling the research gap and demonstrating that China may mitigate carbon tax-related issues and relieve the economic burden on low-income families via CCTs. More importantly, it builds on the existing CCTs (TPA) to improve targeting. Inevitably, there are still technical and political limitations to this paper: identifying and reaching poor households requires high technical requirements, and enacting reforms that disadvantage wealthy households may encounter obstacles. Therefore, future research needs to be more committed to addressing these issues.

3. METHODOLOGY

3.1. Research Design

Shanghai was selected as the pilot city for this case study based on the economy, geographical location, and China's CO2 emission accounts and carbon emissions from 1997-2017 in Scientific Data. (Figure 1) Some may question why the pilot province is not Shandong, the province with the worst carbon emissions. Specifically, Shandong has a disproportionate number of ethnic minorities, which predicts that other factors such as religion and customs will need to be considered in distributing new subsidies. And the complex group categories represent harder to pinpoint the target group. In addition, the disproportionate number of isolated mountainous areas somehow implies a relatively large proportion of poverty, which means that the dissemination channels for new grant distribution are limited. However, Shanghai has a medium carbon

footprint and is a worldwide commercial, teaching, research & engineering, production, tourist, cultural, and transit hub [22]. Besides, the geographical proximity to economically developed provinces with high carbon emissions, such as Guangdong, also facilitates the dissemination of the new subsidy allocation. As can be seen, the selection of Shanghai as a pilot city in this paper is imminent and exemplary.

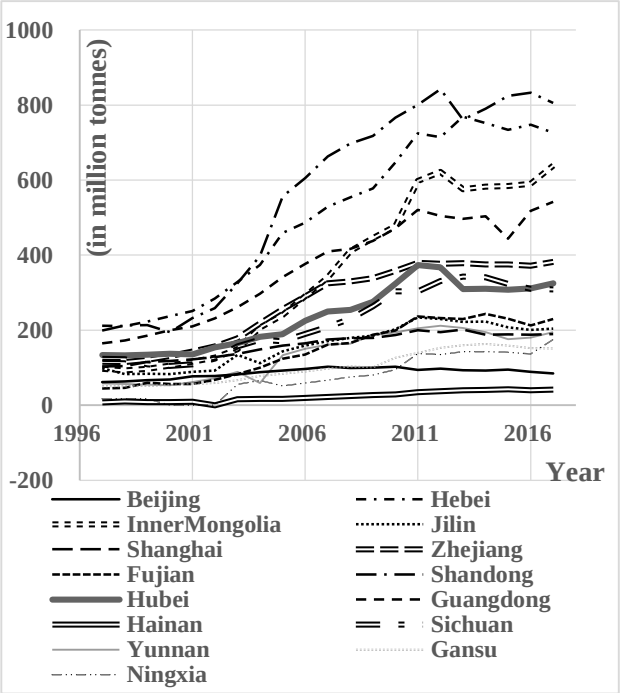

Figure 1 CO2 emissions inventory of China's provinces, 1997–2017, using a sectoral method (in million tonnes) [23]

3.2. Data Collection

To enable the Chinese government to mitigate the side effects of carbon taxes through existing CCTs (TPA), the case study method of Shanghai on weighing targeting and compensation amounts are used in this paper. The technique is the same as that used by Jiang [18] with some changes. Specifically, this article uses Jiang's total distributional effect computation but distributes the subsidy amount by making the total distributional effect for each income group closer to the mean. For data sources, the characteristics of Shandong and Shanghai were obtained from Wikipedia and Scientific Data [22]. In addition, carbon emissions were collected from the CO_2 emissions inventory of China's provinces, 1997–2017, using a sectoral method (in million tonnes) [23]. Besides, poverty lines in China's two major income strata and the four consumption segments in developing countries were supplied by the World Bank [24-25].

3.3. Data Analysis

The case study of Shanghai is divided into three parts: the Project Assumptions, the Target Group Identification, and the Project Design.

3.3.1. Project Assumptions

CCTs differ from purely unconditional cash transfer programs. Their design relies on the following program assumptions: The first is a transfer effect: direct cash transfers help reduce poverty rates, which holds, at least in economic dimensions. The second is a conditional effect: more poverty benefits may help offset the social cost of the carbon tax.

3.3.2. Target Group Identification

The project's target group identification process is divided into two stages: first, selecting an area as a case study location, and second, finding impoverished families. For area identification, Shanghai was selected as the pilot city for this case study due to its economy, geographic location, and CO2 emissions. Besides, in identifying poor households, this paper combines the existing criteria for CCTs in China (Table 1) and international standards (Table 2) to set the classification criteria for different income households.

Table 1. Poverty lines in China's two major income strata [24]

Income Groups	Lower Middle	Upper Middle
Total daily per capita consumption (2011 PPP)	$3.20	$5.50
Total daily per capita consumption (RMB)	¥ 12.6 (2016)	¥ 21.7 (2016)

Table 2. The four consumption segments in developing countries [25]

Income Groups	Lowest	Low	Middle	Higher
Total daily per capita consumption (PPP)	<$2.97	$2.97- $8.44	$8.44- $23.03	>$23.03
Total daily per capita consumption- Based on the exchange rate of USD to RMB at 01:37am BST on August 19, 2021 (1 USD = 6.4847 RMB)	< ￥19.2596	￥ 19.2596- 54.7309	￥ 54.7309- 149.3426	> ￥149.3426
Global income distribution (percentile)	<50th	51st–75th	76th–90th	>91st

Table 3. The new classification criteria for poor households

Income Groups	Lowest	Low	Middle	Higher
Total daily per capita consumption (RMB)	< ￥19	￥19- 37	￥37- 55	> ￥55
Global income distribution (percentile)	<50th	51st- 75th	76th–90th	>91st

Notes: For calculation purposes, only whole numbers are retained.

Table 4. The total distributional effect of the carbon tax [18]

Income Groups	Direct effect		Indirect effect		Total distributional effect
	Taxes paid per capita (￥)	Taxes as a percentage of expenses (%)	Taxes paid per capita (￥)	Taxes as a percentage of expenses (%)	Taxes as a percentage of expenses (%)
Low	3.062	0.024	104.08	0.829	0.853
Mid-low	3.508	0.022	130.46	0.817	0.839
Mid	5.472	0.025	160.43	0.742	0.767
Mid-high	7.029	0.026	195.9	0.732	0.758
High	12.767	0.031	277.29	0.681	0.712

3.3.2.1. Existing Standards for CCTs in China

Table 1 depicts China's two major income strata poverty lines: The lower-middle-income group lives in poverty at 12.6 RMB (2016), or $3.20 per capita a day (2011 PPP); the upper-middle-income group lives in poverty at 21.7 RMB (2016), or USD 5.5 per capita a day (2011 PPP). (Table 1)

3.3.2.2. International Standard

As shown in Table 2, the Global Consumption Database divides developing-country families into four consumption sectors: "lowest", "low", "middle", and "higher" [24]. A global income distribution index ranks the world's population by income per capita [24]. The lowest, low, middle and higher consumption bands refer to the 50th percentile and below, the 51st-75th percentile, the 76th-90th percentile, and the 91st percentile and above, respectively [24]. These cutoff points were utilized to define four consumption segments: the lowest, the low, the middle, and the higher. They are correspondingly less than $2.97 per capita per day, $2.97-$8.44 per capita per day, $8.44-$23.03 per capita per day, and more than $23.03 per capita per day [24]. (Table 2) Comparing the classification criteria of poor households for the existing CCTs in China (Table 1) with those in developing countries (Table 2), the former is cruder. Generally, it has lower values, even lower than the latter's "Low." Therefore, this paper removes the extreme values, i.e., the shallow "12.6 RMB poverty threshold for lower-middle-income class" for China's existing CCTs and the very high "higher income groups" (¥149.3426) for developing countries. The figures are arranged from small to large: ¥19.2596, ¥21.7, and ¥54.7309, with only whole numbers retained for ease of calculation. The median of ¥19 and ¥55, i.e., (55-19)/2=18, was taken instead of ¥22 since ¥19 and ¥22 were too close and far from ¥55. Finally, the new classification criteria for poor families are as follows: the lowest, the low, the middle, and the higher. They are

correspondingly less than ¥19 per capita per day, ¥19-¥37 per capita a day, ¥37-¥55 per capita a day, and more than ¥55 per capita a day. (Table 3)

3.3.3. Project Design

The study design aims to allocate subsidy amounts according to household income groups to test whether China can mitigate carbon tax-related problems through CCTs. There are three specific steps:

3.3.3.1. Step One

The per capita tax and the share of the tax in the direct and indirect effects expenditures are first derived [18]. Columns 2 and 3 of Table 4 show the direct impact of the carbon tax on different income groups. Besides, columns 4 and 5 reflect the indirect effects of the carbon tax on different income groups.

3.3.3.2. Step Two

The direct + indirect effects = total distributional effect around the carbon tax [18]. The total distributional effect around the carbon tax is calculated in column 6 of Table 4.

3.3.3.3. Step Three

The subsidy amount can be allocated according to the objective of moving the value of the total distributional effect of each income group closer to the average. In other words, in terms of total distributional effects, the share of tax payments in expenditures should be close to the mean value of 0.7858. Otherwise, the percentage of a carbon tax of expenses is too much or too little. The "Low" and "Mid-low" income groups need 0.0672 and 0.0532 to get close to the mean, respectively, and thereby these two groups need to be compensated for the reduction in other expenditures caused by the carbon tax. The value minus the mean is negative for each income group, indicating that the tax expenditure does not affect other general public consumption and therefore does not need to be subsidized.

Finally, how is the exact amount of compensation calculated? The household income categories in Table 4 are different from those mentioned in Table 3. Therefore, for the convenience of calculation, the "Lowest," "Low," "Middle", "Higher" in Table 3 corresponds to the "Low", "Mid-low", "Mid", and "Mid-high" in Table 4 and the "High" in Table 4 is ignored. However, the above compensation ratios are only indicative and can only be applied to other geographic areas when the specific household income classification criteria are specified. Finally, the Grant Amounts are as follows: Lowest- ¥466.032 per year; Low- ¥718.466 per year; Middle- ¥0 per year; Higher- ¥0 per year. (Table 5)

Table 5. The percentage of compensation

Group (in Table 4)	Taxes as a percentage of expenses (%)	The percentage of compensation	Group (in Table 3)	Grant (per capita)	Grant (per year)
Low	0.853	0.0672	¥ 19	1.2768	466.032
Mid-low	0.839	0.0532	¥ 19-37	1.9684	718.466
Mid	0.767	0	¥ 37-55	0	0
Mid-high	0.758	0	¥ 55	0	0
High	0.712	0	-	0	0

Notes: Grant (per year) =365*Grant (per capita).

4. RESULTS

The case study results found clear support for China's ability to alleviate the problem associated with carbon tax through CCTs. They were divided into two parts: First of all, for target group identification, Shanghai was chosen as a pilot city considering the carbon emissions, economy, and geographical location. Next, new criteria for classifying poor households were developed by combining China's existing conditional cash transfer criteria and international standards, including the lowest, the low, the middle, and the higher. They are correspondingly less than ¥19 per capita per day, ¥19-¥37 per capita a day, ¥37-¥55 per capita a day, and more than ¥55 per capita a day (see Table 3). Secondly, for project design, the Grant Amounts are as follows: Lowest- ¥466.032 per year; Low- ¥718.466 per year; Middle- ¥0 per year; Higher- ¥0 per year. (See Table 5)

5. DISCUSSION

On the whole, the grant amounts for the new family income classification are presumed to be $466.032, $718.466, and the remaining two $0 per year.

Nevertheless, the above compensation ratios can only be applied to other geographic areas when specific household income classification criteria are specified. When comparing the findings to those of prior research, it must be pointed out that this paper proposes that China's targeted poverty alleviation strategy (TPA) is equivalent to CCTs in China and fills a gap in the literature on the application of CCTs to carbon income distribution in China. Regarding the limits of the method, it might be argued that there is a lack of support from the relevant literature. In succession, the research method of case study analysis cannot comprehensively analyze the results as China's existing conditional cash transfer policy is somewhat geographically distinct. It can only be applied precisely to Shanghai and not to China as a whole. The originality of this paper lies in the combination of the existing CCTs in China and the international standard classification of households by income. The data obtained on household income is less consistent with the significant trends. However, the analysis enables the author to determine that China can mitigate carbon tax-related problems through CCTs, as the compensation ratio in this paper is only indicative and can change depending on the different household income data. The research was concerned with the application of CCTs in carbon income distribution; however, the results can also apply to CCTs in other areas.

6. CONCLUSION

This paper is to find out the result of a Shanghai-based case study on the relative importance of CCTs as an instrument for carbon revenue allocation in the field of climate change economics. It focuses on the connection between CCTs and the mitigation of carbon tax-related issues in particular. The case study included two parts in addition to providing the project hypothesis and the target group selection. The two parts found that: Firstly, the new criteria for classifying poor households include Lowest, Low, Middle, and Higher. Secondly, the corresponding grant amounts are ¥466.032, ¥718.466, ¥0 and ¥0 per year, respectively. The current state of knowledge in CCTs crossover carbon tax side effects has been studied by developed and some developing countries, except for China. However, this paper fills this gap with a case study of Shanghai and thereby finds the new classification criteria for poor families and their grant amounts. The research methodology used in this case study shed fresh light on the use of CCTs to carbon revenue distribution in China, despite the fact that it limited the dissemination channels for new grant distribution. Based on these conclusions, practitioners should consider the CCTs, redistribution of carbon revenues, and entry points for Chinese climate policy. Additional study is necessary to get a better grasp of the significance of these results. For example, the effectiveness of the Chinese CCTs program in this paper can be evaluated. Moreover, the effects of the relationship between precisely target poor households and political barriers to carbon income distribution are unknown, necessitating additional study.

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