Economic and Environmental Consequences of Market Power in the South-East Europe Regional Electricity Market

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Two major historic processes of the last four decades have shaped current electricity markets worldwide. First, the unbundling of vertically integrated utilities resulted in imperfectly competitive electricity markets. Second, concerns about greenhouse gas emissions led to carbon pricing through transferable property rights, e.g., allowances or permits. As with any other market, that for carbon allowances can be subject to the exercise of market power.

We investigate the economic and environmental effects of market power on electricity and permit markets in regional electricity markets where participants are not all subject to the same CO_2-emission-reduction policies. An example is the South-East Europe Regional Electricity Market (SEE-REM), which comprises both EU members subject to the emission cap of the EU Emissions Trading System (ETS) and non-EU members exempt from such a cap. Towards that end, we examine how a dominant firm can (i) gain an economic advantage and (ii) affect carbon leakage by manipulating both the electricity and permit prices.

We use a game-theoretic model with firms, consumers, and an independent system operator (ISO). Each firm owns several plants and maximises its profit via its production, while consumers are represented by nodal inverse-demand functions. The ISO determines the welfare-maximising imports/exports at each node. The case study is based on data from the year 2013 comprising transmission capacities, generation capacities, hydropower availabilities, and seasonal demand. The electricity market is cleared by equating nodal net supply and demand, and the price of CO_2 emissions is determined endogenously through a binding constraint on emissions from ETS units. Since we investigate the effect of market power in both electricity and permit markets, we have (i) a baseline perfect competition model [PC], (ii) a bi-level model with a Stackelberg leader that manipulates only the electricity prices taking the PC permit prices as given [S-T], and (iii) same as (ii) except that the Stackelberg leader manipulates both the electricity and permit prices [S].

In each of the three market settings, we impose emission-reduction scenarios varying from no cap on ETS emissions to a 40% reduction on ETS emissions. Under [PC], a binding cap on ETS emissions curbs ETS production. As the cap tightens, the price differential between ETS and non-ETS areas of SEE-REM increases, thereby enticing non-ETS production and leading to higher non-ETS emissions. Consequently, there is carbon leakage between 39%-11% for caps of 10%-40% reduction, respectively, compared to the baseline. The leader's strategy under [S-T] changes with the stringency of the environmental regulation. When natural gas is the marginal technology, which occurs at lower carbon-tax levels, the leader withholds production from its dominant technology (coal) in order to raise electricity prices. Higher electricity prices entice ETS natural-gas (including the leader's) and non-ETS production, which partly replaces the share vacated by the leader's coal

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plants. As a result, ETS (non-ETS) emissions fall below (rise above) the corresponding [PC] level. Since the reduction in ETS emissions offsets the increase in non-ETS emissions, carbon leakage is lower under [S-T] vis-à-vis the corresponding [PC] setting. For a carbon tax such that coal reaches cost parity with natural gas, the leader conversely expands coal production in order to set equilibrium prices. Higher electricity prices entice ETS coal and non-ETS production resulting in ETS and non-ETS emissions as well as carbon leakage above the [PC] level. Under [S] with a modest emission cap, the leader holds back more coal compared to that in [S-T] in order influence the permit price. A lower abatement cost results in higher ETS natural-gas production and ETS emissions compared to those in the corresponding [S-T] setting leading to higher carbon leakage. When coal reaches marginal-cost parity with natural gas under a more stringent cap, the leader expands coal to a lesser extent compared to that under the corresponding [S-T] setting as it does not want to increase the permit price. Contrary to [S-T], since the ETS fringe cannot increase coal production because of the cap, it increases natural-gas production. This leads to lower ETS emissions and carbon leakage vis-à-vis the [S-T] setting. Generally, the leader reaps higher profits when it has the ability to manipulate both markets. Hence, understanding the incentives of such a dominant firm is pertinent to devising EU carbon policy.