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Transaction costs, market structure and efficient coverage of emissions trading scheme: A microlevel study from the pilots in China

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HIGHLIGHTS

- We evaluate the effect from transaction costs on the efficient coverage of ETS.
- The market structure is regarded as another guidance to the coverage of ETS.
- A database of the industrial firms in the ETS pilots is established for the case study.
- It is found that the MRV cost is the main factor to break down the efficiency of ETS.
- Market structure has little effect on the efficient coverage of the ETS.

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ABSTRACT

Regulators need to pay attention to the negative effects of the transaction costs when they define the reasonable coverage of the emissions trading scheme (ETS). In addition, the market structure in the ETS also needs to be considered in the market efficiency evaluation, as most covered firms come from industries with high market concentration. This paper incorporates transaction costs (monitoring, reporting and verification (MRV) costs and trading costs) and market structure into a partial equilibrium model to study their effect on the reasonable coverage of the ETS. A database of the 1867 industrial firms included in the ETS pilots in China is established for the case study. It is found that the MRV costs become the main factor of the breakdown in efficiency of the ETS. However, there seems to be no inherent relationship between the market structure and the efficient coverage of the allowance market. The policy implications derived from the case study can provide useful references for the upcoming national ETS in China.

1. Introduction

Regulators carefully define the reasonable coverage of an emissions trading scheme (ETS) as the extent to which the coverage can affect the efficiency of the market. Some governments have anticipated expansion of ETS coverage to increase the economic aggregate of covered sectors [1–3]. However, this will also increase the administrative efforts of the government and the aggregate compliance costs to relevant sectors [4–6]. Meanwhile, the ETS itself has relatively high administrative costs and a complex implementation process [7]. The resulting transaction costs are not proportional to the size of the covered firms [8–10]. In addition, these costs have become a significant deterrent to the efficient traders in the ETS.

The question of transaction costs has become relevant for regulators determining the coverage of the ETSs in several countries [11]. Governments regard the ETS as an effective measure for controlling greenhouse gas (GHG) emissions [12–16]. Nevertheless, it is inappropriate for regulators to include too many emitters in an ETS given the presence of the transaction costs. The inclusion of combustion installations led to a broad coverage of small installations during the first and second phases in the European Union Emissions Trading Scheme (EU ETS). Given the relatively high transaction costs in the ETS, the costs of operating an ETS may be too high in comparison to the benefits from such a broad coverage [8]. In consideration of this, the EU ETS raised the threshold of carbon dioxide (CO_2) to the 25,000 tons beginning in 2013 [17].

China has also been prudent in determining a reasonable coverage of its carbon market in view of the effect of transaction costs. The local regulators in the ETS pilots have already defined the different industrial coverage and the threshold for covered entities, as indicated in Table 1

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Table 1
Provisions in the threshold of incumbent firms included in the ETS in each pilot in China.

Region	Inclusion threshold
Beijing	10,000 tons CO_2/year in both direct and indirect emissions in 2013–2015 5,000 tons CO_2/year in both direct and indirect emissions from 2016
Tianjin	20,000 tons CO_2/year in both direct and indirect emissions
Shanghai	20,000 tons CO_2/year (2015);10,000 t CO_2/year (2016) for power and industry 10,000 tons CO_2/year in both direct and indirect emissions for non-industry
Chongqing	20,000 tons CO_2e/year
Hubei	60,000 tons coal equivalent/year
Guangdong	20,000 tons CO_2/year or 10,000 tons coal equivalent/year
Shenzhen	3000 tons CO_2e/year for enterprises 20,000 m^2 for public buildings 10,000 m^2 for government buildings

Source: International Carbon Action Partnership (ICAP) (icapcarbonaction.com).

[18,19]. In addition, the central government only covers power sector in the first phase of the nationwide ETS. We infer that the transaction costs have been taken into account in the above determination of the industrial coverage [20]. For example, the power sector is regarded as a suitable choice for involvement in China's ETS because, of all sectors, it is the best prepared and holds the most comprehensive emission data. The narrow coverage will keep the carbon market from yielding higher administrative costs during the complex implementation process. Then, the government can take advantage of the flexible Program to curb GHG emissions in a cost-effective way [21–24].

Therefore, it is worth considering the most efficient coverage of the ETS in view of the effect of transaction costs [25,26]. While governments have been concerned about this issue, few studies have quantified the effect of transaction costs on the coverage of the ETS. Moreover, we realize that most covered firms come from industries with high market concentration, such as the power sector in China. It is also important to understand transaction costs in the oligopolistic allowance market [27]. Market structure has rarely been considered in the relevant discussion. Consequently, a thorough understanding is needed for the determination of reasonable coverage in the oligopolistic allowance markets with transaction costs.

In this paper, we first choose an appropriate framework to quantitatively analyse the reasonable coverage of the ETS. In some relevant studies, researchers have taken no account of the transaction costs [28,29]. Meanwhile, the bulk of the literature on transaction cost has focused on its effect on the cost-effectiveness rather than on the efficient coverage of the ETS [30–32]. However, with the presence of transaction costs, including more emitters may not increase efficiency gains from allowance trading. Expenses have been identified as a key element determining the costs and benefits of including additional emitters in the ETS [33–36]. Therefore, Betz et al. [8] proposed a conceptual framework to describe this issue: they compared the "blanket system" with a "partial coverage" in consideration of the transaction costs. This paper follows the above line of research to discuss the effect of transaction costs on the reasonable coverage of the ETS.

Second, we introduce market structure into the analytical framework. Some studies have discussed the issue of sectoral or regional expansion of an ETS where the countries have market power [37,38]. Fan and Wang [4] then discuss the reasonable sectoral coverage of the carbon market in consideration of transaction costs. They mainly describe the agents' market power based on the classical-Hahn-Westskog model. Such a model assumes that some agents are nominated as the price-takers in the ETS [39,40]. However, it is harder to justify the competitive behaviour of specific players in the real market. Therefore, we try to place no restriction on the number of agents acting strategically in the ETS. The trade in allowances in Godal [41] is construed as a two-stage noncooperative cooperative game in which everyone is a strategist. Therefore, referring to the work of Godal [41], we establish a dynamic model to analyse the reasonable coverage of the oligopolistic allowance market.

Third, a case study at the firm level is presented to discuss the reasonable coverage of the ETS pilots in China. Some researchers in relevant studies have collected data on transaction costs mainly based on surveys and interviews [8,27]. Then they adopt econometric models to estimate the transaction costs in the EU ETS [9,42]. However, since there are insufficient data for an empirical study, we utilize a case study to discuss the issue of the ETS coverage in China's pilots. The industrial firms included in the ETS pilots are chosen to build a database for the case study. Therefore, the relationship between the transaction costs and reasonable coverage of the ETS can be investigated from a microlevel perspective.

Finally, we focus on the transaction costs incurred by firms in our discussions, and these costs are defined as a composite of the monitoring, reporting and verification (MRV) costs and trading costs. On the one hand, the accurate measurement of the covered firms' emissions demands a high quality system of MRV, which would in turn raise the MRV costs [43]; on the other hand, the carbon exchanges charge allowance traders trading costs because they facilitate the allowance transaction among participants. As the direct transaction costs, these expenses can affect the cost-effectiveness of the ETS, which can determine the coverage of the ETS.

In short, this paper incorporates transaction costs and market power into a partial equilibrium model to study their effects on the reasonable coverage of an ETS. The potential contributions to the previous literature can be summarized as follows: (1) A microlevel methodology is proposed to determine the efficient coverage of an ETS with consideration of transaction costs; (2) The market structure is introduced into the framework to discuss the impacts in the oligopolistic allowance market; and (3) A case study based on firm-level investigation is presented to discuss the reasonable coverage of China's ETS pilots. The policy recommendations derived from the case study can provide references for the establishment of the nationwide ETS in China, as well as for other proposed carbon markets in developing countries.

Our paper proceeds as follows. Section 2 describes the analytical framework concerning the effect of the transaction costs in an ETS. Section 3 provides the description of the data collection and estimation. The case study results and relevant discussion are presented in Section 4. Section 5 concludes.

2. Model description

2.1. Basic framework of benefit-cost analysis

We first introduce the benefit-cost analytical framework to discuss the effect of transaction costs in an ETS. The differences between our model and that in Betz et al. [8] manifest in the following three aspects. First, we introduce the market structure into the analytical framework. Second, we compare the compliance costs of each firm regulated by a uniform emissions standard and an ETS within the analytical framework. The definitions of so-called "blanket coverage" and "partial coverage" are not taken into account here. Third, we only take into account the MRV costs and trading costs incurred by firms. Other indirect costs, such as the administration costs to the regulator, have not been estimated in our study.

Suppose that the regulator's objective is to achieve an exogenous set cap $\bar{e}$ for a uniformly mixed flow pollutant such as CO_2[1]. The cap is

[1] Only emissions of CO_2 are taken into account in this paper, similar to most of the pilot regions in China.