Taxing International Emissions Trading

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Outline of the presentation

- Subject and motivation
- Research strategy and literature review
- Theoretical results
- Simulations
- Further (ongoing) investigations

Subject of the paper

- We investigate how the tax treatment of emission allowances may affect an international permits market in terms of cost effectiveness, abatement decisions and welfare

- We focus on existing taxation (not on the endogenous choice of introducing it)

Motivations (1)

- In principle, the revenue from selling permits can either contribute to firm's taxable income or be fiscally exempted (totally or partly)
- Similarly, the cost of buying permits can represent a (total or partial) rebate in firm's taxable income
- Despite an extended literature have examined emissions trading in several respects, the tax treatment of emission permits has not been fully addressed yet, implicitly assuming that tradable permits would be outside any tax regime or that the impact of taxes would be neutral.

Motivations (2)

- On the contrary, the fiscal treatment of emission permits represents a very important aspect of cap-and-trade regulations (OECD, 2009). According to Estrada et al. (2010)
  - taxing tradable permits may introduce distortions in their efficient allocation, by affecting the costs of acquiring permits and the benefits from their selling.
  - failing to consider potential (dis)incentives effects of taxes on permits revenue could lead to wrong conclusions about the desired level of GHG reductions and the related costs.
  - a proper tax treatment is crucial to avoid that emission permits transactions are undertaken exclusively for fiscal reasons, involving distortions such as industries relocation or non fulfillment of delivery obligations of some Member States

Related literature

- Most of the contributions considering emissions trading jointly with tax issues deal with pros and cons of overlapping regulatory instruments (Bohringer et al. 2008; Brechet and Peralta 2007; D'Amato and Spisto 2009; Eichner and Pething 2009; Johnstone 2003).
- Papers explicitly addressing issues related to emissions trading taxation:
  - Fischer (2006) focuses on the impact of differentiated corporate income tax on abatement efforts by taking the equilibrium permit price as exogenous
  - Kane (2009) provides a detailed descriptive analysis on how different fiscal treatments of permits affect firms' behaviors on the permits market
  - Yale (2008) examines how income taxation affects a national permits' market. Taxing returns from permits does not distort firms' decisions at the margin within a single tax period, while it may distort firms' decisions on banking permits.

Research strategy

- To deal with this issue we introduce a simple model featuring I countries and I "representative" competitive firms, one in each country. Firms take permits taxation as well as permits endowments as given and choose emissions and permits selling or buying behavior.
- Theoretical outcomes are complemented by a CGE model (a modified GTAP-E model), where realistic features of international emissions trading systems are accounted for and a more detailed analysis can be performed.
- Country specificities (asymmetries in tax rates or differences in marginal abatement costs) are explicitly considered in our empirical simulations in order to evaluate the relative role of different structural features in explaining the impact of permit taxation.
- Finally, the cost effectiveness analysis is complemented with a welfare evaluation based on net sellers' and net buyers' equivalent variation.

The theoretical framework

- I countries and I representative firms
- $B_i(x_i)$ is firm i's benefit from pollution, $B_i'(x_i)>0$, $B_i''(x_i)<0$.
- Each firm receives an exogenous amount of emissions permits, e_i, that can be traded on a perfectly competitive market

- **Proposition.** *In the presence of heterogeneous permits taxation across countries, the cost effectiveness property of emissions trading is violated.*

- Each firm i maximizes the net benefit from pollution

$$\Pi_i = B_i(x_i) - p(1-t_i)(x_i - e_i)$$

- From the F.O.C.:

$$B_i'(x_i) = p(1-t_i)$$

which implies $B'_i(x_i) \neq B'_j(x_j)$ for any i, j = 1, ...I, whenever $t_i \neq t_j$

Some comparative statics

By totally differentiating the FOCs of the firm's maximization problem:

$$B_i''(x_i)dx_i - dp(1-t_i) + pdt_i = 0$$

implying:

$$\frac{dx_i}{dp} = \frac{(1-t_i)}{B_i''(x_i)} < 0 \qquad \frac{dx_i}{dt_i} = \frac{-p}{B_i''(x_i)} > 0$$

Remark: The reactivity of x_i w.r.t. p decreases with t_i and with the concavity of $B_i(x_i)$, while the reactivity of x_i w.r.t. t_i increases with p and decreases with the concavity of $B_i(x_i)$.

Permits price

- From the equilibrium on the permits market, defined by

$$\sum_{i \in I} x_i(p, t_i) = \sum_{i \in I} e_i$$

- we get

$$\frac{dp^*}{dt_i} = -\frac{\frac{\partial x_i}{\partial t_i}}{\sum_{i \in I} \frac{\partial x_i}{\partial p}} > 0$$

Remark: The reactivity of p w.r.t. t_i increases with $\frac{\partial x_i}{\partial t_i}$ and decreases with $\sum_{i \in I} \frac{\partial x_i}{\partial p}$

- **Proposition.** *An increase in t_i in any country $i \in I$, ceteris paribus, generates an increase in emissions (and permits demand) in country i and a decrease in emissions (and permits demand) in all other countries.*

$$\frac{dx_i^*}{dt_i} = \frac{\partial x_i^*}{\partial t_i} + \frac{\partial x_i^*}{\partial p^*}\frac{dp^*}{dt_i}$$

direct effect ***indirect effect***

the positive direct effect always dominates the negative indirect/equilibrium effect!

$$\frac{dx_j}{dt_i} = \frac{\partial x_j}{\partial p^*}\frac{\partial p^*}{\partial t_i} < 0$$

- **Proposition.** If *country i is a net seller ($x_i < e_i$), its revenue increases with taxation if*

$$\left(p + \frac{dp^*}{dt_i} t_i \right)(e_i - x_i) > t_i p \frac{dx_i}{dt_i};$$

if country i is a net buyer ($x_i > e_i$), its revenue always decreases (i.e. the rebate increases) with its tax rate.

- Tax revenue is defined as $R_i = t_i p(e_i - x_i)$

  therefore:

$$\frac{\partial R_i}{\partial t_i} = \left(p + \frac{dp^*}{dt_i} t_i \right)(e_i - x_i) - t_i p \frac{dx_i}{dt_i}$$

- **Proposition.** If *country j is a net seller its revenue always increases with t_i ,whereas if country j is a net buyer its revenue decreases (i.e. the rebate increases) with t_i if*

$$\left|\left(e_j - x_j\right)\frac{dp^*}{dt_i}\right| > \left|p\frac{dx_j}{dt_i}\right|;$$

The tax related spillover is defined by:

$$\frac{\partial R_j}{\partial t_i} = t_j\left[\left(e_j - x_j\right)\frac{dp^*}{dt_i} - p\frac{dx_j}{dt_i}\right]$$

First set of simulations

- assess the impact of the introduction of a tax rate on emission permit revenues (or a rebated tax rate on permits costs) compared with an IET no Tax simulation;
- test the overall effects on the permit equilibrium price as well as on emission abatement decisions when homogeneous tax rates across countries are present ;
- assess the effects related to the magnitude of the gap between the tax rates in net selling and net buying countries, specifically assuming that tax rates are at their maximum level in net selling countries while rebates are reduced in net buyers;
- examine the case in which no taxation is in force for net buyers while the tax rate for net sellers assumes its maximum and minimum value.

Simulation results

- ***Table 1- Alternative homogeneous tax and rebate rates***

	Rebate				No rebate	
	Full		Partial		Homogeneous Tax	
IET Countries	(1)	(2)	(3)	(4)	(5)	(6)
Net sellers						
European Union	15.0%	35.0%	35.0%	35.0%	35.0%	15.0%
Former Soviet Union	15.0%	35.0%	35.0%	35.0%	35.0%	15.0%
Belarus	15.0%	35.0%	35.0%	35.0%	35.0%	15.0%
Switzerland	15.0%	35.0%	35.0%	35.0%	35.0%	15.0%
Net buyers						
United States	15.0%	35.0%	25.0%	15.0%	0.0%	0.0%
Canada	15.0%	35.0%	25.0%	15.0%	0.0%	0.0%
Australia	15.0%	35.0%	25.0%	15.0%	0.0%	0.0%
New Zealand	15.0%	35.0%	25.0%	15.0%	0.0%	0.0%
Japan	15.0%	35.0%	25.0%	15.0%	0.0%	0.0%
Croatia	15.0%	35.0%	25.0%	15.0%	0.0%	0.0%
Norway	15.0%	35.0%	25.0%	15.0%	0.0%	0.0%
Average tax rate $(\bar{t}_{tax})$	*15.0%*	*35.0%*	*35.0%*	*35.0%*	*35.0%*	*15.0%*
Average rebate rate $(\bar{t}_{rebate})$	*15.0%*	*35.0%*	*25.0%*	*15.0%*	*0.0%*	*0.0%*

Simulation results

- ***Table 2- Emission levels (tons of CO2) and permits price with homogeneous tax and rebate rates***

IET Countries	Kyoto target	IET no Tax	Rebate				No rebate	
			Full		Partial		Homogeneous Tax	
			(1)	(2)	(3)	(4)	(5)	(6)
Net sellers								
European Union	3,904.3	3,677.9	3,677.9	3,677.5	3,708.7	3,735.5	3,769.6	3,713.2
Former Soviet Union	2,053.9	1,634.7	1,637.4	1,642.5	1,671.5	1,696.5	1,727.9	1,670.2
Belarus	69.8	63.1	63.3	63.7	64.2	64.6	65.1	63.9
Switzerland	54.5	51.2	51.1	51.1	51.7	52.2	52.9	51.9
Net buyers								
United States	4,676.5	5,136.8	5,135.0	5,130.8	5,083.6	5,043.6	4,992.8	5,081.8
Canada	407.0	488.7	488.6	488.5	484.2	480.6	476.0	483.8
Australia	287.0	336.8	336.7	336.4	332.9	329.9	326.1	332.7
New Zealand	23.9	30.6	30.6	30.6	30.4	30.2	29.9	30.3
Japan	1,059.1	1,102.1	1,101.9	1,101.2	1,095.1	1,090.0	1,083.3	1,095.0
Croatia	19.9	21.1	21.1	21.2	21.0	20.9	20.7	20.9
Norway	29.1	41.7	41.6	41.6	41.4	41.2	40.9	41.4
equilibrium price ($ per ton CO2) (p_e)	-	*22.86*	*27.05*	*35.82*	*32.79*	*30.28*	*27.22*	*24.49*

Second and third sets of simulations

- The tax rate for net buyers is set to 0 (i.e. no rebate takes place);
- a uniform 15% tax rate for sellers is taken as a benchmark.
- This baseline is then compared with cases where only one of the net sellers imposes a larger tax rate (i.e. a tax rate equal to 35%).
- This exercise allows us to consider the relative impact of country specific features, including heterogeneous tax rates, on the permit market for net sellers.
- A third set of simulations performs the same exercise w.r.t. net buyers.

Simulation results

- ***Table 4- Alternative heterogeneous tax rates with no rebate***

	No rebate				
	Hom. Tax	Heterogeneous Tax			
IET Countries	(6)	(7)	(8)	(9)	(10)
Net sellers					
European Union	15.0%	35.0%	15.0%	15.0%	15.0%
Former Soviet Union	15.0%	15.0%	35.0%	15.0%	15.0%
Belarus	15.0%	15.0%	15.0%	35.0%	15.0%
Switzerland	15.0%	15.0%	15.0%	15.0%	35.0%
Net buyers					
United States	0.0%	0.0%	0.0%	0.0%	0.0%
Canada	0.0%	0.0%	0.0%	0.0%	0.0%
Australia	0.0%	0.0%	0.0%	0.0%	0.0%
New Zealand	0.0%	0.0%	0.0%	0.0%	0.0%
Japan	0.0%	0.0%	0.0%	0.0%	0.0%
Croatia	0.0%	0.0%	0.0%	0.0%	0.0%
Norway	0.0%	0.0%	0.0%	0.0%	0.0%
Average tax rate $(\bar{t}_{tax})$	*15.0%*	*19.4%*	*26.6%*	*15.1%*	*15.0%*
Average rebate rate $(\bar{t}_{rebate})$	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*

Simulation results

- ***Table 5- Emission levels (tons of CO2) and permits price with heterogeneous tax rates (no rebate)***

IET Countries	Kyoto target	IET no Tax	No rebate				
			Hom. Tax	Heterogeneous Tax			
			(6)	(7)	(8)	(9)	(10)
Net sellers							
European Union	3,904.3	3,677.9	3,713.2	3,789.5	3,692.1	3,712.8	3,712.8
Former Soviet Union	2,053.9	1,634.7	1,670.2	1,651.5	1,745.8	1,669.8	1,669.8
Belarus	69.8	63.1	63.9	63.5	63.4	65.9	63.9
Switzerland	54.5	51.2	51.9	51.5	51.4	51.8	53.6
Net buyers							
United States	4,676.5	5,136.8	5,081.8	5,038.2	5,040.6	5,080.5	5,080.5
Canada	407.0	488.7	483.8	480.0	480.3	483.7	483.7
Australia	287.0	336.8	332.7	329.5	329.7	332.7	332.7
New Zealand	23.9	30.6	30.3	30.1	30.2	30.3	30.3
Japan	1,059.1	1,102.1	1,095.0	1,089.5	1,089.5	1,094.9	1,094.9
Croatia	19.9	21.1	20.9	20.8	20.8	20.9	20.9
Norway	29.1	41.7	41.4	41.1	41.2	41.4	41.4
equilibrium price ($ per ton CO2) (p_e)	-	*22.86*	*24.49*	*25.80*	*25.74*	*24.51*	*24.51*

Simulation results

- As expected, when the tax is increased in relatively small sellers, the change in the permits price is small.
- large economies have a more significant impact on the equilibrium price.
- MAC differentials (i.e. Specific countries features) are shown to affect the impact on permits price, given the change in net supply (demand – see below).
- Another interesting insight from this second set of simulations stems from the revenue analysis. Indeed, it is possible for a country's revenue to be non increasing in own tax rate, as it is the case of Switzerland.

Simulation results

- ***Table 7- Alternative heterogeneous rebate rates (homogeneous tax)***

		Hom. reb.	Heterogeneous rebate						
			High av. reb.			Low av. reb.			
IET Countries		(4)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Net sellers									
European Union		35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%
Former Soviet Union		35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%
Belarus		35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%
Switzerland		35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%	35.0%
Net buyers									
United States		15.0%	35.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%
Canada		15.0%	15.0%	35.0%	15.0%	15.0%	15.0%	15.0%	15.0%
Australia		15.0%	15.0%	15.0%	35.0%	15.0%	15.0%	15.0%	15.0%
New Zealand		15.0%	15.0%	15.0%	15.0%	35.0%	15.0%	15.0%	15.0%
Japan		15.0%	15.0%	15.0%	15.0%	15.0%	35.0%	15.0%	15.0%
Croatia		15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	35.0%	15.0%
Norway		15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	35.0%
Average tax rate	$(\bar{t}_{tax})$	*35.0%*	*35.0%*	*35.0%*	*35.0%*	*35.0%*	*35.0%*	*35.0%*	*35.0%*
Average rebate rate	$(\bar{t}_{rebate})$	*15.0%*	*30.7%*	*18.4%*	*17.2%*	*15.3%*	*17.1%*	*15.1%*	*15.5%*

Simulation results

- ***Table 8- Emission levels (tons of CO2) and permits price with heterogeneous rebate rates (homogeneous tax)***

IET Countries	Kyoto target	IET no Tax	Hom. rebate	Heterogeneous rebate						
				High av. reb.			Low av. reb.			
			(4)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Net sellers										
European Union	3,904.3	3,677.9	3,735.5	3,692.1	3,731.8	3,732.6	3,735.5	3,730.2	3,735.5	3,735.5
Former Soviet Union	2,053.9	1,634.7	1,696.5	1,656.1	1,693.2	1,693.4	1,696.3	1,691.4	1,696.3	1,696.3
Belarus	69.8	63.1	64.6	63.9	64.5	64.5	64.6	64.5	64.6	64.6
Switzerland	54.5	51.2	52.2	51.4	52.2	52.2	52.2	52.1	52.2	52.2
Net buyers										
United States	4,676.5	5,136.8	5,043.6	5,163.4	5,033.4	5,035.8	5,043.0	5,030.3	5,043.0	5,043.0
Canada	407.0	488.7	480.6	470.1	499.6	479.9	480.5	479.5	480.6	480.5
Australia	287.0	336.8	329.9	321.7	329.2	345.6	329.8	328.8	329.8	329.8
New Zealand	23.9	30.6	30.2	29.7	30.1	30.1	31.2	30.1	30.2	30.2
Japan	1,059.1	1,102.1	1,090.0	1,075.2	1,088.8	1,088.8	1,089.8	1,116.1	1,090.0	1,089.8
Croatia	19.9	21.1	20.9	20.6	20.8	20.8	20.9	20.8	21.4	20.9
Norway	29.1	41.7	41.2	40.6	41.1	41.1	41.2	41.1	41.2	42.2
equilibrium price ($ per ton CO2) (p_e)		*22.86*	*30.28*	*34.43*	*30.61*	*30.57*	*30.30*	*30.75*	*30.29*	*30.30*

Summing up

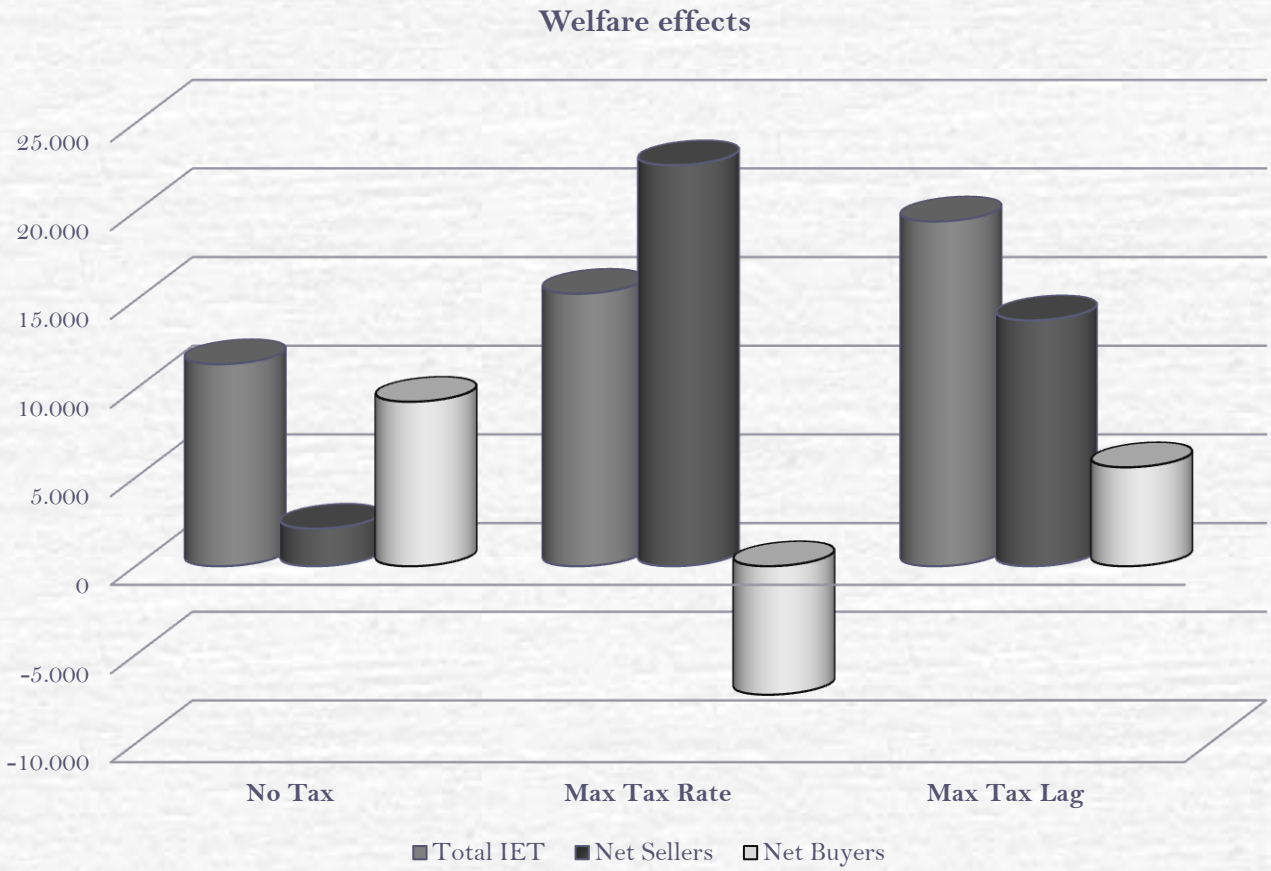
- A change in equilibrium permits price can be significant. Though not explicitly modelled, we can expect that a large increase in the equilibrium permits price can lead to significant changes in regulated firms' behaviour in the long run, in particular in terms of the choice of energy efficiency.
- This might be viewed as a significant (and positive) side effect of emissions trading taxation in the stream of an environmental tax reform, and should be weighted against short run distortions.
- The effects of increases in its own as well as other countries' tax rates on revenues are ambiguous; Switzerland, for example, as a net seller of permits, exhibits a decreasing tax revenue in its own tax rate, given its small impact on the equilibrium permits price.
- The existence of a tax related spillover is confirmed.

Welfare effects

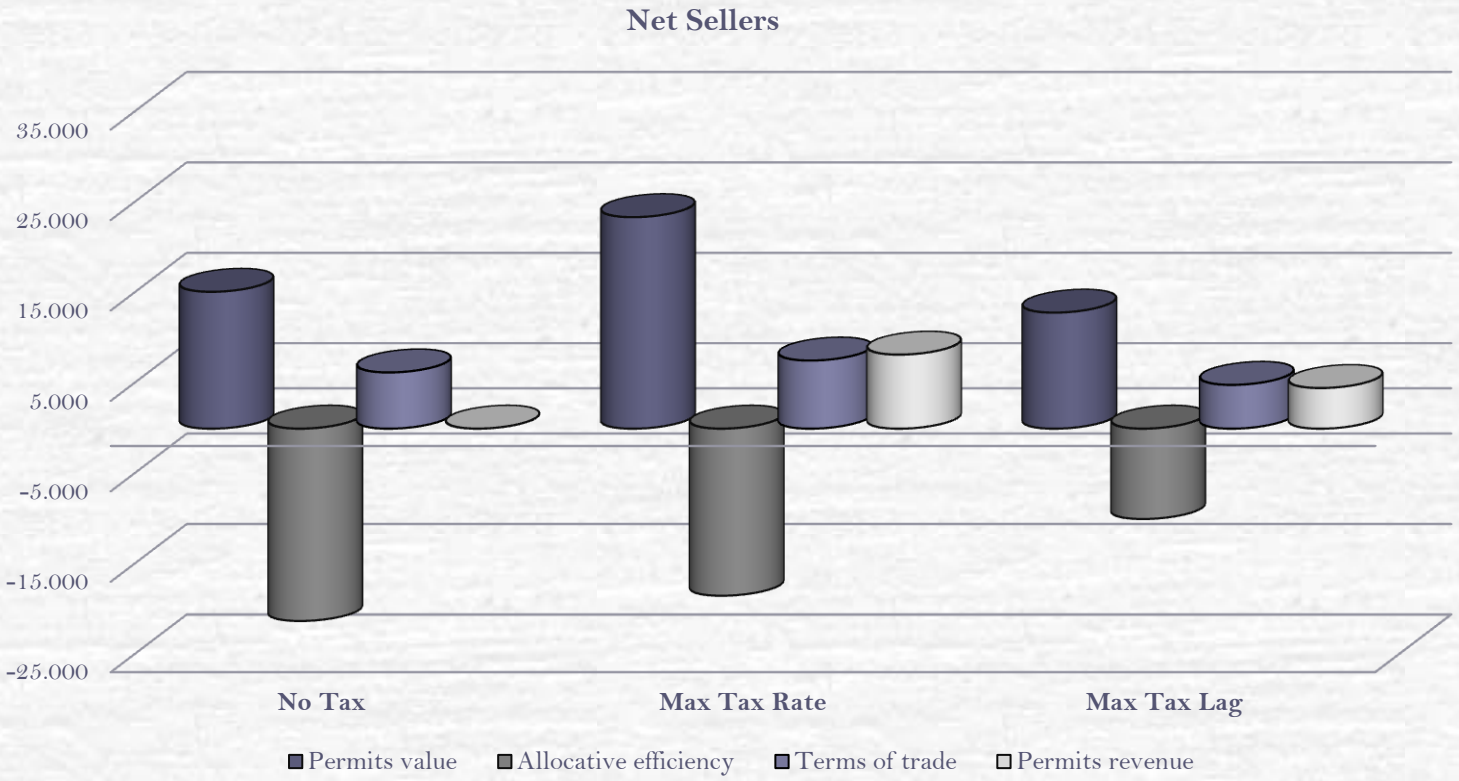
The impact of permits taxation on welfare is expected to depend

1. on "pure" cost effectiveness considerations
2. as well as on broader effects related to the interaction of the permits market with the whole economy.

Welfare effects
Net equivalent variation



Welfare effects
Net sellers



Welfare effects
Net buyers

Future extensions

- Disaggregate EU in order to simulate the effect of permits taxation in the EU ETS:
- Countries' dimensions play an important role in our simulations and suggest to take into account the possible presence of market power in the model
  - In this respect we still have some preliminary theoretical results

IET taxation and market power

- Firms are divided in two categories, according to whether they have market power in the permits market or not.

- Firms can be
  - either part of a competitive fringe ($i \epsilon F$)
  - or can be part of a set of strategists ($i \epsilon S$)

The theoretical framework

- Based on standard literature on ETS under market power (Hahn, 1984)
- Our model is a two stage game:
  - Stage 1: strategists set their emission quantities
  - Stage 2: the price takers firms clear the market
- The tax rate and the received amount of allowances are exogenously given for any firm

  $i \in I = F \cup S.$

Preliminary results

- All firms minimize compliance costs

$$\min_{x_i} c(x_i) + p(1-t_i)(x_i - e_i)$$

- solving the above problem for $i \in F$ we get

$$\left.\frac{\partial p}{\partial x_i}\right|_{i \in S} = \frac{1}{\sum_{i \in F} \frac{(1-t_i)}{c''(x_i)}} > \frac{1}{\sum_{i \in F} \frac{1}{c''(x_i)}}$$

- the degree of market power might be affected by ET taxation

Preliminary results

- By assuming a single dominant firm (*S*) and a single representative fringe firm (*F*) and by focusing on quadratic costs, we also get

$\frac{\partial p}{\partial t_i} > 0 \text{ for } i = S, F$ $\frac{\partial p}{\partial t_i} > 1$ depends on initial endowment

$\frac{\partial x_S}{\partial t_F} < 0$ $\frac{\partial x_S}{\partial t_S} > 0$ $\frac{\partial x_F}{\partial t_F} > 0$ $\frac{\partial x_F}{\partial t_S} < 0$

- Reallocating permits implies a change in the equilibrium price due to market power and to taxation.

Preliminary results

- if some form of taxation is charged on permits, the negative effect of market power can be compensated, or even completely neutralized, by the presence of taxation, and viceversa
  - Cost effectiveness is guaranteed by the presence of some tax rate differential, at least between countries hosting the competitive fringe and those countries hosting the set of dominant-strategists.
  - A larger tax rate for S is called for if S is a monopsonist and vice versa.
  - The Marginal Costs will fall short of the (net) equilibrium price.