

Electricity pricing under “carbon emissions trading”: A dominant firm with competitive fringe model

Monica Bonacina, Francesco Gulli*

Iefe-Bocconi University, Viale Filippetti 9, 20122 Milan, Italy

Received 21 September 2006; accepted 16 February 2007

Available online 12 April 2007

Abstract

The aim of this paper is to analyze the impact of trading of CO₂ emissions allowances on electricity pricing in the short run. We mainly refer to the European Emissions Trading Scheme (ETS) and are interested in understanding the role of electricity market structures. We carry out a simple analytical model useful to verify whether (and under which conditions) the impact of the ETS under market power could be lower (or higher) than that under perfect competition. We analyze a context where generators compete in a uniform, first price auction. Market power in the form of a dominant firm facing a competitive fringe model is assumed. The paper highlights that the marginal CO₂ opportunity costs are fully included in energy prices when the electricity market is perfectly competitive. Under market power the impact of the ETS equals or exceeds that under the competitive scenario only when there is excess capacity and the share of most polluting plants in the market is low enough. Otherwise, the impact under market power is less than under perfect competition and significantly decreases in the degree of market concentration. This especially occurs when there is not high excess capacity and regardless of either the plant mix or the allowance price. In this case, moreover, the marginal pass-through rate is lower in the peak than in the off-peak hours and can be even nil if the degree of market concentration is high enough.

© 2007 Elsevier Ltd. All rights reserved.

Keywords: Emissions trading; Electricity prices; Market power

1. Introduction

This paper studies the impact of “carbon emissions trading” (trading of CO₂ emissions allowances) on electricity pricing. To provide a better understanding of the topic and stress its importance, we start by recalling the policy context from which the need of implementing a carbon emissions trading scheme (ETS) arises.

It is widely recognized that the emissions of the so-called “anthropogenic” greenhouse gases (GHG), among which carbon dioxide (CO₂) is the most important, contribute to global warming and, consequently, to climate change. This is the reason why, for many years, the international community has been engaged in finding the way of stabilizing the concentration of these gases in the atmosphere. For this purpose, in 1992, the United Nations Framework Convention on Climate Change (UNFCCC)

has been signed and, in 1997, a large number of industrialized countries agreed to the Kyoto Protocol, coordinating on imposing emissions reduction targets. In order to minimize the social costs of achieving these targets, several tools of environmental policy are strongly recommended. Since emissions trading plays a crucial role among them, several countries and regions have already decided to implement an emissions trading scheme.¹ This is the case for the European Union (EU) where an industry CO₂ emissions trading scheme started in 2005.²

¹An Emissions Trading Scheme is a typical *cap and trade* system. A given amount of emissions allowances is allocated among participating installations which can use or trade allowances in order to cover their emissions.

²In the period 2005–2007, each European country allocates allowances to eligible firms. At least 95% of the total amount of allowances are allocated free of charge and firms can use or trade them. At the end of each calendar year each eligible firm must deliver a number of allowances corresponding to his total emissions in that year. At the beginning of 2008 a new ETS starts and the old allowances become worthless.

*Corresponding author. Tel.: +39 0258363820; fax: +39 0258363890.
E-mail address: francesco.gulli@unibocconi.it (F. Gulli).

The European ETS covers several sectors of which the largest is power generation. Therefore, on the one hand, the effectiveness of the ETS largely depends on whether it will be able to induce power industry to significantly reduce its emissions. On the other hand, the ETS might have a significant impact on electricity prices and, consequently, on social welfare.

This study focuses on this latter issue, attempting to provide a better understanding of how a CO₂ price could impact on electricity pricing.³

The economic literature on emissions trading is wide enough and covers several fields.⁴ However, existing studies have been mainly concerned with design issues rather than with the impact on correlated (product) markets. Concerning the electricity sector, only recently specific research effort has been made to study the effects of the ETS on product prices but studies generally assume purely competitive frameworks which are far from the reality of electricity markets. These, in fact, are more or less concentrated markets where one or more firms are able to exercise market power. Thus the need of extending the study to imperfect competition arises and in particular the need of answering two important questions:

- (1) How does the impact of the ETS on electricity pricing depend on electricity market structures?
- (2) What role does market power in electricity markets play, in this respect⁵?

Studies aimed at answering these questions do exist but they provide a very controversial framework. Sijm et al. (2005) and Wals and Rijkers (2003), by using a game theoretical simulation model based on the theory of Cournot competition and Conjecture Supply Functions,⁶ find that the electricity price in a competitive scenario increases more than under market power, on both percentage and absolute basis. They attribute this result to the assumption of linear demand function they adopt. Surprisingly, however, Lise (2005) achieves the opposite result (electricity price increases more under market power) even though the author uses the same model. Reinaud (2003), relying on price competition, and Newbery (2005),

³Indeed, this is a very recent question. Currently, in Europe there is a very controversial debate on whether (and up to which extent) the rise in power prices is due to the pass through of the carbon opportunity cost.

⁴Main contributions deal with (1) comparative studies of alternative policy tools (Bohm and Russell, 1985), (2) analysis of static and dynamic efficiency, (3) studies of the effects of uncertainty and risk (Montero, 2004) as well as of (4) market power (Hahn, 1984; Malueg, 1990; Eshel, 2005) and (5) transaction costs (Stavins, 1995).

⁵This question is important also for another reason. The impacts of the ETS on electricity prices influences power demand and consequently the environmental performance of the market. Many authors deal with the link between market structure and environmental issues. See, in particular, the contributions of Oates and Strassman (1984) and Cropper and Oates (1992). For a survey, see also Requate (2005).

⁶The COMPETES model. For details on this model, see Day et al. (2002), Hobbs and Rijkers (2004a, b).

by assuming constant price elasticity, state that electricity prices are likely to increase more under market power.

This controversial framework highlights that results significantly depend on the choice of competition models.⁷ In the economic literature on the electricity sector several approaches are generally used for modeling competition and several classifications are proposed.⁸ Examining recent developments in the literature on electricity spot markets, von der Fehr and Harbord (1998) distinguish three groups of approaches: the standard oligopoly models⁹; the “supply function” approach¹⁰; the “auction” approach.¹¹

In the present work we will follow the suggestion of authors who argue in favor of the “auction” approach. In fact, several electricity spot markets have characteristics which make standard models not well-suited to their analysis. In particular in these markets pricing mechanism is a uniform, first price auction. Furthermore, since we have to isolate the effect of the environmental regulation, in the form of a typical *cap and trade* regulation (namely, a market of carbon emissions allowances), we do not account for the problem of capacity with holding, grid congestion and contract market which, in the opinion of some authors (Borenstein et al., 1999), can be better investigated by using the standard oligopoly models.

⁷In particular, price elasticity choice is very important in simulating the impact of the ETS and can undermine the effectiveness of a model. For example, the existence of Nash equilibria within the Cournot model requires substantial negative price elasticity. This is the case, for example, of the COMPETES model cited above. Whereas completely inelastic demand seems to be more appropriate for the power industry, at least in the short-run. Moreover, Bolle (1992) proves that in this latter case no equilibrium exists in the supply function model.

⁸See Borenstein et al. (1999), von der Fehr and Harbord (1998) and Smeers (1997, 2005).

⁹Among these models the authors include the “capacity-constrained, Bertrand competition” approach and the “repeated interaction, price collusion” approach. Other authors (Borenstein et al., 1999) emphasize the usefulness of the Cournot–Nash approach considered flexible in order to incorporate other institutional aspects of the electricity markets (bilateral trading, startup costs, ramping rate, transmission constraints, etc.) as well as its usefulness to study the capacity with holding problem.

¹⁰This group is based on competition with supply functions which means that producers can select their strategies from a space with an infinite number of dimensions. One of the main advantages of a supply function equilibrium model is that it seems to be suited to the characteristics of the actual electricity markets. The general formulation of this model was introduced by Klemperer and Meyer (1989). Bolle (1992, 2001) and Green and Newbery (1992) provide applications to the UK electricity market. For an interesting comment about the results of this latter contribution, see von der Fehr and Harbord (1993, 1998). Recent works using the supply function approach have extended the previous analyses in order to include contract market and contestable entry (Newbery, 1998).

¹¹Many contributions use the “auction” approach in order to model competition in the electricity markets. Among them, we have to recall the former contribution by von der Fehr and Harbord (1993). This approach has been recently extended in order to study the problem of capacity with holding (Crampes and Creti, 2001) and the discriminatory or “pay your bid” electricity auctions (Fabra et al., 2004).

متن کامل مقاله

دریافت فوری ←

ISIArticles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات