Price Containment in Emissions Permit Markets and Its Impact on Capacity Investments

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Abstract

There have been two major concerns regarding to a cap-and-trade policy to regulate CO_2 emissions from the electricity sector. One concern is the significant increase of electricity prices caused by potentially high permit prices; while the other is the extreme volatility of permit prices. A price containment mechanism, known as the safety valve, has been proposed or implemented to address both concerns. In such a mechanism, additional emission allowances are introduced into the market to keep the CO_2 permit price at a (pre-specified) fixed level (the safety valve) should the permit price rises above the level. To reduce permit price volatility when the prices are actually low, a low-side safety valve has also been proposed, in which emission allowances will be purchased back to prevent the permit prices to fall below a certain level. In contrary to these price-based approaches, quantity-based approaches, such as allowance banking/borrowing, which provide intertemporal flexibility for firms to manage their emissions allowances, are also among the policy debate.

In this work, we will compare the impacts of various price containment mechanisms (one-sided safety valve, two-sided safety valve, and allowance banking/borrowing) in a two-stage market setting, in which electric power suppliers make capacity investment decisions in the first-stage, and compete in the electricity spot market that consists of the second stage. A novel complementarity-based reformulation translates the non-smooth permit price functions under a safety valve into a smooth complementarity problem (CP). We will further show the equivalence of the CP to a smooth nonlinear programming problem, which facilitates large-scale computation. Existence and uniqueness of the market equilibrium will be presented. We will also show the simulated market outcomes based on real market data from PJM. The results of our work will provide policy makers important insights regarding the influence of different permit price containment policies on green investments, electricity prices and CO_2 emissions.