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Implications of the EU Emissions Trading System for the South-East Europe Regional Electricity Market

Verena Višković[a], Yihsu Chen[c], Afzal S. Siddiqui[a, b, d, *]

[a] Department of Statistical Science, University College London, United Kingdom
[b] Department of Computer and Systems Sciences, Stockholm University, Sweden
[c] Department of Technology Management, University of California, Santa Cruz, United States
[d] Department of Decision Sciences, HEC Montréal, Canada

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ABSTRACT

As part of its climate policy, the European Union (EU) aims to reduce greenhouse gas (GHG) emissions levels by 20% by the year 2020 compared to 1990 levels. Although the EU is projected to reach this goal, its achievement of objectives under its Emissions Trading System (ETS) may be delayed by carbon leakage, which is defined as a situation in which the reduction in emissions in the ETS region is partially offset by an increase in carbon emissions in the non-ETS regions. We study the interaction between emissions and hydropower availability in order to estimate the magnitude of carbon leakage in the South-East Europe Regional Electricity Market (SEE-REM) via a bottom-up partial equilibrium framework. We find that 6.3% to 40.5% of the emissions reduction achieved in the ETS part of SEE-REM could be leaked to the non-ETS part depending on the price of allowances. Somewhat surprisingly, greater hydropower availability may increase emissions in the ETS part of SEE-REM. However, carbon leakage might be limited by demand response to higher electricity prices in the non-ETS area of SEE-REM. Such carbon leakage can affect both the competitiveness of producers in ETS member countries on the periphery of the ETS and the achievement of EU targets for CO_2 emissions reduction. Meanwhile, higher non-ETS electricity prices imply that the current policy can have undesirable outcomes for consumers in non-ETS countries, while non-ETS producers would experience an increase in their profits due to higher power prices as well as exports. The presence of carbon leakage in SEE-REM suggests that current EU policy might become more effective when it is expanded to cover more countries in the future.

1. Introduction

Convincing evidence provided by the most recent IPCC report suggests that human activity is causing climate change (Stocker et al., 2013). Regardless of whether the energy sector is vertically integrated or deregulated, policymakers have implemented several measures to facilitate the reduction of greenhouse gas (GHG) emissions using both market-based mechanisms, e.g., taxes, subsidies, and emissions trading, and other policy instruments, e.g., voluntary agreements and regulatory protocols.[1] An example of legally binding GHG emissions controls is the 20–20–20 targets[2] set by the

* Corresponding author at: University College London, Department of Statistical Science, Gower Street, London WC1E6BT, United Kingdom.
E-mail addresses: verena.viskovic.13@ucl.ac.uk (V. Višković), yihsuchen@ucsc.edu (Y. Chen), afzal.siddiqui@ucl.ac.uk (A.S. Siddiqui).

[1] Whether deregulation of the power sector makes it easier for the government to reduce GHG emissions remains debatable. On the one hand, the lock-in of sunk capital by incumbents under the regulated paradigm has been viewed as a barrier to environmental policies so that deregulation is typically associated with the adoption of new technology. For example, an empirical study by Hyman (2010) suggests that a significant investment in gas-fired facilities in the U.K. was undertaken after restructuring. Indeed, recent expansion of distributed energy resources seemingly suggests that deregulation is more likely to lead to emissions reduction when mandated by the government via market-based instruments (von Hirschhausen, 2014). On the other hand, Wilson (2002) argues that the traditional vertically integrated paradigm is more likely to enforce policy due to its tighter regulation and a more involved role for the state.

[2] EU 20–20–20 refers to the EU's three climate targets to be reached by 2020. First, 20% reduction in GHGs compared to 1990 levels. Second, 20% improvements in energy efficiency relative to 1990 levels. Third, 20% of EU energy to be produced from renewables.

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European Union (EU). One of the EU 20–20–20 targets is the reduction in GHG emissions by 20% by the year 2020 compared to those in 1990 (EC, 2007). In order to facilitate this transition, the EU launched its Emissions Trading System (ETS) as a market-based mechanism in 2005. The ETS is a cap-and-trade (C&T) system that sets a cap on aggregated emissions, and companies receive or buy tradeable emissions allowances within the cap. The cap is reduced over time in order to curb emissions. Today, it is the most extensive international system for emissions trading covering 11,000 power stations, industrial plants, and airlines in 31 countries (EC, 2015).

The trading of CO_2 allowances represents an increased cost for both electricity producers and energy-intensive industries. If either such industries were to move their production to countries with less-strict climate policies (EC, 2009; Chen, 2009) or the countries in the regulated area were to increase their imports from non-regulated areas (Chen, 2009), then so-called "carbon leakage" would result. Thus, perversely, a C&T system could lead to an increase in CO_2 emissions in the non-regulated areas (Chen, 2009). Electricity generation in the EU ETS is for the most part covered without the possibility of leakage with the exception of some borders with non-regulated areas like in South-East Europe. In particular, the South-East Europe Regional Electricity Market (SEE-REM) comprises countries that are part of the EU and may partly offset the emissions reductions from domestic production with imports from non-regulated neighbouring countries. The potential for such carbon leakage to occur as a consequence of the EU ETS in the context of SEE-REM has received little attention in the literature.

Carbon leakage might delay the achievement of environmental objectives such as EU 20–20–20 by reducing allowance prices so that producers have less than anticipated incentive to switch to less-polluting sources of power generation or to implement carbon-reduction technologies in conventional sources (Višković et al., 2014) than they would otherwise. While reducing domestic emissions, the EU ETS does not account for increased emissions in the non-regulated area that result from increased exports from the non-ETS area to the ETS area in order to meet ETS electricity demand.

We use a stylised 22-node network to model the electricity sector and associated emissions of SEE-REM comprising neighbouring countries with inconsistent CO_2 emissions reduction regulation (i.e., only some countries are covered by the EU ETS). The model estimates the magnitude of leakage (in percentage terms) relative to the emissions from the ETS[3] part of SEE-REM in the short term before any adjustment in capacity can occur with consideration of the impacts of hydropower availability on market outcomes. Under this framework, we treat both availability of hydropower and allowance prices exogenously, thereby not allowing for 1) possible impact of hydro availability on the allowance price or 2) changing dispatch of hydropower in response to the allowance price. Parametric treatment of allowance prices is equivalent to treating the allowance price as a carbon tax, determined by the larger ETS area where the allowances are initially allocated through auction. Given that we have a fixed cap under the C&T, our assumption implies that the increase of SEE-REM emissions covered by ETS would be offset elsewhere in the wider ETS not covered in our model.

There are three central findings resulting from our study: (i) emissions leaked into the non-ETS area could amount to 6.3% to 40.5% of the emissions reduction in the SEE-REM ETS area[4]; (ii) higher electricity prices in some non-ETS countries could mitigate leakage due to non-ETS demand response that lowers consumption; and (iii) higher CO_2 emissions could occur in the ETS area of SEE-REM as a result of demand response to lower electricity prices from higher availability of cheap hydropower throughout the entire SEE-REM. Moreover, the results observed under (i) and (ii) suggest a need for a more careful assessment of what to consider as CO_2 emissions within the ETS, i.e., the regulator should also take into account the imports into the ETS area as part of the CO_2 emissions produced by the EU and decide whether imports should be subject to the C&T regime. However, our findings highlight the benefit of expanding the EU ETS to neighbouring countries within a regional electricity market in order to maximise the effectiveness of the program. We believe that the EU ETS paves a promising pathway to enhancing the coverage of the program.

The structure of this paper is as follows. Section 2 reviews the literature to put our work into context. Section 3 formulates the equilibrium problem. Section 4 introduces the data sources, calibrates the SEE-REM model, and presents the results of the case studies. Section 5 summarises the paper's contributions and provides directions for future research.

2. Literature review

Up until the 1970s, least-cost methods were adequate for supporting decisions in the electric power system due to tight regulation of the electricity industry. Hobbs (1995) points out that with deregulation and unbundling, there is a need for optimisation models that account better for endogenous price formation and strategic interactions in electricity markets. Starting from Hobbs (2001), complementarity models have evolved to analyse deregulated electricity industries (Gabriel et al., 2012).

Concerns about environmental issues in the past decade have increased the need for policy-enabling models. Such models have illustrated that mechanisms such as C&T and renewable portfolio standards (RPS) do not always work as intended (Tanaka and Chen, 2013). For instance, Limpaitoon et al. (2011) study the impact of the C&T mechanism on electricity markets in the presence of transmission congestion and strategic behaviour. They find the possibility of less-polluting firms' exercise of market power in electricity markets by withholding supply or over-consuming permits, leading to higher electricity and permit prices. Inflated permit prices translate into a higher abatement cost for more-polluting firms. Those relatively dirty firms then decrease their generation and surrender their market share to "cleaner" firms, which results in "cleaner" firms' earning higher profits (Chen and Hobbs, 2005; Limpaitoon et al., 2014). The deployment of such strategies is supported by empirical evidence. Kolstad and Wolak (2003) find that firms manipulated the nitrogen oxides (NO_x) pollutant market in the Los Angeles metropolitan area as a way of exercising market power in the California electricity market. Specifically, the analysis suggests that some firms with a number of their generation units located in the area covered by the NO_x market deliberately paid higher prices for the permits in the years 2000 and 2001 in order to be able to justify higher offers into the California market for all electricity they produced. The result was higher electricity prices in California over 2000 and 2001.

An emission tax could also interact with power transmission in a surprising way. For instance, Downward (2010) reports that a carbon tax could cause changes in the merit order and reverse flow

[3] The International Energy Agency (IEA) publishes one figure for both electricity and heat sectors. Thus, it is not straightforward to obtain an estimate of electricity sector emissions only for the entire EU ETS. However, according to the IEA, the emissions from electricity and heat generation of the countries modelled in SEE-REM were approximately 23% of the electricity and heat generation emissions of the whole EU ETS in 2013 (IEA, 2015).

[4] The level of leakage to the non-ETS part of SEE-REM is equivalent to approximately 0.5% of electricity and heating emissions of the entire EU ETS. We obtain this figure by dividing our average estimated increase in CO_2 emissions in the non-ETS part of SEE-REM (6.5 Mt) as a result of a positive CO_2 price by the total EU ETS electricity and heating emissions (1256.2 Mt).