Energy Economics 63 (2017) 248–252

Contents lists available at ScienceDirect

Energy Economics

journal homepage: www.elsevier.com/locate/eneco

Tradable quota taxation and market power☆

Alessio D'Amato[a,b,*], Edilio Valentini[c], Mariangela Zoli[a,b]

[a] University of Rome Tor Vergata, Italy
[b] SEEDS Interuniversity Research Centre, Italy
[c] University G. D'Annunzio of Chieti Pescara, Italy

ARTICLE INFO

Article history:
Received 3 March 2016
Received in revised form 1 November 2016
Accepted 29 January 2017
Available online 24 February 2017

JEL classification:
Q58
H23

Keywords:
Tradable quota markets
Market power
Tradable quota taxation

ABSTRACT

We investigate how *corrective* taxation can improve the efficiency properties of tradable quota systems affected by market power. Indeed, we show that, when there is a dominant firm in the tradable quota market, the regulator can set an *ad hoc* taxation on firms' traded quotas that restores cost effectiveness without driving the dominant firm's net demand to zero. Achieving cost effectiveness with market power and quota taxation implies some costs in terms of tax revenue that, however, can be justified by the corresponding reduction of compliance costs. Moreover, we see that there may be cases where all firms result to be better off after the implementation of corrective taxation.

1. Introduction

In recent years environmental policies have been characterized by a remarkable increase in the adoption of market instruments, with price signals to regulated agents arising from emission quantity restrictions coupled with trading schemes (Hepburn, 2006). Several types of market instruments have been put in place. Markets for tradable pollution permits, for instance, have been established to control SO_2 emissions and other air pollutants in the US, as well as to cut CO_2 emissions in the EU; further, the development of an international permit market for CO_2 emissions has been one of the cornerstones of the flexibility mechanisms under the Kyoto Protocol. Markets for tradable certificates have been introduced also to stimulate investments in energy efficiency and in electricity generation from renewable energy sources. The functioning of these tradable quota (TQ) systems has been investigated extensively by the literature starting from the seminal article by Montgomery (1972) as, in some cases, they have the potential to attain environmental policy targets cost-effectively, i.e. at the minimum aggregate cost. The property of cost effectiveness, however, relies upon the somehow controversial hypothesis that TQs are traded in perfectly competitive markets. When the assumption of perfect competition is relaxed, some players can exploit their market power by decreasing TQ supply/demand, leading to larger total abatement costs (Hahn, 1984; Westskog, 1996). Even though the presence of market power is empirically debated in the practice of emission trading (Tietenberg, 2006) and its relevance should be probably assessed case by case (Sturn, 2008), the ability to manipulate emissions' price has been recognized to be a potential problem in the case of a hypothetical Kyoto-like international emission trading system (Alvarez and André, 2015), as well as a source of concern in local or nationwide carbon markets. This is testified, for instance, by the different ways in which pilot carbon trading schemes introduced in China are trying to prevent, or at least reduce, market power (Zhang, 2015), or by the attention devoted to the emergence of strategic behaviors in other TQ systems, such as the Scandinavian market for renewable energy certificates (Amundsen and Bergman, 2012).

The analysis of the effects of market power on the economic performance of TQ systems is also a thought provoking research question, as it is shown by the large theoretical literature that has

☆ Previous versions of this paper have been presented at the Pescara 2012 Law & Economics workshop, at SIEP, SIE, SIDE-ISLE, NERI, EAERE and IAERE conferences. We wish to thank all attenders at those presentations as well as Simone Borghesi, Cesare Dosi, Fabio Fiorillo, Carolyn Fischer, Beat Hintermann, Yoram Margaliot, Antonella Nocco, Alessandro Rubino and two anonymous referees for comments and suggestions. The usual disclaimers apply.
* Corresponding author at: University of Rome Tor Vergata, Italy.
E-mail address: damato@economia.uniroma2.it (A. D'Amato).

http://dx.doi.org/10.1016/j.eneco.2017.01.024
0140-9883/

followed the seminal article by Hahn (1984) (see, for instance, Disegni Eshel, 2005; Hagem and Westskog, 2009; Godal and Meland, 2010, Hintermann, 2011, Liski and Montero, 2011, Montero, 2009; and Haita, 2014). In some cases, authors provide policy suggestions to address inefficiencies that might arise when TQ markets are not perfectly competitive. Hahn (1984), for instance, suggests that a possible way to eliminate market power in TQ systems is through an ad hoc, cost-effective initial allocation of TQs. However, there are situations where the regulator cannot control the initial allocation of TQs to each emission source, or it could be unaware of the presence of market power when the initial distribution of quotas is realized, while being able to observe and regulate it only ex-post (Hagem and Westskog, 2009).

In this paper we put forward an alternative proposal to the efficient allocation of TQs discussed by Hahn (1984). Namely, we investigate the possibility of restoring cost effectiveness through an *ad hoc* differentiation of prices faced by each firm in the TQ market. We show that the task of differentiating prices can be assigned to a system of taxes and rebates that would allow the regulator to tackle market power and achieve cost effectiveness. Indeed, we derive the conditions required by an optimal tax/rebate rule to restore cost effectiveness in TQ markets where one dominant firm has the possibility to affect the equilibrium price. For the sake of simplicity, we focus on a theoretical model dealing with emission trading, but results could be easily replicated in an alternative model where TQs are either energy saving certificates or renewable energy certificates[1].

Specifically, we consider I firms emitting pollution. There are two types of firms, namely, a dominant firm and $I-1$ firms belonging to a competitive fringe.[2] Each firm optimally chooses its level of emissions, given its initial endowment of quotas; we assume that a system of firm-specific taxes (rebates) can be applied to revenues (costs) arising from quota selling (buying) behavior. Each firm decides whether to be a net seller or buyer of quotas by comparing its cost of increasing/reducing emissions and the price of quotas, which is exogenous when the firm is price taker and endogenous when the firm is a dominant firm.

We find that an optimal corrective taxation implies a tax (rebate) rate on the net selling (buying) dominant firm lower (higher) than the tax and rebate rate which is applied to the other firms. Such difference between the rates applied to the dominant firm and to other firms brings about that restoring cost effectiveness comes at a cost in terms of additional public expenditure. As this expenditure is a net transfer from taxpayers to the TQ market, it can be justified as long as the benefit of restoring cost effectiveness is larger than the deadweight loss of the required tax revenue. Moreover, we identify a case where all firms are better off when an ad hoc corrective tax rule is implemented.

This is not the first paper dealing with TQ taxation. Fischer (2006), for instance, investigates the interaction between multinational taxation and abatement in an international emission trading scenario where the equilibrium permit price is exogenous, while Yale (2008) examines under what circumstances income taxation interferes with cap-and-trade environmental regulation. Both Fischer (2006) and Yale (2008) deal with a comprehensive corporate income taxation which taxes both profits (net of abatement costs) and permits' revenues/costs by the same tax rate. Costantini et al. (2013), instead, isolate the specific impact of permit taxation in an international emission trading market where no other taxes are taken into account. In this way they elicit the impact of permit taxation within an emission trading scheme that would perform in a cost effective way without this type of taxation[3]. None of these papers, however, considers market power or the possibility that TQ taxation can be used as corrective regulatory tool.

Our paper is also related to the literature on environmental policy design under market power (see, among others, Gersbach and Requate, 2004 and Fischer, 2011) and to those papers suggesting ways to restore cost effectiveness in a TQ system featuring market power. In particular, Hagem and Westskog (2009) suggest a mechanism restoring cost effectiveness by making allocation in one period dependent on the market price of permits observed in previous period(s). However, such mechanism does not work when the TQ system prevents the regulator from manipulating the allocation of quotas.

The rest of the paper is organized as follows: Section 2 presents the theoretical model; Section 3 illustrates the properties of the proposed corrective taxation scheme restoring cost effectiveness; Section 4 addresses its distributional consequences, and Section 5 concludes.

2. The model

We adopt a framework *à la* Hahn (1984), and assume a market featuring I firms. Each firm $i \in I$ minimizes net emissions' cost $c_i(x_i)+p(x_i-e_i)$, where x_i and e_i are, respectively, the amount of pollution emitted by firm i and the initial endowment of quotas which is exogenously allocated to firm i, $c_i(x_i)$ is the (gross) cost of pollution (with $c_i' < 0$ and $c_i'' \geq 0$), $p(x_i-e_i)$ is the cost (revenue) of buying (selling) quotas and p is the equilibrium price.

As in Hahn (1984), all firms are price takers except one, the dominant firm, labeled as d. The remaining $I-1$ firms belong to a competitive fringe F, and they are labeled as f. In a standard two stage game, the dominant firm sets emission quantities (*first stage*) before the price takers firms clear the market (*second stage*).

Specifically, given the quota price which arises from the after-trade market clearing condition $\sum_{i=1}^{I} x_i = \sum_{i=1}^{I} e_i = E$, in the second stage each firm $f \in F$ chooses the level of emissions minimizing the net emission cost. E labels the (exogenous) aggregate emission cap. The first order condition of this minimization problem, in the absence of taxation, is as follows[4]:

$$c_f'(\hat{x}_f) + p = 0, \tag{1}$$

where $\hat{x}_f$ is the equilibrium emission level of firm f. Note that, if all firms are price takers, then condition (1) for all firms implies that the exogenous environmental target is achieved at the minimum cost.

In the first stage, when the dominant firm decides its optimal levels of emissions, it anticipates how the fringe, and consequently the equilibrium price of quotas, will react to its choice; the first order condition of the dominant firm's minimization problems is

$$c_d'(\hat{x}_d) + p + \frac{\partial p}{\partial x_d}(\hat{x}_d - e_d) = 0 \tag{2}$$

where $\hat{x}_d$ is the equilibrium emission level of firm d, and $\frac{\partial p}{\partial x_d}(\hat{x}_d - e_d)$ (i.e. the marginal effect on quota price of polluting decisions of firm d

[1] A supplementary material showing how the model presented in this paper can be interpreted in terms of energy saving certificates and renewable energy certificates, is available at http://ediliovalentini.jimdo.com/research.

[2] Focusing on a setting *à la* Hahn (1984), with a single dominant firm, does not affect the generality of our conclusions (we thank an anonymous reviewer for drawing our attention on this point). Indeed, our main results can be easily replicated in an alternative framework where more than one firm features market power. Such framework is also discussed in the supplementary material available at http://ediliovalentini.jimdo.com/research.

[3] Another paper in this stream of literature is Kane (2009) who provides a descriptive analysis of the different fiscal treatments affecting the permit trading markets.

[4] We assume that the relevant second order conditions are satisfied.