Permit banking in emission trading: Competition, arbitrage and linkage

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\textbf{A B S T R A C T}

Several existing or proposed climate policies have considered bankable permits in a cap-and-trade (C&T) program that covers beyond a single sector, e.g., electric power, or allows the program to link to external C&T programs in other regions. This paper develops a model of permit banking under imperfect competition and imperfect inter-temporal arbitrage, in which the firms in one dominant sector can exert market power in both product and permit markets, while those in other sectors or linked programs are perfectly competitive. A simple analytical model is developed to generate contestable hypothesis. We further extend the model to account for the physical power system, institutional rules and market conditions, and then apply it to the Pennsylvania-Jersey-Maryland (PJM) market. We show that if the dominant firm has market power, then the permit price rises at a higher rate than the discount rate, contrary to perfectly competitive permit market, where the permit price rises at the discount rate following the classic Hotelling's rule. Furthermore, under a declining emissions cap system with the permits front-loaded in early time periods, the dominant firm has an incentive to suppress the permit prices (monopsony) when buying the permits in early periods, and then inflate the permit prices (monopoly) when selling them in later periods. Numerical results of the PJM case are consistent with the analytical conclusion.

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1. Introduction

Several existing or proposed climate policies have considered bankable permits in a cap-and-trade (C&T) program that covers beyond a single sector, e.g., electric power, or allows the program to link to external C&T programs in other regions. For example, California’s AB32 calls for a reduction of GHG emissions to 1990 levels by 2020 for the whole economy beyond electric sector, and the government also came to an agreement with the Quebec’s counterpart to link C&T of the two regions (CARB, 2015). Moreover, the Regional Greenhouse Gas Initiative (RGGI) also includes a project-based “offset” provision that allows greenhouse gas emission reduction outside of the capped electric power generation sector to qualify for the emission credits. With a perceived permit “supply” or “demand” curve from other regions/economy facing different product markets, firms might recognize that they can enhance their market position by cumulating permits through inter-temporal permit banking. This might lead to a deviation of the trajectory of permit prices from the path for the perfectly competitive permit market, distorting market signals for investments in renewables and pollution abatement.

In this paper, we apply a partial equilibrium modeling approach to study inter-temporal permit banking under imperfect competition in a setting with other sectors or linked-permit trading markets. As alluded to earlier, this can be the case when a C&T program covers more than one dominant sector, e.g., electric sector, or when a program is linked to C&T programs in other regions (or a offset provision exists). In particular, the firms in one dominant sector can exert market power to manipulate both product and permit prices in their favor, while the firms in the other sectors (or programs) are price-takers in their product and permit markets.\textsuperscript{1} Moreover, firms in the other sectors are assumed to have limited ability to undertake inter-temporal arbitrage in the permit markets.

Of course, to what extent firms in other sectors can effectively engage in inter-temporal arbitrage is an empirical question. However, imperfect arbitrage could possibly emerge for a number

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\textsuperscript{1} Empirical analysis of the 2000–01 power crisis in California suggests that large generators put a cost-squeeze on other firms by intentionally consuming more allowances than necessary, raising allowance costs for other companies that were short of allowances (Kolstad and Wolak, 2008).
of reasons. Limited financial and human resources possessed by small companies might prevent them from accessing knowledgeable brokers (Dasgupta and Heal, 1979). Firms in other sectors might also be less experienced in trading permits than the dominant sector, e.g., electric power sector. Information acquisition could still be much more costly for those companies, particularly for which bilateral trading remains to be the way how transactions for permits are executed in most cases. Although some financial companies may also attempt to arbitrage the market, regulator could limit the financial industry to access the permit market in fear of price speculation. Those speculators thus may face restrictions and transaction costs due to market regulations. For example, a European-wide legislation called Markets in Financial Instruments Directive II (MiFID II) adopts asymmetric regulations between compliers of EU Emissions Trading System (EU ETS) and other entities such as financial companies. MiFID II requires banks, traders and brokers to purchase a MiFID licence and to hold large capital reserves to trade emissions allowances. By contrast, this rule does not apply to allowances trading activities conducted by firms for compliance purposes with the EU ETS. Another example is the RGGI in the U.S., in which the states retain flexibility to limit eligibility of entities that can receive allowances. Those asymmetric treatments could lead to imperfect arbitrage in the permits markets.

The paper proceeds in two steps. First, an analytical model, which examines the decisions of a single dominant firm in a two-period setting, is developed to generate contestable hypothesis. Second, the analytical model is extended to account for the physical power system, detailed institutional rules, market conditions, and other factors that are known to be crucial to study the power sector. In particular, a Cournot-based formulation is implemented when modeling producers’ strategic behavior in the power sector. The model is then calibrated with 2012 data to study the implication of RGGI cap-and-trade policies in the PJM (Pennsylvania-New Jersey-Maryland) regional market. We focus on the PJM regional electric market for the following three reasons. First, the power industry in PJM has been active in the RGGI with CO2 permit trading since 2009. Second, the PJM State of Market Report indicates that economic incentives to exercise market power remain possible in transmission-constrained regions. As most states within the PJM have been deregulated, large firms within the region might be more responsive to rent seeking opportunity. Third, under newly introduced federal Clean Power Plan policy, more states might be interested in joining the regional RGGI C&T market to lower states compliance cost.

The paper has the following major findings from the analytical and numerical results. First, if the dominant firm has market power in the permit market, then the permit price rises at a higher rate than the discount rate. This is in contrast with the case of perfectly competitive permit market, where the permit price rises at the discount rate following the classic Hotelling’s rule (Hotelling, 1931). Second, under a declining emissions cap system with the permits front-loaded in early time periods, the strategic firms in the dominant sector have an incentive to suppress the permit prices as “monopoly/oligopoly” when buying the permits in early periods, and then raise the permit prices as “monopoly/oligopoly” when selling them in later periods. Numerical results of the PJM case are consistent with the analytical conclusion. Moreover, when facing regulation uncertainty where selling permits to the other sectors is less likely an option, firms would be reluctant to bank permits in earlier periods, leading to lower permit prices in earlier periods. As a result, firms’ incentive to exercise monopsony market power in last period is diminished, resulting in lower permit prices in the later period as well.

The remaining of the paper is organized as follows. Section 2 gives literature review, followed by presenting a basic model of emission permit banking under imperfect competition and imperfect arbitrage in Section 3. An extended model with more structure which reflects the reality of electric power system is developed in Section 4. We then apply our model to study the PJM market with a cap-and-trade program in Section 5, and numerical results are presented in Section 6. Section 7 concludes the paper.

3 MiFID II also puts restrictions on high frequency algorithmic trading techniques.
5 The recent development of JP Morgan (Wall Street Journal, 2012), again, highlights the fact that market manipulation or exercising market power could still be a concern as firms, traders, financial institutions, and other market participants exploit the loopholes of complicated rules that guide the operations of the power markets. In particular, the firm takes advantage of CAISO’s rule that a generator will be paid to ramp-down its output by under-bidding in one day (so that the generator is dispatched) with an over-bidding at $999 the next day so that the generator will be requested by CAISO to back down its output. We might actually expect the power market to be more vulnerable to those manipulations when bulk of renewables, as a result of Renewable Portfolio Standards (RPS), require more supply and demand side resources to balance the markets.

2 More recent works analyze permit banking by incorporating various price-containment policies such as safety valve or price collar (e.g., Newell et al., 2005; Fell and Morgenstern, 2010; Liu and Chen, 2017).

3 MiFID II also puts restrictions on high frequency algorithmic trading techniques.
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