# THE TAX TREATMENT OF EMISSION ALLOWANCES UNDER INTERNATIONAL EMISSIONS TRADING

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# The Tax Treatment of Emission Allowances under International Emissions Trading

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**Abstract**

According to OECD, most of the tradable permit regimes have ignored the role of emission allowances taxation. The aim of our paper is to take a first step towards a full investigation of such taxation. We introduce a simple two stage game featuring two countries and two "representative" competitive firms, one in each country. In the second stage of the game firms take emission permits taxation as given and choose emissions and permits selling or buying behaviour. In the first stage, governments choose the level of the tax on permits' revenues. We compare two institutional settings: a non harmonized one, in which countries set the tax rate in a non cooperative way, and a harmonized one, where the tax rate on emissions trading revenue is set by a single supranational authority maximizing aggregate social welfare. Our results show that explciitly accounting for emission permits taxation implies a distortion in equilibrium permits price. More specifically, taxing the revenues from permits trading implies an upward shift in the equilibrium price, as well as a distortion in the allocation of output and emissions among the net selling an the net buying country. Turning to the preferred institutional setting, we show that tax harmonization might lead to larger tax rate and emissions depending on the benefits related to public revenues arising from permits trading taxation and on the related deadweight losses. Finally, we show that counterintuitive welfare implications might arise.

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# 1 Introduction

In the context of international environmental negotiations, tradable emission permits have emerged as an economically efficient and effective means of implementing environmental policy objectives. It is well known that cap-and-trade regulations allow overall emission reduction targets to be met at lower costs than conventional command-and-control mechanisms, as they provide an opportunity to take advantage of differences in marginal abatement costs across emission sources. Under trading-based mechanisms, governments allocate a given amount of emission permits, consistently with a predefined ceiling. Firms can then trade permits among each other on the basis of their market price. Specifically, a firm holding permits can decide to emit the corresponding volume of greenhouse gases, to buy other permits and increase the amount of GHG produced, or to spend more on abating emissions and sell its surplus permits.

Despite an extended literature have examined the issue in several respects, there is one relevant aspect that has not been addressed to date: the tax treatment of emission permits. According to OECD, most of the tradable permit regimes have ignored the role of corporate and personal income tax and VAT, implicitly assuming that tradable permits would be outside these taxes or that the impact of the taxes would be neutral. In practice, however, taxing tradable permits may introduce distortions in their efficient allocation, by affecting the costs of acquiring permits and the proceeds from their selling. Failing to consider potential (dis)incentives effects of taxes on permits revenue could then lead to wrong conclusions about the desired level of GHG reductions and the related costs. Furthermore, under international emissions trading (EU – Kyoto), differential tax treatments of permits revenues are likely to generate distortions both in the permits market and in international trade flows. As emissions trading systems are growing in terms of geographical coverage, the presence of international spillovers among regulated firms and countries can no longer be overlooked.

This work represents a first step in the direction of investigating the tax treatment of emission allowances. To this end, we introduce a simple two stage game featuring two countries and two "representative" competitive firms, one in each country. In the second stage of the game firms take emission permits taxation as given and choose emissions and permits selling or buying behaviour. In the first stage, governments choose the level of the tax on permits' revenues, while we assume, coherently with existing international environmental agreements, that the total amount of allowances is given.

We compare two institutional settings: a non harmonized one, in which countries set the tax rate in a non cooperative way, and a harmonized one, where the tax rate on emissions trading revenue is set by a single supranational authority maximizing aggregate social welfare.

Our results show that explciitly accounting for emission permits taxation implies a distortion in equilibrium permits price. More specifically, taxing the revenues from permits trading implies an upward shift in the equilibrium price, as well as a distortion in the allocation of output and emissions among the net selling an the net buying country.

Turning to the preferred institutional setting, we show that tax harmonization might leadt to larger tax rate and emissions depending on the benefits related to public revenues arising from permits trading taxation and on the related deadweight losses. Finally, counterintuitive welfare implications might arise.

To the best of our knowledge, there is only one theoretical contribution which have explicitly addressed the impact of emission trading revenues taxation. Yale [4] examines the extent to which income taxation interferes with cap-and-trade environmental regulation. He reaches two opposite conclusions according to the time horizon under scrutiny. Within a single tax period, taxing returns from permits does not distort firms' choices at the margin between using and selling permits or between buying permits and abating. At the opposite, taxes may distort firms' decisions regarding whether and to what extent they save permits for future use (permit banking). It is particularly true when permits are provided freely (gratis) and their value is excluded from taxable income (holders with a zero basis in their permits). In these cases permit prices will rise and the tax exemption is capitalized into the price of permits. Accordingly, tax rules can modify the relative costs of abatement in present and future periods by affecting the cost-effective allocation of emissions allowances.

Our paper is also related to the literature on overlapping environmental regulation. An example, under this respect, is the survey on the potential interaction of the UK climate policy and the European ETS as presented by Sorrell and Sijm [3] who argue that the EU ETS is incompatible with the climate policy in the UK, due to distributional effects upon different groups, double regulation, double counting, differential treatment of regulated and non regulated sectors. Other papers dealing with the goods and the bads of overlapping regulation are Johnstone [2] and Boehringer et al. [1]. In particular, the latter paper investigates the potential efficiency losses arising from the imposition of emission taxes on sectors that are covered by the EU Emissions Trading Scheme (EU ETS), concluding that substantial excess cost might arise due to overlapping regulation.

Our contribution to the existing literature is twofold: first of all, we explicitly model permits trading revenue taxation in a realistic setting where multiple firms and multiple countries interact. Further, we take a step towards a full investigation of the consequences of emissions trading taxation, in line with what is suggested by the OECD.

The rest of the paper is organized as follows. In Section 2 the basic model is introduced, while in Section 3 we explicitly consider the tax treatment of emission allowances, by distinguishing between two different tax settings. Section 4 provides the main results.

## 2 The model: the benchmark case

We assume that there are two firms, each of them is representative of two different countries ($i$ and $j$). Both firms are subject to an international emissions

trading system, according to which they receive a fixed number of tradable permits to pollute. The amount of emission allowances issued in each country is supposed to be exogenous. This is the case, for example, of the EU Emissions Trading System, where the total number of permits must be set in accordance with EU and each country's environmental obligations.The permit market is perfectly competitive, i.e. firms are price takers. Each firm can either use or sell its permits. For simplicity, we assume that there is a 1 to 1 relationship between production and polluting emissions.

Consider first the country $i$. The domestic firm aims at maximizing its profits, given by:

$$q_i - \frac{\beta_i}{2} q_i^2 - p(q_i - x_i)$$

where $q_i$ are polluting emissions (and production), $p$ is the price of permits and $x_i$ is the amount of emission allowances.

The first order conditions for this problem are as follows:

$$p = 1 - \beta_i q_i$$

which imply

$$q_i = \frac{1}{\beta_i}(1 - p)$$

The same reasoning holds for country $j$, leading to the following amount of emissions:

$$q_j = \frac{1}{\beta_j}(1 - p)$$

Equilibrium on permits market requires that total emissions are equal to the overall number of permits, or, in other terms, to the aggregate target $E = x_i + x_j$:

$$\frac{1}{\beta_i}(1 - p) + \frac{1}{\beta_j}(1 - p) = E$$

Equilibrium price is therefore:

$$p = 1 - \frac{\beta_i \beta_j}{\beta_i + \beta_j} E$$

and the corresponding levels of emissions/production for each country are:

$$q_i = \frac{\beta_j}{\beta_i + \beta_j} E \tag{1}$$

$$q_j = \frac{\beta_i}{\beta_i + \beta_j} E \tag{2}$$

# 3 The tax treatment of emission allowances: introducing a specific tax

## 3.1 Second stage: firms

We now introduce a simple tax on revenues from emission allowances. To evaluate the effects of the tax, we need to distinguish here if the country is a net seller ($s$) or a net buyer ($b$) of emission permits. Since we are considering only two countries, one of them will be a net seller whilst the other will be a net buyer. We assume that permits selling revenues are taxed, but no exemption is granted to firms in the net buying country. Indeed, a rebate on permits related costs would be politically burdensome.

The firm's profits in the country $s$ become equal to:

$$q_s - \frac{\beta_s}{2} q_s^2 - (p-t)(q_s - x_s)$$

where $t$ is the tax rate on emission allowances revenue. Clearly, as the country is a net seller, it must hold that $q_s < x_s$.

The Lagrangian from the maximization problem is:

$$q_s - \frac{\beta_s}{2} q_s^2 - (p-t)(q_s - x_s) + \tau_s(q_s - x_s)$$

where $\tau_s$ is the Lagrangian multiplier.

First order conditions for the net seller are[1]:

$$1 - \beta_s q_s - p + t = 0$$

implying the following emissions level

$$q_s = \frac{1}{\beta_s}(1 - p + t) \tag{3}$$

The problem for the net buyer is the same as in the benchmark case, subject to the condition that $q_b > x_b$.The Lagrangian in this case is:

$$q_b - \frac{\beta_b}{2} q_b^2 - p(q_b - x_b) + \tau_b(x_b - q_b)$$

which leads to the following first order conditions:

$$1 - \beta_b q_b - p - \tau_b = 0$$

$$q_b = \frac{1}{\beta_b}(1 - p) \tag{4}$$

The equilibrium condition on the permits market implies that their price is equal to:

$$p = 1 + \frac{\beta_b}{\beta_s + \beta_b} t - \frac{\beta_s \beta_b}{\beta_s + \beta_b} E \tag{5}$$

We can now derive the first result of our paper:

[1] As we assume that country $s$ is a net seller of permits, then $\tau_s = 0$.

**Proposition 1** *Emissions increase (decrease) with the tax rate in the net selling (buying) country.*

Indeed, combining (3), (4) and (5) it is easily shown that:

$$q_s = \frac{t + \beta_b E}{\beta_b + \beta_s} \tag{6}$$

$$q_b = \frac{-t + \beta_s E}{\beta_b + \beta_s} \tag{7}$$

The intuition for such result is straightforward: an increase in $t$ implies, *ceteris paribus*, an increase in the equilibrium price of permits. This is the only impact on the net buying country, so that the corresponding emissions level is reduced. On the other hand, country $s$ also experiences a negative *direct effect,* which is, in absolute terms, larger than the positive *indirect effect* related to the change in permits price. As a result, emissions decrease in country $s$.

To conclude, notice, from the comparison of (1) with, respectively, (6) and (7), that a positive tax rate implies larger than first best emissions in the net selling country and smaller than first best emissions in the net buying country.

## 3.2 First stage:

In this stage the tax rate is chosen in order to maximize social welfare. As already outlined in the introduction, we distinguish two scenarios: in the fully centralized case, the tax rate is chosen in a harmonized way across countries by a single supranational auhority, while in a decentralized tax setting the tax rate is chosen in a non-harmonized way, i.e. non cooperatively, by the net selling country.

### 3.2.1 Centralized authority

In this case, the tax rate is set by a centralized regulator in order to maximize social welfare, corresponding to the sum of producer surplus in the two countries *minus* environmental damages (that are given, as $E$ is exogenous) *plus* the benefits related to the tax revenue in the selling country *minus* the distortion caused by the tax introduction:

$$W_f = E - \frac{\beta_s}{2} q_s^2 - \frac{\beta_b}{2} q_b^2 - dE^2 + \mu t \left(q_s - x_s\right) - \frac{\lambda}{2} t^2$$

where the subscript $f$ indicates the full centralization case and $\mu$ is the tax revenue marginal benefit.

From the first order conditions for this maximization problem we obtain the following tax rate:

$$t_f = \frac{x_b \mu \beta_b - x_s \mu \beta_s}{1 - 2\mu + \lambda \beta_b + \lambda \beta_s} \tag{8}$$

### 3.2.2 National governments

In the decentralized framework, the tax rate is chosen in a non-cooperative way by the government in the net selling country ($s$) to maximize domestic social welfare:

$$W_n = q_s - \frac{\beta_s}{2} q_s^2 - p(q_s - x_s) - \frac{d}{2}(q_s + q_b)^2 + \mu t\,(q_s - x_s) - \frac{\lambda}{2} t^2$$

where the subscript $n$ stands for non cooperative. Notice that, in a decentralized setting, only domestic benefits from emissions are accounted for.

The corresponding tax rate is now given by:

$$t_n = \frac{\left(\beta_b^2 - \mu\beta_b^2 - \mu\beta_b\beta_s\right) x_b + \left(\mu\beta_s^2 - \beta_b\beta_s + \mu\beta_b\beta_s\right) x_s}{2\mu\beta_b - \beta_s - 2\beta_b + 2\mu\beta_s - \lambda\beta_b^2 - \lambda\beta_s^2 - 2\lambda\beta_b\beta_s} \tag{9}$$

The tax differential between the harmonized and the decentralized tax setting is as follows:

$$\Delta t = t_f - t_n = \frac{x_b\mu\beta_b - x_s\mu\beta_s}{-2\mu + \lambda\beta_b + \lambda\beta_s + 1} - \frac{\left(\beta_b^2 - \mu\beta_b^2 - \mu\beta_b\beta_s\right) x_b + \left(\mu\beta_s^2 - \beta_b\beta_s + \mu\beta_b\beta_s\right) x_s}{2\mu\beta_b - \beta_s - 2\beta_b + 2\mu\beta_s - \lambda\beta_b^2 - \lambda\beta_s^2 - 2\lambda\beta_b\beta_s}$$

# 4 Comparisons

In this Section we provide results from comparisons between the two different tax setting. To achieve readable insights, we assume complete symmetry in parameter values across countries, i.e. $\beta_b = 1$ and $\beta_s = 1$.

The corresponding tax rates are:

$$t_f = \frac{\mu\,(x_b - x_s)}{2\lambda - 2\mu + 1}$$

and

$$t_n = \frac{(2\mu - 1)\,(x_b - x_s)}{4\lambda - 4\mu + 3}.$$

As a preliminary condition, we need to guarantee that country $s$ is indeed a net seller of permits. The net selling behaviour requires, under both institutional settings, that $q_s < x_s$. Since:

$$q_s - x_s = \frac{1}{2}\,(x_b - x_s)\,\frac{2\lambda - \mu + 1}{2\lambda - 2\mu + 1}$$

in order for having $q_s < x_s$ two cases may hold:

- either $x_b < x_s$ and $\frac{2\lambda - \mu + 1}{2\lambda - 2\mu + 1} > 0$
- or $x_b > x_s$ and $\frac{2\lambda - \mu + 1}{2\lambda - 2\mu + 1} < 0$.

However, in the second case, if $x_b > x_s$, we must have $2\lambda - 2\mu + 1 > 0$ and therefore $2\lambda - \mu + 1 > 0$ (so that $\frac{2\lambda-\mu+1}{2\lambda-2\mu+1} > 0$) to guarantee $t_f > 0$. Such a case is therefore impossible, in that assuming $x_b > x_s$ implies a negative $t_f$ for $s$ to be indeed a net seller.

Assume, therefore, $x_b < x_s$, so that $2\lambda - 2\mu + 1 < 0$, guarantees $t_f > 0$. In order for country $s$ to be a net seller, we must have the additional condition that $2\lambda - \mu + 1 < 0$, so that $\frac{2\lambda-\mu+1}{2\lambda-2\mu+1} > 0$. It is enough to assume that $\lambda < \frac{1}{2}\mu - \frac{1}{2}$.

Turning to $t_n$, we can have two cases, given $x_b < x_s$ :

1. $2\mu - 1 > 0$ and $4\lambda - 4\mu + 3 < 0$

   the above inequalities imply $\mu > \frac{1}{2}$ and $\lambda < \mu - \frac{3}{4}$. As $\mu - \frac{3}{4} - \left(\frac{1}{2}\mu - \frac{1}{2}\right) = \frac{1}{2}\mu - \frac{1}{4} > 0$ if $\mu > \frac{1}{2}$ then the assumption $\lambda < \frac{1}{2}\mu - \frac{1}{2}$ implies $\lambda < \mu - \frac{3}{4}$.

2. $2\mu - 1 < 0$ and $4\lambda - 4\mu + 3 > 0$.

   the above inequalities imply $\mu < \frac{1}{2}$ and $\lambda > \mu - \frac{3}{4}$. As $\mu - \frac{3}{4} - \left(\frac{1}{2}\mu - \frac{1}{2}\right) = \frac{1}{2}\mu - \frac{1}{4} < 0$ if $\mu < \frac{1}{2}$ then this case takes place when $\mu - \frac{3}{4} < \lambda < \frac{1}{2}\mu - \frac{1}{2}$.

Previous assumptions then guarantee that tax rates are positive in both cases.

As far as production levels are concerned, they are strictly positive in the seller country, while they must be proved to be positive in the buying country. To this end, we substitute in turn $t_f$ and then $t_n$.

$$q_b|_{t=t_f} = \frac{-t_f + \beta_s E}{\beta_b + \beta_s} = \frac{1}{2}\frac{(2\lambda - \mu + 1)(x_b + x_s) - 2x_b\mu}{2\lambda - 2\mu + 1} > 0$$

$$q_b|_{t=t_n} = \frac{-t_n + \beta_s E}{\beta_b + \beta_s} = \frac{(2\lambda - \mu + 1)(x_b + x_s) - x_b(2\mu - 1)}{4\lambda - 4\mu + 3}$$

When case 1 holds, $2\mu - 1 > 0$ and $4\lambda - 4\mu + 3 < 0$, so that it is always the case that $q_b|_{t=t_n} > 0$. In case 2, $2\mu - 1 < 0$ and $4\lambda - 4\mu + 3 > 0$, so that a positive production level in the net buying country requires:

$$(2\lambda - \mu + 1)(x_b + x_s) > x_b(2\mu - 1)$$

It should be clear, from the analysis so far, that it is not anough to assume $x_s > x_b$ to guarantee that country $s$ is indeed a net seller of permits. This is due to the fundamental asymmetry across countries related to the emissions trading revenues taxation.

We can now get to the following result.

**Proposition 2** *For sufficiently low (high) marginal benefits of public expenditure, the tax rate and emission level in net selling country exceeds (falls short of) the ones arising under tax setting decentralization.*

**Proof.** If we consider the tax differential:

$$\Delta t = t_f - t_n = (x_b - x_s)\frac{2\lambda - \mu + 1}{(2\lambda - 2\mu + 1)(4\lambda - 4\mu + 3)}$$

as $x_b < x_s$ , $2\lambda - \mu + 1 < 0$ and $2\lambda - 2\mu + 1 < 0$, we can conclude that:

- under case 1, i.e. $\mu > \frac{1}{2}$, we have $4\lambda - 4\mu + 3 < 0$, so that $\Delta t > 0$.
- under case 2, i.e. $\mu < \frac{1}{2}$, we have $4\lambda - 4\mu + 3 > 0$, so that $\Delta t < 0$ (assuming that conditions for $q_b|_{t=t_n} > 0$ hold).

Comparing production/emission levels, we get:

$$q_s|_{t=t_f} - q_s|_{t=t_n} = \frac{t_f + \beta_b E}{\beta_b + \beta_s} - \frac{t_n + \beta_b E}{\beta_b + \beta_s} = \frac{1}{\beta_b + \beta_s}(t_f - t_n)$$

where the sign of the inequality is the same as that for $\Delta t$. ■

We finally turn to social welfare, which corresponds to:

$$W_f = E - \frac{\beta_s}{2}\left(\frac{t_f + \beta_b E}{\beta_b + \beta_s}\right)^2 - \frac{\beta_b}{2}\left(\frac{-t_f + \beta_s E}{\beta_b + \beta_s}\right)^2 - dE^2 + \mu t_f \left(\frac{t_f + \beta_b E}{\beta_b + \beta_s} - x_s\right) - \frac{\lambda}{2}t_f^2$$

in the full centralization, and to:

$$W_n = E - \frac{\beta_s}{2}\left(\frac{t_n + \beta_b E}{\beta_b + \beta_s}\right)^2 - \frac{\beta_b}{2}\left(\frac{-t_n + \beta_s E}{\beta_b + \beta_s}\right)^2 - dE^2 + \mu t_n \left(\frac{t_n + \beta_b E}{\beta_b + \beta_s} - x_s\right) - \frac{\lambda}{2}t_n^2$$

under tax setting decentralization.

Comparing welfare levels we get:

$$W_f - W_n = \frac{1}{4}(x_b - x_s)^2 \frac{(2\lambda - \mu + 1)^2}{(2\lambda - 2\mu + 1)(4\lambda - 4\mu + 3)^2} < 0$$

as $2\lambda - 2\mu + 1 < 0$. We get, therefore, the following result:

**Proposition 3** *Full centralization implies a lower social welfare than tax decentralization.*

Though surprising, such result might be explained by the interplay of two countervailing forces. On one hand, decentralization implies a number of spillovers across countries which are vehiculaed by the permits price. For example, when country $s$ chooses the tax rate non cooperatively, it does not account for the negatice impact such choice has on country $b$ emission level. On the other hand, when the tax rate is set in a centralized (i.e. harmonized) way, asymmetries across countries cannot be accounted for. In our very simple example, a crucial asymmetry is in the initial distribution of permits. Indeed, notice that the welfare differential would vanish (and the tax would only have distributional consequences) if $x_b - x_s = 0$.

Of course, the welfare differential result requires further investigation. It suggests, however, that the environmental and social welfare performance of emissions trading systems might be strongly affected by the choice of taxing the related revenues.

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