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Market power in cap-and-trade auctions: A Monte Carlo approach

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HIGHLIGHTS

- The theory of market power behavior in emissions auctions is furthered.
- Monte Carlo simulation environment Oligopsony 1.0 is introduced.
- Simulations provide analysis of optimum bids to exercise market power.
- Significant non-linearities exist between profit and the exercise of market power.

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ABSTRACT

Recent greenhouse gas auctions have resulted in base level prices while remaining significantly concentrated. How do dominant firms receive such a large share of emissions allowances without bidding up the market price? This paper provides a Monte Carlo simulation analysis based on a contemporary regional greenhouse gas market in the United States. It introduces a *C#* simulation software environment, Oligopsony 1.0 that simulates uniform-price emissions auctions in repeated iterations. The results of these simulations indicate that there can be significant non-linearities between profit and market power as exercised through strategic demand reduction. This analysis finds the optimum point of strategic demand reduction that enables firms to exploit these non-linearities. The use of auctions to distribute tradeable pollution rights to firms in heavily concentrated markets can have significant unintended consequences, as it can exacerbate the problems of market power that exist within those markets.

1. Introduction

As the international community looks to market-based mechanisms to address negative externalities such as climate change, the success and efficiency of extant markets can play heavily into design and operation considerations for future markets. Traditionally, transferable property rights (cap-and-trade) markets have utilized direct allocation of property rights (emissions allowances or permits). That approach, although generally effective, has been shown to suffer from inefficiencies such as political misallocation (Dewees, 2008; Ellerman et al., 2000) and regulatory distortions (Arimura, 2002). Emerging cap-and-trade programs have improved upon this by utilizing market-based allocation through auctioning initial property rights. Because the initial allocation can influence both the efficiency and competitiveness of the emissions market, the performance of these auctions is of central importance. And, because the firms that operate within these auctions are the same firms that operate within concentrated deregulated electricity markets, the issue of concentration and the exercise of market power in emissions auctions is of central importance.

Distortions of the emissions market from market failures such as market power, can lead to inefficient price signals for producers (Godby, 2000; Tietenberg, 2006). When emissions prices are below the socially-optimal price, which is the case for modern auction-based programs and the one evaluated here, producers do not internalize the full cost of the environmental externality. This incentivizes socially-inefficient levels of pollution consisting of over-production from high-emissions resources (Tietenberg and Lewis, 2012), with significant consequences to the global environment and human health.

The purpose of this paper, therefore, is to evaluate the degree to which the strategic exercise of market power can influence the performance of emissions auctions. Following a brief review of extant literature, this paper introduces a model of a contemporary two-stage auction-based emissions market. A Monte Carlo emissions auction simulation software, Oligopsony 1.0, is then introduced. A set of simulation results is then presented, based upon parameters roughly consistent with a contemporary U.S. market, the Regional Greenhouse Gas Initiative, Inc. (RGGI). Sensitivity analyses and probability density analysis follows.

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2. A brief background on the literature

The theory of market power in emissions markets is developed by Hahn (1984) whose analysis of the Los Angeles region emissions market considers the case of a single dominant firm among smaller competing fringe firms. Hahn's analysis suggests that the nature of market power is a product of the initial degree of misallocation, which can transform the dominant firm into either a dominant buyer or seller, who can then reap excessive profits by exploiting the inelastic portions of competitors' demand curves.

This is furthered by the work of Misiolek and Elder (1989) who suggest that those dominant firms have altogether higher valuations in the emissions market because they are willing to pay for increased market share, barriers to entry, and the exclusion of rivals in common product markets (Rogerson, 1984; Salop et al., 1983, 1984, 1987; Williamson, 1968). Moreover, limits on the exercise of market power have been extended as far as the sanction cost for noncompliance (Chavez and Stranlund, 2003; Malik, 2002; Van Egteren and Weber, 1996). However, others have suggested that market power, despite its presence in emissions markets, is rather weak (Tietenberg, 2006), and has only minuscule impacts on market prices (Hagem and Westkog, 1998; Liski and Montero, 2006). On the other hand, laboratory experiments have provided robust analysis on market behavior in recent years (Milgrom, 2004). Emissions market experiments have provided evidence that the exercise of market power can be rather extreme (Godby, 2000; Holt, 1989; Muller et al., 2002; Wrake et al., 2008). And Godby (2000) provides even more striking results than Hahn (1984) in terms of the potential for market power to be exercised.

Auctions have been analyzed as an alternative allocation method for addressing the problem of misallocation (Krishna, 2009; Milgrom, 2004). The literature lauds auctions for their overall system efficiency improvements (Joskow, et al., 1998; Parry et al., 1999; Ruth et al., 2008; Tietenberg, 2006; Van Dyke, 1991; Wrake et al. 2008), for their strengths in reducing tax distortions, creating market flexibility, creating innovation incentives, and disincentivizing rent seeking (Cramton and Kerr, 2002). And they are lauded for their redistributive strengths; their ability to allow government to offset social costs (Bovenberg and de Mooij, 1994; Bovenberg and Goulder, 1996; Goulder et al., 1999; Parry et al., 1999; Smith et al., 2002; Wrake et al., 2008).

Just as the Coase Theorem suggests that overall system efficiency is independent of the initial distribution of the property right (Coase, 1960), Vickrey (1961) argues that the efficiency of auctions, and the revenue they generate, is independent of the format of the auction. However, just as the Coase Theorem is built upon a series of assumptions that are sometimes tenuous in practice, Vickrey (1961) makes two major assumptions. He assumes that all bidders are risk neutral, and that bidder valuations are identically and independently distributed (I.I.D.). These assumptions have been handsomely challenged (Maskin and Riley, 2000; McAfee and McMillan, 1987). Furthermore, bidder valuations are fundamentally impacted by market power, and by the expectation of arbitrage (Garratt and Troger, 2006; Zheng, 2002)—the 'trade' in cap-and-trade.

The degree of exercisable market power therefore becomes a key issue in the design of property rights auctions, because it directly affects the valuation of market participants. Market power has been consistently revealed in related electricity markets (Kahn et al., 2001; Wolfram, 1998). If the same firms that participate in those markets also participate in regional emissions markets, the same disproportionate market composition may influence market performance in emissions markets.

3. Why market power?: background and structure

The Regional Greenhouse Gas Initiative (RGGI) is the first-ever mandatory carbon cap-and-trade program in the United States, and it heavily influences national and international discourse on the development of carbon markets. The success or failure of RGGI, particularly in terms of economic efficiency, is a vital pivot point on the pendulum of future Coasian policy mechanisms. Although there have been previous tradeable property rights markets such as Southern California's Regional Clean Air Incentives Market (RECLAIM), the US Acid Rain Program, and the Virginia NO_x Program, RGGI is the first market to target greenhouse gases, which are far more difficult to mitigate or abate.

RGGI also serves as a model for larger programs because of its key institutional feature—RGGI is the first cap-and-trade program to use a nearly 100 percent auction allocation method. The initial distribution of property rights (allowances/permits) plays heavily into both the efficiency and the equity of the emissions market (Hahn, 1984; Tietenberg, 2006). More importantly, unmitigated market power in the distribution (auction), if exercised, can heavily bias the efficiency of the secondary trading market, making price discovery difficult.

Unlike some other emissions markets, RGGI only covers the electricity sector; transportation, agriculture and other GHG-emitting sectors are not covered entities. As a result, market power is a larger concern because this sector is already heavily concentrated, and its participants are the same natural monopoly firms that operate wholesale power generation.

3.1. Background

RGGI began as the pet project of former New York Republican Governor George Pataki, who invited neighboring state governments to compact with New York in curtailing negative effects of climate change in 2003. Today, ten east coast states are signatories: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey,[1] New York, Rhode Island, and Vermont. Each RGGI state legislature has agreed to the terms of the compact, which are outlined in the RGGI Model Rule, and each state has independently determined a reasonable emissions cap (RGGI, 2008).

RGGI auctions include more than electricity sector firms, however, as banks and hedge funds also participate. Liquidity was a concern from the inception of RGGI, stemming from the significant concentration of market participants (Holt et al., 2007). Market developers therefore decided to permit non-covered entities (banks and hedge funds) to participate in RGGI auctions, to serve two main purposes. First, economic theory dictates that greater competition leads to more efficiency, and thus market developers aimed to increase the quantity of market participants beyond the roughly 30 covered entities that would have otherwise participated by fiat. Second, despite the fact that many RGGI participants are protected by rate-of-return regulation, electricity firms in particular have a proclivity for seeking sufficient hedging instruments against economic risk. Participation by banks and hedge funds can facilitate a much more robust derivatives market.

Auctions are held quarterly for two separate vintages of allowances. Current-term vintages constitute the large majority of sales, and forward-term vintages, which are outside the scope of this analysis because they constitute a very small part of the market and have since been discontinued altogether. Allowances are fully bankable (can be held for use in future compliance periods), but are not borrowable (which would otherwise enable emissions in the present for allowance purchases in the future).

[1] New Jersey has recently discontinued its participation in RGGI.