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Research article

Market power in auction and efficiency in emission permits allocation

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ABSTRACT

This paper analyzes how to achieve the cost-effectiveness by initial allocation of CO_2 emission permits when a single dominant firm in production market has market power in auction, and compare two prevalent allocation patterns, mixed allocation and single auction. We show how the firm with market power may manipulate the auction price, thereby this leads to fail to achieve cost-effective solution by auction unless the total permits for allocation equal to the effective emissions cap. Provided that the market power firm receives strictly positive free permits, the effective emissions cap of mixed allocation is larger than that of single auction. The production market share of dominant firm is increasing with the free permits it holds. Finally, we examine the compliance costs and welfare of mixed allocation and single auction, the result show that the former is preferred to the later when policy makers consider economic welfare without welfare cost due to CO_2 emissions.

1. Introduction

Greenhouse gas reduction has become a global issue. As a market mechanism, carbon market is a cost-effective measure to address global climate changes. Carbon emission permits initial allocation, which has been extensively studied in theoretical and empirical methods, is a pivotal issue to build carbon market. Reasonable allocation schemes embody fairness as well as efficiency. CO_2 emissions reduction undoubtedly increases the compliance costs of the firms, and cost-effectiveness has gradually become a common trend for CO_2 permits allocation (Okada, 2007; Cui et al., 2014).

There exist three issues worthy of consideration in carbon permits allocation. First, how to achieve cost-effectiveness by permits allocation. Second, which allocation patterns should be implemented. Third, how the allocation results impact production market. Because the compliance costs are closely related to CO_2 emission reductions, we intend to focus on how to determine the total permits of the emitters which comprise the firms or facilities. Thus it is necessary to integrate production market with the permits initial allocation. A fairly and reasonable way needs to be carried out to allocate to emitters after confirming the total emissions cap. The prevailing ways of CO_2 permits initial allocation are free allocation, auction and mixed allocation which integrates auction with free allocation. Recently, the permits are distributed to firms by mixed allocation in EU-ETS, and the proportion for auction will be 48% in the third phase. Furthermore, auction will be the main allocation way in the future (the proportion for auction will be 90% by 2021–2030). However, the market power actually widely exists in auction, and it may lead to inefficient allocation. Thus we intend to explain how the market power firm may excise influence to manipulate the auction price and how to achieve cost-effective solution. The production markets are impacted inevitably by the allocation results finally. It's necessary to examine the relationships between permit initial allocation and production markets. Moreover, the total abatement costs and welfare by mixed allocation may differ from that by single auction, and we wonder which is preferred for government.

The study on market power and permit allocation with permits transferable market alone was started by Hahn (1984). A well-known result was found that trading market can lead to cost-effectiveness only if the amount of the permits received by the market power firm equals to the number it needs in equilibrium. Market power firm will decrease the price if it is a net buyer, and vice versa. Westskog (1996) and Egteren and Weber (1996) developed the models of multiple cournot firms and non-compliance based on Hahn respectively and they get the essentially same results. The model of Maeda (2003) with an dominant firm which is net seller, the second dominant firm and other fringe firms that are

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net buyers, develops a result different from Hahn's that the equilibrium price of permits cannot be below the price in competitive market, but the result subjects to the model setup.

More literatures focus on the issue of both production and permit markets. Misiolek and Elder (1989) reveal that the dominant firm exercise the market power to raising the rivals' cost by increasing the permits price, thus it will hold permits exceed the ones in Hahn's cost-effective situation. The market power in permit tradable market will limit the competition in output market, and permits initial allocation is proposed to be policy instrument to control the market power (Sartzetakis, 1997a; Disegni, 2005). Furthermore, if the production market is imperfect competition, the permits trading market will not be efficient any more (Sartzetakis, 1997b). Hatcher (2012) examined the market power in both production and permit market, and the market power firm will hold excess permits if its initial permits are strictly positive. Hintermann (2015) supplied theoretical and empirical analysis and found that the Hatcher's result is still tenable provided that market power only exists in permit market. The study above support that permit allocation will not be efficient via trading market when market power exists in production or permit market, thus some of them regard initial allocation of permit as policy instrument to decrease efficiency distortion by controlling market power. However, none of these papers has analyzed whether permits allocation will be efficient when market power exists in auction.

As for comparison about different allocation patterns, auction is preferred to grandfathering, because an auction allows reduced tax distortion, provides clear price signals for tradable permits thereby reducing the transaction cost (Cramton and Kerr, 2002). Hahn and Noll (1982) and Plott et al. (1989) argue that sealed auction is superior to other transaction schemes for the following reasons: first, auction prevent the minority firms to being monopolies in emission permits; second, auction makes for keeping the price of permits stability. However, Borenstein (1988) suggests that government should decide a proper proportion for free allocation at the beginning of emission permit trading system and gradually decrease the proportion till all permits are auctioned in several periods. Kling and Zhao (2000) proves that the proportions of free permits should depend on the pollutant's nature, and part of the permits should be free allocation if the pollution damage elasticity of firms' emissions is greater than that of the number of firms.

The impacts of abatement cost and social welfare from different allocation methods have been theoretically and empirically examined. An imperfect competitive market of production leads to inefficient results by permit trading market, and the social welfare of administrative regulation on emissions is greater than that of trading market under certain conditions (Sartzetakis, 2004). Jensen and Rasmussen (2000) fully analyze the cost and welfare of auction, grandfathering and allocation according to market shares for CO_2 emission permits, and the results show that auction has lowest welfare cost but also with a large unemployment in energy-intensive departments. Nevertheless, whether auction can be more cost-effective than grandfathering depends on how the auction revenue is used to reduce the taxes distortion (Bohm, 2002). Golombek et al. (2013) examine how different allocation methods for CO_2 emission permits affect European electricity market. Similarly, Weber and Vogel (2014) considers how free allocation influence the prices and investments of European electricity industry and he found that free permits are likely to cause distorting incentives for investments and result in abatement costs above efficient levels. These papers are focus on examining the free allocation and auction. None of them have analyzed the mixed allocation and auction.

We consider such situation in this paper: one dominant firm in production market has market power in auction, and the fringe firms are price takers in auction. We analyze the market power firm how to decide the auction price in equilibrium, and show that the minimized abatement cost is closely related to CO_2 emissions cap. In addition, the equilibrium in auction is disturbed by the free permits of market power firm. Then we examine the auction price and how to influence production market. Finally, we examine the abatement cost and welfare between mixed allocation and auction, and we find that mixed allocation is preferred to auction.

The main contributions lie in threefold: first, considering market power exists in auction, we demonstrate that mixed allocation or auction can lead to minimized abatement cost only if the total permits equal to the effective amount of permits that all firms hold in equilibrium. Second, we demonstrate that the emissions controlling by auction is stricter than that by mixed allocation provided that the dominant holds strictly positive free permits. Third, we explore the relationship between production market and the auction price, and the market shares of dominant firm increase with the free permits it holds. Finally, without the welfare loss caused by CO_2 emission, this study shows that mixed allocation is more preferred to auction due to less welfare cost.

The following section sets a framework considering both production market and mixed allocation. The behavior of the market power firm is examined in section 3 and the relationships between production and permit allocation are showed in section 4. Section 5 put forward a comparison between mixed allocation and single auction and the final section concludes.

2. Framework

We set up the model with both production market and mixed allocation. There are n firms that produce the same production with CO_2 emissions. We consider the Stackelberg model in the production market with $n-1$ fringe firms and dominant firm 1. The total outputs of the fringe firms are $\sum_{i=2}^{n} q_i$ and the output of the dominant firm is q_1. The inverse demand function is $P=A-BQ$, where $A>0$, $B>0$.

A total of E permits are allocated to the firms through free allocation and auction. We consider that n firms with firm 1 designed as the firm with market power in CO_2 emission permit auction, i.e.$n-1$ firms are the price takers except the market power firm 1. We consider that the auction is uniform price auction (UPC), in which all permits in auction will be sold at a market-clearing price that equals to the highest rejected price. Each firm receives free permits $e_i^0 (e_i^0 \neq 0)$ which is determined by government, then the rest of permits, $E - \sum_{i=1}^{n} e_i^0$, will be auctioned. e_i refers to final number of emission permits hold by each firm i after initial allocation, and the permits cannot be traded each other. The amount of permits by auction for each firm is $e_i^1(\beta) = e_i - e_i^0$, where β is the market-clearing bid price in auction. According to Hahn (1984), we suppose that the demand of permits of price takers decreases with auction price and in a linear curve case: $e_i' < 0$ and $e_i'' = 0$. The auction market is clearing, thus $\sum_{i=2}^{n} e_i + e_1 = E$.

To concentrate on the main issue in this paper, we consider abatement costs instead of production costs. The function of abatement costs for each firm is $C^i(q_i, e_i)$. We suppose that the costs decrease in emissions, increase in outputs and convex in both parameters, so that $C_e^i < 0$, $C_q^i > 0$, $C_{qq}^i > 0$, $C_{ee}^i > 0$, $C_{qe}^i < 0$ and $\Delta_i = C_{ee}^i C_{qq}^i - (C_{eq}^i)^2 \geq 0$. Moreover, the third and higher order partial derivatives of abatement costs function are all ignored due to simplifying the calculation, and this will not influence the results.

To analyze the equilibrium, we first examine the behavior of the