Renewables, Allowances Markets, and Capacity Expansion in Energy-Only Markets

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Executive summary

The long-term capacity expansion decision in the electricity sector (the so-called energy-mix decision) is key to the goal of a low-carbon economy. Electricity and heat generated by fuel combustion are responsible for 35% to 45% of carbon dioxide emissions worldwide. Together with other environmental policies, Emission Trading Systems (ETS) have become the central policy instrument to control carbon dioxide emissions in many countries worldwide. Today, ETS are operational in several jurisdictions including, among others, several states of the US, the European Union, South Korea, and some provinces of China.

Central to the energy-mix decision is the tradeoff on profits associated with increased renewable generation. Investments in renewables drive fossil fuel plants out of the market, resulting in costly idle capacity. Investments in renewables generate higher rents with respect to conventional technologies because green generation can be sold at the marginal cost of fossil fuel plants. However, in energy-only markets, as renewables replace fossil fuel plants, electricity prices tend to fall to zero, eliminating any profit opportunity for the electricity sector. This means that electricity producers might have an incentive to withhold investments in renewable capacity. Surprisingly, the introduction of an ETS can restrain investments in renewables even further.

In this paper, we study the distortion mechanism introduced via an ETS. The paper proposes a model of an electricity sector endowed with two technologies (conventional and non-conventional), structured as a cooperative oligopoly (or, equivalently, as a monopoly) under uncertain electricity demand. It derives analytical dependencies between the energy-mix decision and market prices. Given a low demand elasticity and a high pass-through coefficient, typical of the electricity sector, the monopolist increases the price of electricity passing on the non-compliance cost of exceeding the emissions cap. We show that the distortion effect is twofold: (1) emissions exceed the cap and (2) profits increase (mainly due to the so-called allowance component). In practice, the monopolist actively seeks to set up an energy-mix such that the emissions associated with fossil generation exceed the cap in a systematic fashion. Crucially, the larger the sum of allowances and renewables, the lower the chances that emissions exceed the cap. Thus, the incentive to withhold investments in renewable capacity becomes stronger as allowances increase. Therefore, in the presence of a cooperative oligopoly (i.e. a monopoly) in the electricity sector, an ETS can generate substantial profit opportunities and (even more relevant from an environmental point of view) limit heavily the share of renewables in the long-term energy-mix. These findings highlight the need for a critical appraisal of the dependence between allowances and electricity prices and the long-term capacity expansion decision.

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Our conclusions are basically unaltered when relaxing the model assumption of perfectly inelastic electricity demand and various key modeling choices (capacity adjustments, banking of allowances, and regulatory adjustments).