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Cutting CO_2 intensity targets of interprovincial emissions trading in China

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HIGHLIGHTS

- A Shapley value approach for emissions reduction targets allocation are presented.
- This scheme considers capacity, responsibility, potential and energy efficiency.
- Equally provincial targets reducing regional differences and interactions are analyzed.
- Different targets may achieve divergent shares of emissions reduction burdens.

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ABSTRACT

This paper proposes the allocation of CO_2 emissions increment quotas and carbon intensity reduction burdens based on information entropy method. Allocating emissions increment quotas and cutting emissions intensity target should consider each province's objective weights of some valuable factors, such as carbon emissions reduction capacity, responsibility, potential and energy efficiency under interprovincial emissions trading system in China. Those provinces with better economic level, heavier cumulative CO_2 emissions, stronger industrial carbon intensity and greater energy consumers may undertake greater shares of carbon intensity reduction targets during 2014–2020. All provinces in China may achieve a surprising reduction of CO_2 emissions increment quotas during 2014–2020 with an increase of national emissions intensity reduction targets, and then have to increase greater burdens of emissions intensity reduction compared with the 2013 level.

1. Introduction

An increase of greenhouse gas emissions and haze–fog are major threats to ecologic environment in China. As the biggest energy consumer and carbon emitter country in the world, action plan on greenhouse gas emission-reduction in China is of great significance. With the approval of the State Council of China, several cities such as Beijing, Shanghai, Shenzhen, Tianjin, Guangzhou, Wuhan and Chongqing have announced regional pilot emissions trading market since December, 2013. In order to carry out action planning of air pollution control and comprehensive program of energy-saving and emission-reduction, the National Development and Reform Commission of China (NDRCC) has announced Interim Measures of Emission Trading Management (IMETM) on December 10, 2014. Chinese objectives are fully integrating market-driven climate regulation into various development policies which improve energy efficiency and consumption structure, increase renewable energy usage and decrease greenhouse gas emissions. China strongly emphasizes the establishment of national pilot emissions trading market in China by 2016.

Chinese government has committed to decrease 40–45% carbon intensity relative to the 2005 level by 2020. Based on overall targets of national greenhouse gas emissions reduction, the State Council of China determines the total amount of each provincial emissions reduction quotas, considering cumulative carbon emissions responsibility, economic level, energy efficiency and emissions reduction obligation. Emissions reduction quotas are freely allocated in the pilot phase, and decision-makers introduce auction scheme in the right time. Action Plan of Energy Development Strategy during 2014–2020 (APEDS2014–2020) announced by the State Council of China shows that total quantity of primary

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energy consumption are no more than 4.8 billions tons standard coal equivalent (SCE) by 2020, including 62% coal consumption, 10% natural gas consumption and 15% renewable energy source. Therefore an important and urgent task is to establish a scientific, equal and feasible emissions trading system for the State Council of China in order to solve a dilemma both emission-reduction targets and sustainable economic growth.

The State Council of China will set specific provincial targets and establish national emissions trading market to reduce CO_2 emissions by 2016. However, most of provinces in China have usually significant divergences in resource endowments, economic development levels and energy consumption patterns. It implies that emissions abatement costs in different provinces are likely to be divergent. From macro-level, a potential quota-based emissions trading policy to reduce the overall abatement emissions costs is to allow different provinces to mutually trade their emissions reduction quotas. One of the most significant and controversial issues of emissions trading scheme depends on the initial quotas allocation mechanism, and initial allocation procedure has the potential to affect efficiency of the final emissions quotas allocation [1]. Different emission-reduction targets and initial quotas allocation rules may lead to different outcome and carbon emissions performance in different countries and regions.

Previous literatures provide various indicators and methods of emissions quotas allocation which has various distributional impacts. Grandfathering principle allocates free carbon quotas based on the historical CO_2 emissions while generating market distortion [2,3]. Richer countries and regions should have heavier emissions reduction burdens, thereby per capita GDP allocation principle should be equally treated with an increase of their capacity and economic level [4–6]. Cumulative carbon emissions should bear more historical responsibility for carbon emissions reduction, an allocation scheme based on cumulative CO_2 emissions may achieve an equitable carbon emissions space for different countries and regions [7,8]. Different countries and regions have emitted much greenhouse gas during the industrialization process, and then have greater carbon emissions reduction potential [9]. Some scholars propose carbon emissions quotas allocation given the multi-attribute methods, such as the equity, economic efficiency and other attributes together. Mackenzie et al. show initial quotas allocation using cumulative emissions and output is optimal only in closed trading system [10]. Wei and Rose analyze an interregional energy conservation-quota trading system using various equity criteria respectively included energy consumption-based and production-based equity, egalitarian equity, ability-to-pay equity and economic activity equity criteria [11]. Yi et al. allocate regional emissions reduction quotas using hypothetical weights of emissions reduction capacity, responsibility, and potential [12]. Wei et al. identify regional allocation of carbon dioxide abatement based on assumed weights of equity and efficiency indexes [13]. Yu et al. verify that CO_2 emissions intensity and per capita emissions are the most important indicators affecting regional emissions characteristics in interprovincial distribution of emissions reduction in China [14]. In brief, those results in the above literatures verify that carbon emissions quotas among provinces or regions is of the significant basis of national emissions trading market, GDP per capita, carbon emissions intensity, cumulative CO_2 emissions are the most significant indicators affecting interprovincial emissions quotas allocation.

Establishing an effective emissions trading market has received increasing attention in different countries and regions. Higher emissions allowances prices in emissions trading scheme translate into stronger incentives for the demand-side energy efficiency and reduce energy consumption, ambitious energy efficiency and renewable energy targets also guarantee significant reductions in greenhouse gas emissions [15–17]. Several policy such as designs different quotas allocation mechanisms and price mechanism in emissions quotas, and energy markets are the significant details to achieve emissions trading market efficiency and abatement targets [18,19].

Carbon trading market is considered an effective market tool which reduces the amount of greenhouse gas emissions, improves energy usage efficiency, and acquires low-cost emissions reduction means. Carbon trading market has four advantages. Firstly, carbon emissions trading is easy to get interest-groups' favor and decision-maker support. Secondly, carbon emissions trading can reach expected emission-reduction targets under more rigorous emissions reduction situation. Thirdly, carbon emissions trading could yield a significant impact on total abatement costs and abatement costs-saving in different regions. Fourthly, carbon emissions permits attain added auction revenues which are used to reduce market distortion and get economic dividends. Carbon trading price depends on expected market scarcity induced by emissions caps, supply and demand amount in emissions trading market. Future economic growth trends, energy efficiency, emissions cap and trading coverage and emission-reduction targets etc directly affect emissions trading market effectiveness and abatement potential. Conversely, an economically efficient regional emissions permits allocation induces a much stronger fall in total compliance costs than a suboptimal (i.e. too stricter) emissions permits allocation [20]. Emissions trading system increase total production cost in energy-intensive manufacturing industries, however a more efficient allocation shifts abatement efforts and compliance costs to energy-intensive industries [20,21]. The unified carbon emissions trading market can significantly reduce mitigation cost of the whole economy, and achieve the 42.5% reduction in carbon intensity over the period 2005–2020 [22,23]. Those findings may be useful for promoting the development of carbon emissions trading in China.

To sum up, previous relevant studies mainly focused on several allocation indicators and methods of emissions trading quotas in different countries and regions, while there are still some problems to be solved. Early studies give several solutions in several influential factors of carbon emissions allocation, while their emissions allocation solutions have not integrated into economic growth level, energy consumption pattern, industrial emissions intensity and cumulative CO_2 emissions amount, lacking of objective and systemic allocation solution. This paper proposes a comprehensive and equal allocation method of CO_2 emissions intensity reduction targets for interprovincial emissions trading system on the basis of information entropy theory, and then our empirical results provide how to allocate abatement targets of interprovincial carbon intensity. Compared with the earlier studies, this paper has two main contributions. Firstly, Based on IMETM and APEDS (2014–2020) in China, the allocation of CO_2 emissions increment quotas and carbon intensity reduction burdens under interprovincial emissions trading system is a comprehensive and equal solution considering economic growth level, energy consumption patterns, cumulative carbon emissions amount and carbon emissions intensity. Therefore, we use information entropy method to allocate future interprovincial carbon emissions increment quotas and carbon intensity reduction burdens during 2014–2020, which proves more comprehensive and equal solution. Secondly, we attempt to introduce different targets of CO_2 emissions intensity reduction, and then most of provinces achieve divergent shares of interprovincial carbon intensity reduction burdens during 2014–2020.

The rest of this paper is organized as follows. The allocation methodology of carbon emissions quotas and intensity reduction burdens and estimated model based on information entropy method are constructed in Section 2. Section 3 put forwards the empirical results and discussions. And the conclusions and policy implications are given in Section 4.