Tradable Quotas Taxation and Market Power: Supplementary Material

Alessio D'Amato[*], Edilio Valentini[†], Mariangela Zoli[‡]

November 1, 2016

Abstract

In this supplement we show how the main proposition stated in the paper survives in an alternative setting where market power is exerted by more than one firm and the tradable quotas system is a market for green certificates instead of an ETS[1].

[*]University of Rome Tor Vergata

[†]Corresponding author: University G. D'Annunzio of Chieti Pescara - email: valentin@unich.it

[‡]University of Rome Tor Vergata

1 Cost effectiveness and market power in a green certificates' market

We assume a market for green certificates featuring I firms[2]. An initial target in terms of green power production, $\overline{g}_i$ is assigned to each firm $i \in I$. Any firm is free to satisfy this target by either producing green power, g_i or buying green certificates. Indeed, if $g_i > \overline{g}_i$ the firm obtains an amount of certificates equal to $g_i - \overline{g}_i$ and it is free to sell them in in the market. On the contrary, if $g_i < \overline{g}_i$ the firm must buy an amount of certificates equal to $g_i - \overline{g}_i$ in order to comply with its target. Each firm $i \in I$ chooses its optimal level of g_i in order to maximize its net benefits $p(g_i - \overline{g}_i) - c_i(g_i)$, where $c_i(g_i)$ is the cost of producing green power (which is increasing and convex in g_i), $p(g_i - \overline{g}_i)$ is the revenue (cost) of selling (buying) green certificates, p is the price of certificates and $\overline{g}_i$ is exogenously imposed to firm i.

Firms are divided in two categories, according to whether they have market power in the certificates market or not. More specifically, firms can be part of a competitive fringe F or can be part of a set of strategists S, where $F \cup S = I$ and $F \cap S = \emptyset$. We can represent this model as a two stage game: *in the first stage,* strategists set their quantities of green power before the price takers firms clear the market *(the second stage)*. Strategists are therefore assumed to compete *à la* Cournot on the green certificates market.

Solving backward we look first at the optimal choices of the firms belonging to the competitive fringe. Given the price which arises from the after-trade market clearing condition $\sum_{i=1}^{I} g_i^* = \sum_{i=1}^{I} \overline{g_i}$, each firm $i \in F$ chooses the level of production maximizing its net benefit. The first order condition of this maximization problem is as follows:

$$p - c_i'(g_i^*) = 0 \tag{1}$$

In the first stage, when the strategists decide their optimal levels of production, they anticipate how the fringe will react to their choices and, consequently, the equilibrium price of certificates; the first order condition of their maximization problems is:

$$p + \frac{\partial p}{\partial g_i}(g_i^* - \overline{g}_i) - c_i'(g_i^*) = 0 \tag{2}$$

for every $i \in S$.

[2] A white certificates market, focused on energy efficiency, or other equivalent quotas markest, can be analysed using the same setting developed here.

2 The effects of certificates taxation on cost effectiveness

Assume that a tax (rebate) rate t_i is applied on revenues (costs) generated by the amount of certificates sold (when $g_i > \overline{g}_i$) or bought (when $g_i < \overline{g}_i$). Therefore, for any firm $i \in I$, the maximization problem becomes

$$\max_{g_i} p(1-t_i)(g_i - \overline{g}_i) - c_i(g_i) \tag{3}$$

which implies that the first order conditions for the fringe and the strategists become, respectively,

$$p(1-t_i) - c_i'(g_i^*) = 0 \tag{4}$$

and

$$p(1-t_i) + \frac{\partial p}{\partial g_i}(1-t_i)(g_i^* - \overline{g}_i) - c_i'(g_i^*) = 0. \tag{5}$$

Given (4) and (5), cost effectiveness requires that:

(i) For any couple of firms $i, j \in F$ it must be

$$p(1-t_i) = p(1-t_j)$$

i.e.

$$t_i = t_j$$

which implies that *all firms belonging to the competitive fringe are subject to the same tax/rebate rate*, exactly as it is required by condition (a) of Proposition 1 in the paper for the case of emission permits markets.

(ii) For any strategist j and any firm i belonging to the fringe it must be

$$p(1-t_i) \;\; = \;\; p(1-t_j) + \frac{\partial p}{\partial g_j}(1-t_j)(g_j^* - \overline{g}_j) \tag{6}$$

i.e.

$$p(1-t_i) - p(1-t_j) \;\; = p(t_j - t_i) = \tfrac{\partial p}{\partial g_j}(1-t_j)(g_j^* - \overline{g}_j) \tag{7}$$

which implies that *net seller (buyer) strategists must be taxed with a rate which is lower (greater) than the tax/rebate rate of the competitive fringe.*

This is exactly what is required by condition (b) of Proposition 1 in the paper when the tax/rebate rate to be applied to the dominant firm is compared to that applied to the competitive fringe. Note that in this framework the strategist is a seller when $g_i^* > \overline{g}_i$ while in the case of emissions trading being sellers requires $x_i^* < e_i$. However since here $\frac{\partial p}{\partial g_i} < 0$ while, under emissions permits, $\frac{\partial p}{\partial x_i} > 0$, the same condition applies to both frameworks.

Moreover, in a framework where more firms have market power *net seller strategists must be taxed with a tax rate which is smaller than the rebate rate applied to net buyer strategists.* This does not need a formal proof since it follows as a consequence of (i) and (ii).

Finally, the following must also be true:

Corollary 1. *In a green certificates market affected by market power, taxation restoring cost effectiveness implies that the revenue raised from net sellers is smaller than the lost revenue from net buyers.*

Indeed, conditions (b) and (c) of Proposition 1 in the working paper version of the article (see footnote 1) also apply to this supplement.

[1] Another version of the paper, which has been published as CEIS research paper (https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2754172), deals with an emission trading market where more than one firm enjoy market power.