Hot Air and Market Power in Internation Emissions Trading

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Abstract: In respect to carbon emission targets set in the Kyoto Protocol in 1997, emission quotas trading will be implemented among the Annex-B participating countries to lower the mitigation costs of the international cooperation on climate change issue. Nonetheless, in the way the market was designed, the States of the Former Soviet Union and Eastern Europe are likely to become large sellers of carbon as a result of the drop in emissions level due to economic downturn, referring to "Hot Air". Indeed, these countries may exert substantially market power in the international permits market since the US had decided to withdraw from the Kyoto Protocol. This paper aims to develop a better understanding of the consequence of "Hot Air" in the international carbon emission trading using some policy variants simulated with the GEM-E3 World model. The present analyse focuses particularly on the measures of "Hot Air" and the implications of potential market power in the emission trading market. Under various scenario options, the exercise of market power lead to a misallocation of abatement effort accross the remaining Annex-B countries as a consequence of permits price and welfare effets.

Keywords: Emission Trading, Interntional Climate Change, Market Power, Computable General Equilibrium Model

JEL Classification: D43, D58, Q48

1 Introduction

In December 1997, the Kyoto protocol set limits to the Greenhouse Gases Emissions and defined reduction objectives for the OECD industrialized countries, Central Europe and the States of the Former Soviet Union (FSU), as listed in the Annex 1 of the protocol. On average in the time range of 2008-2012, the Annex 1 parties have entailed a reduction of their emissions by 5,2 per cent relative to their 1990 emissions. In this respect, international trading of Assigned Amounts Units (AAUs), provided by the article 17 of the protocol, will be implemented among participating countries committed to emission limits in order to lower the mitigation costs of the international cooperation on climate change issue. Nonetheless the evolutions, in the way the market was designed, from the Kyoto Protocol (1997) to the Johannesburg conference (2002) raise the issue of imperfections in emission trading in the forms of strategic behaviors. Indeed, some signatory countries may exert substantial market power in the carbon permits market as the FSU is likely to turn out as large sellers of carbon unit whilst the US stands for a large buyer.

In addition since the Bonn Conference (2001), as the US had decided to withdraw from the international cooperation on climate change , a major concern of the Kyoto Protocol is its ratification by at least 55 Annex B countries representing at least 55% of the 1990 carbon dioxide emissions level. As the States of the Former Soviet Union and Eastern Europe account for approximately two-third of total emission objectives commitments in Kyoto, they get more bargaining power and may turn out as dominant countries acting as oligopolist. Indeed, Russia and Ukraine will play a central role in the international emission trading owning to their potential "Hot Air", which represents a pre-condition for cost-manipulation in the international carbon emissions trading. This potential may either undermine the efficiency of the Kyoto Protocol as trading this "Hot Air" represents a large supply of emissions, which weakens the incentive for abatement efforts.

This paper aims therefore to develop a better understanding of the implications of the participation structure and potential market power in the international carbon emission trading using some policy variants simulated with the GEM-E3 world model. We try to assess the implications of imperfections in the international tradable emission permits system related to the potential "Hot Air" of the FSU, taking account of the US withdrawal from the Kyoto Protocol. Indeed, the present analyze focuses particularly on the measures of market power in the context of the emission trading market relative to environmental effectiveness (*i.e.* how far does emissions trading achieve the required emissions reduction) and economic efficiency (*i.e.* which allocation in achieving cost-efficient abatement efforts).

The starting point of this paper investigates the relation between Annex 1 countries since the Kyoto protocol concerning the participation structure and the rules in the international emission trading. Then, we address an overview of definitions and implementation of market power (oligopolistic stances of Cournot-Nash type) in the GEM-E3 world model. In the following, we turn to various scenario options to determine the implications of these alternatives on the permits price and the social welfare to meet the Kyoto objectives in the Annex B countries. So far, we identify the distribution of emission abatement efforts and the potential efficiency loss resulting from imperfections in trading.

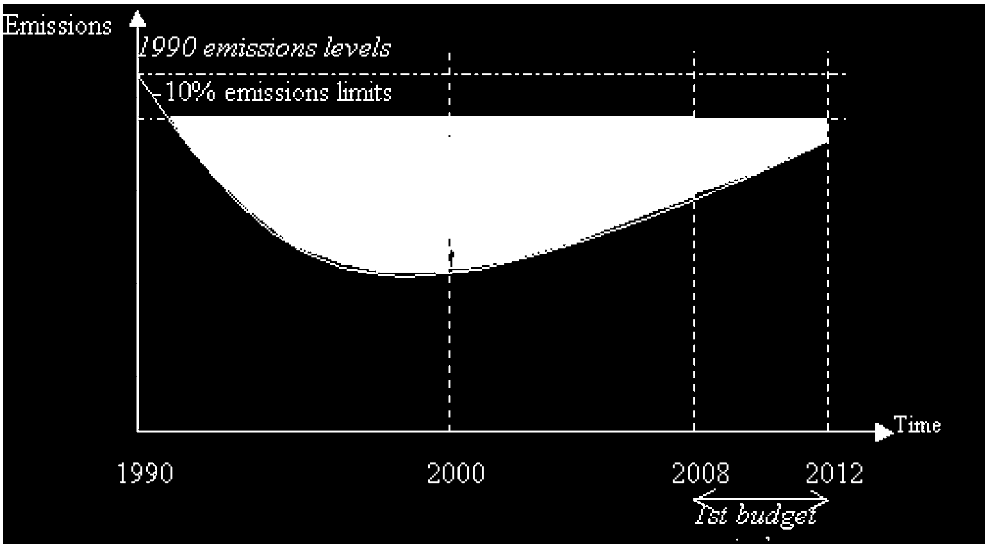
2 Is there a potential for market power exerting by the states of the Former Soviet Union

The Kyoto Protocol commits the Former Soviet Union countries to stabilize their carbon emissions up to the reference year of 1990 level for the period 2008-2012. Therefeore, the Russian Federation and Ukraine are allocated emisssion quotas equaled to their 1990 emissions level. Nontheless, as a consequence of economic downturn with the collapse of the Soviet Union, carbon emissions declined sharply in the early 1990s, remaining 32% lower than their 1990 levels in 1995. The following figure describes the discrepancy between the business-as-usual emissions path and the 1990 level.

• "Superheated Air" is the difference between the actual emission in the period from the ratification of the Protocol to the begining of the budget period.

• "Hot Air" is the actual emission levels projected in 2008-2012 and the quantified emissions limitations.

Therefore, the FSU have a key role to play in the determination of abatement efforts since their Assign Amounts Units are rather large due to the potential "Hot Air" and their dominant position among Annex-B countries since the US has decided to withdraw from the Kyoto Protocol.



Moreover, the actual emissionsstill ly far below the 1990 level targets established under the Protocol. This excess between the anticipated emissions in 2008 and the lower 1990's emissions are called "Hot Air", also being referred to as "base mitigation credits". As for the size of this "Hot Air", it will depend on the nature of restructuring as well as the timing of recovery in the FSU countries until the begining of the commitment period in 2008. The Russian Federation and Ukraine seem to account approximately two-third of the total "Hot Air" raging from 150 to 500Mt CO_2.

This potential "Hot Air" may be used by the Former Soviet Union Countries in order to acquire a dominant position in the carbon emission trading. In this context, Russia and Ukraine have a strong incentive to withhold their emission quotas so as to increase emission permits and raise gains from the international trading. Since the US defection from the international trading, this kind of market manipulation lead to misallocation of emission abettement effort, but to some degree, increase environmental effectiveness as the Annex B countries face a much higher emission permits price.

3 Formalisation of market power in international emission permits trading

3.1 Definitions and measures of market power

How important is market power characterized in the context of international emission trading when permits market are dominated by a few? Formally, two major concerns arise related to price manipulations in marketable permit systems.

- *"Simple cost-price manipulation":* This first type of market power strategies, so called "Cost minimizing (or profit maximizing) manipulation" studied by Hahn (1984), identifies the ability to which a dominant participant (a firm or a country) can influence the price of emission quotas traded. In particular it follows that when emission sources seeks to minimize its expenditures in permits purchases (or maximize its revenues from permits sales), acting either as a dominant buyer monopsony/oligopsny (or seller monopoly/oligopoly), thus, it induces additional costs to meet their emissions reduction targets. Indeed, under simple manipulation, a dominant participant lowers its volume of Assigned Amounts Units traded, by either reducing the quantity it purchases (or sells), and then, underprices (or overprices) permits actually traded. Therefore, compared with the competitive outcome market, this would entail a resulting efficiency loss, which is particularly relevant if the allocation of quotas to this dominant source deviates from its cost-effective level.

- "*Exclusionary manipulation and predatory pricing strategy":* The second type of strategic manipulation, referred to "Exclusionary manipulation" pointed out by Misiolek and Elder (1986), occurs when a price-setting participants decides to withhold its emission permits in order to drive up the transaction price and distort competition for the related product market. "Exclusionary Manipulation" is based on the framework of raising rivals' costs strategy formally analyzed by Salop and Scheffman (1987) and Krattenmaker and Salop (1986). In this particular context to emission quotas, the dominant source seeks to exclude established participants or to prevent the entrance of potential competitors, thereby, gains additional product market shares and increases its profits. This kind of manipulation has a deterrent effect as the participant with market power acts strategically to increase the costs of its competitors owning to a raise in the permits price.

In the following, we will only consider the first concern of simple cost-price manipulation exerted by dominant countries in an international carbon emissions quotas market. In fact, to determine the size of susceptible market power in the Kyoto carbon emission market, much attentions have to be paid to the share of Assigned

Amounts Units acquired by a dominant country. Added to this are difficulties arising as there exists no test of historical data for CO_2 emissions among countries, which results in possible defects in allocating the initial quotas to participating countries. Hence what should be established at the very outset is that large holdings of CO_2 units, as well as the number of Cournot countries, enhance substantial market power and lead to potential efficiency loss in the allotment of abatement efforts between countries. As a rule, the relative span of market power depends on the ability of the main emitting countries to affect the price of tradable quotas. By the same token, two alternative positions should be considered in the international trading of emission quotas, whether a country acts either as large seller (such the states of the Former Soviet Union) or as a major buyer (in the case of the US).

In the face of these considerations about strategic behaviour, the way the international market is designed (specially the initial distribution of quotas among countries) becomes pretty suitable for improving the expected efficiency of emissions trading in presence of market power. So, let us have a look at the theorical considerations of these issues.

3.2 Framework for the basic competitive mechanism model

Consider n price taking countries under an international competitive emission permits trading system, which represents under these assumptions a cost effective means for reducing pollution. Each country has a different cost of abatement representing the cost change associated with a marginal reduction of emissions. Let $C_i(a_i)$ be the cost of country i associated with abating a_i, where $C_i'(a_i) > 0$ and $C_i'''(a_i) < 0$. This means that its marginal cost of abatement is increasing with emissions reduction. It's equivalent to the assumption that all countries have a downward sloping demand function for permits. Each permit specifies an amount of allowable emissions in the form of an emission target. $\bar{e}_i$ is the amount of permits, which the country i has received from the international agreement. After the initial distribution, country i 's net demand for permits is $(e_i - a_i) - \bar{e}_i$, where e_i is its baseline emissions. When $(e_i - a_i) - \bar{e}_i > 0$ then the country i demand permits in the international market, in the other hand the country i sells permits when $(e_i - a_i) - \bar{e}_i < 0$. From all this it follows that the pollution abatement costs are, thereby, dependent on permits holdings.

A typical price taking country chooses its abatement level solving the following problem, which minimises its overall compliance costs equalled to the sum of abatement costs and the costs of buying permits (in the case of purchase permits) or minus the profit of selling permits (in the case of permits sales).

$$a_i Min\ C_i(a_i) - P\left[\bar{e}_i - (e_i - a_i)\right] \tag{1}$$

where P is the equilibrium price of permits under perfect competition. It implies by the first order condition with respect to a_i that:

$$C_i'(a_i) = P \tag{2}$$

This relation points out the usual optimality rules in environmental economics: with perfect competition, the permits price equals the marginal cost of abatement. The competitive permits price, determined by the aggregate emissions ceiling and also by the function of abatement costs, is independent of the mode of initial permits distribution.

Each country will buy (or sell) the number of permits at which the marginal cost (or benefit) of an additional permit, measured by the permits price P, equals its marginal cost of abatement $C_i'(a_i)$. Under this condition, the permits price provides the correct incentive for countries to arrange emission levels. Thus, the number of permits demanded (or supplied) by the country i is determined by the optimal emissions abatement choice as a function of the permits price, $a_i^* = a_i(P)$. In short for a country i, its marginal cost of abatement is a proxy of its demand (or supply) for permits.

Within this framework, the question of least-cost property of emission permits can be raised. Assume that two countries u and v have different marginal abatement costs ($MACs$). For a given level of emissions, the induced marginal abatement is lower for the country u than in the country v. Then: $MAC_u < MAC_v$. We expect the country v with relatively high $MACs$ to be a buyer and the country u with low MACs to be a seller. More specifically, instead of reducing its emissions, the country v (the high $MACs$ country) should rather to acquire the corresponding number of permits in the country u (the low $MACs$ country) and compensate this additional effort of emissions abatement in country u up to the point where both countries will equate its $MACs$ schedule with the permits price. This involves an equality of $MACs$ across countries: $MAC_u = MAC_v = P_E$

In the case of n price taking countries, if all do the same, then we get:

$$MAC_1 = MAC_u = MAC_v = MAC_n = P_E \tag{3}$$

which for a uniformly mixed polluant is a necessary efficient condition for cost minimisation accross countries.

Consequently, $MACs$ will be identical for all countries and the following total compliance costs are minimised regardless of the initial endowment of permit. Then, competitive trading of emission quotas yields to an efficient distribution of abatement efforts among countries.

3.3 The model with market power

The preceding discussion has explicitly consider the international permits market in the face of competitive behaviour, where no market power exists for any participant or group of participants. Therefore, the following will assumed market power in the permit market problem, where the dominant countries are able to influence the market price and the resulting distribution of permits.

3.3.1 The theorical model

Assume now an international emission permits market in which m countries are price takers $(i = 1, ..., f, ..m)$ while k dominant countries exert market power $(j = 1, ..., c, ..k)$, in the sense that they can affect market price of quotas traded. This arises when dominant countries recognize the sensitivity of the permits price to their permits sells. Such countries can use its influence on market price, seeking to minimize its compliance costs to achieve the predetermined emission ceiling, which is called Cost-Minimizing Manipulation.

To analyse the imperfect competitive equilibrium in the permits market, we consider a leader-follower class game where dominant countries are leaders. They act as symmetric Cournot rivals, taking account of the reaction of the fringe countries. Indeed, if the dominant countries could commit themselves to exert market power, while knowing that the fringe countries would revise their own plans optimally, the outcome could be driven to the Cost-Manipulation equilibrium.

Following the same reasoning in the case of the competitive equilibrium, a representative country in the competitive fringe will choose its amount of quotas, regardless of its initial permit allocation, to minimize its compliance costs. As established above, the first order condition for a typical fringe country yields to:

$$C_f'(a_f) - P = 0 \tag{4}$$

where the subscript f denotes a price taking country and F indicates the price taking countries. This expression means that the countries of the fringe reduce their emissions up to the level at which their marginal abatement costs equal the permits price.

Then aggregating equation 4 over m price-taking countries specifies the fringe net demand for quotas, defined by: $C'_F(a_F) - P = 0$, thus $a_F^* = a_F(P)$ with $a_F = \sum_{i=1}^{m} a_i(P)$ and where $a'_i < 0$.

Given the total number of permits hold by the fringe, the inverse demand for quotas is determined as:

$$P = P(a_F) \tag{5}$$

Each country with market power determines its abatement efforts given the other market power countries' emissions reduction and the behavior of the fringe countries. The oligopolistic typical country c chooses the amount of quotas, which minimizes its costs, subject to the constraint that the permits price (equation 5) is a function dependant on its emissions abatement efforts and then permit market clears:

$$\begin{cases} a_c Min\ C_c(a_c) - P\left[\bar{e}_c - (e_c - a_c)\right] \\ Sc\ a_F = e_F + \sum\limits_{j=1}^{k} e_j - \sum\limits_{j=1}^{k} a_j - \sum\limits_{i=1}^{m} \bar{e}_i - \sum\limits_{j=1}^{k} \bar{e}_j \\ Sc\ \sum\limits_{i=1}^{m} \bar{e}_i + \sum\limits_{j=1}^{k} \bar{e}_j = \bar{E} \\ Sc\ P = P(a_F) \end{cases} \tag{6}$$

$\bar{E}$ is considering as the international emission reduction commitment, *ie.* the initial amount of quotas allocated within countries.

The first order necessary condition for a symmetric Cournot-Nash equilibrium choice of quotas can be written as:

$$\begin{cases} C'_c(a_c) = P + \frac{dP}{da_c}\left[\bar{e}_c - (e_c - a_c)\right] \\ \frac{dP}{da_c} + \sum_{\substack{j=1 \\ j \neq c}}^{k} \left[\frac{dP}{da_j}\frac{da_j}{da_c}\right] = \frac{dP}{da_c} \end{cases} \tag{7}$$

The right hand side of the expression equation 7 can be interpreted as the country c's marginal factor revenue of selling an additional emissions permit, in the case where permits are considered as an input factor. Upon substitution, and after rewriting the preceding condition (equation 7) for the country c, we get:

$$P = \frac{C'_c(a_c)}{1 - \frac{1}{\eta}\left[\frac{\bar{e}_c - (e_c - a_c)}{a_F}\right]} \tag{8}$$

where η is the demand elasticity for permits of the price taking countries.

Thus, the greater the sensitivity of permit price to country c's permits holding, the greater the difference between the Cournot price relative to its competitive level. As proposed by Hahn (1984): if the dominant countries does not receive an amount of permits equal to its net emissions in equilibrium, then the total expenditure on abatement will exceed the cost minimizing solution. Therefore, the extent to which a dominant country exerts market power, depends not only on its relative size, but is also determined by the degree to which the permits price will be affected by the initial permits holdings of this country with market power.

Then, once market power is considered, the initial allocation of the Cournot-countries determines the final outcome and matters with regard to efficiency standpoint. That stems from a deviation from the cost-minimizing solution as a result of an increase in the total compliance costs.

It raises the issue of the influence on the permits price from the initial endowment of quotas to the representative dominant country. After differentiating equation 7, the comparative static result can be written as:

$$\frac{dP}{d\bar{e}_c} = \frac{\frac{d^2P}{da_c^2}\left[\bar{e}_c - (e_c - a_c)\right] + \frac{dP}{da_c}}{C''_c \frac{da_c}{dP} - 1} > 0 \tag{9}$$

Since in the case of linear demand curve $\frac{d^2P}{da_c^2} = 0$, the expression equation 9 is positive. Thus we can establish that, when a dominant country is using cost manipulations, an increase in its initial allocation generates a rise in the equilibrium permits price and occurs inefficiency loss as a consequence of higher compliance costs.

Therefore, one should point out how the total abatement costs are affected by the initial permits distribution to the dominant countries with market power. Total Abatement Cost TAC is defined as the aggregation of the compliance costs of the fringe and the price-setting countries:

$$TAC = C'_F(a_F) + \sum_{j=1}^{k} C_j(a_j) \tag{10}$$

Considering the constraint that permits market clears, then the TAC can be specified as:

$$TAC = C_F(e_F + \sum_{j=1}^{k} e_j - \sum_{j=1}^{k} a_j - \bar{E}) + \sum_{j=1}^{k} C_j(a_j) \tag{11}$$

By differentiating the expression equation 10 of the TAC relative to the emission quotas initial allocation of the dominant country and manipulating the expression yields to:

$$\left.\frac{dTAC}{d\bar{e}_c}\right|_{\bar{E}=cst} = C_F' \sum_{j=1}^{k} \frac{da_j}{d\bar{e}_c} + \sum_{j=1}^{k} C_j' \frac{da_j}{d\bar{e}_c} \tag{12}$$

Upon substitution and after rewriting the first order condition (equation 7) defined above for the Cournot countries, we get:

$$\left.\frac{dTAC}{d\bar{e}_c}\right|_{\bar{E}=cst} = \frac{dP}{d\bar{e}_c} \sum_{j=1}^{k} \frac{da_j}{d\bar{e}_c} \left[\bar{e}_c - (e_c - a_c)\right] \tag{13}$$

The sign of the condition equation 12 depends upon how the initial demand for quotas of the price-setting countries is influenced by a change in its initial endowment of quotas. Using the following chain rule and assuming that permits market clears, we can sign this partial derivative:

$$\sum_{j=1}^{k} \frac{da_j}{d\bar{e}_c} = \frac{dP}{d\bar{e}_c} \sum_{j=1}^{k} \frac{da_j}{dP} > 0 \tag{14}$$

Combining (equation 9) and (equation 14)) establishes that (equation 12) is positive for dominant selling countries exerting market power. It follows that total abatement costs increase since the initial allocation to the dominant country increases above its permits holdings after trading or decreasse below this level.

3.3.2 Interpretation and comments

The condition equation 7 implies that, for dominant countries, its marginal cost of abatement differs from the competitive permits price. Then marginal costs of abatement deviate across countries, therefore, it gives rise to a dead weight loss under the Cournot-Nash equilibrium relative to the efficient equilibrium. In this case, the initial allocation of permits to the dominant countries determines the ability to exert market power and affects inefficiencies occurred under Cost-Minimizing manipulation. So far, this efficiency loss in the Cournot market is influenced by the discrepancy between the endowment of emission quotas originally received by countries with market power and the amount chosen to be used.

The marginal abatement costs of price-setting countries only coincides with the equilibrium permits price, at which the number of quotas $\bar{e}_c$ initially allocated to the Cournot Countries is equal to the number of quotas $(e_c - a_c)$ they'll hold after trading. Then, as the level of net emissions is less than its permits allocation, $e_c - a_c < \bar{e}_c$, a particular Cournot Country has a positive net demand for permits, and hence, the permit price exceeds its marginal abatement cost $C'_c(a_c)$, while that of other fringe countries is too high.

In this context the initial allocation of permits for the States of the Former Soviet Union and for Central Europe, as a consequence of their potential dominant position in emissions trading due to potential "Hot Air", appears to be a major loopholes of the Kyoto Protocol.

3.3.3 Graphical description and implications of market power in international emission quotas market

The following graph on figure 1 depicts the outcome in presence of market power relative to the competitive level and determines the importance of cost-efficiency loss in the international emissions trading. We consider the market power from oligolistic countries, net sellers of permits owning to their low abatement costs and their initial endowment of permits. In this case, at $\bar{e}_c$, the representative dominant selling country c faces an incremental cost of pollution abatement lower $C''^s_c(a_c)$ than equilibrium permit price P_E.

Note the derived demand for permits (represented by P valuation line) indicates the number of permits acquired by the fringe countries from the oligopolists, which stands for its net emissions. Despite, if the dominant countries acting strategically in permits market, are aware of permits price sensitivity to their sells, they consider the marginal revenue schedule from permits (show by curve CM^s) to set permits price. These countries take also into account their marginal abatement cost $C''^s_c(a_c)$, which represents the marginal opportunity cost of permits sales.

If permits trading occurs in a perfectly competitive market, where P intersect $C''^s_c(a_c)$, the outcome results from the competitive permits price P_{ps} at which $\bar{e}_c - (e^{ps}_c - a^{ps}_c)$ permits are traded to the fringe countries. Regardless of the competitive solution, cost-efficiency is reached as all marginal abatement costs are the same between the fringe and the oligopolistic "price taking" countries.

Aware of its market power, the price-setting countries set permits price P_s where the marginal opportunity cost of permit sales $C''^s_c(a_c)$ equals the marginal revenues of permits CM^s. Here, the oligopolist sell too little permits, at which its marginal abatement cost is lower whereas the abatement cost of the fringe are higher.

This oligopoly power country drives up the permits price and reduces its emissions less than under a fully competitive system. Since oligopolistic permits price is higher, owning to the scarcity of permit sells from the dominant firms, thus, the fringe countries spend too much on pollution abatement.

3.4 Properties of market power in international emissions trading

The discussion presented in this section covers to some extent the properties of an international tradable permits market under imperfect trading.

On the one hand, under perfect competition in permits market, marginal abatement cost across countries are equal to the permits price. In this context, the distribution of permits determines the market price and the underlying allocation of permits between countries. Then, tradable permits, through decentralised method in the efface of perfect competition, create correct incentives for countries to achieve the given optimal ceilings on their emissions at lower compliance costs, which lead to the "cost-efficiency" outcome.

On the other hand, once market power is considered, if the dominant price-setting countries receive an initial allocation of permits exceeding or falling below their optimal cost-efficient use of permits, then total compliance costs would exceed the minimum. Therefore, the final outcome in international market is influenced by the way the initial allocation is distributed. Besides, a sufficient condition for cost-manipulation requires that the sensitivity of permits to the dominant country transaction is great, thus the steeper the inverse demand curve (i.e. $P' > 0$), and marginal abatement cost of a Cournot country differ from the permits price at the initial allocation $\bar{e}_c$.

Moreover we can put forward that, from an efficiency standpoint, the scope of efficiency loss is increasing with the gap between the initial and the cost-effective allocation of permits to the dominant countries

4 Implementation of "Hot Air" with market power in the GEM-E3 World model

4.1 Scenario options in the GEM-E3 World model

The GEM-E3[1] is a multi-country applied general equilibrium model, consisting of 18 inter-linked world country/region-modules, which intends to evaluate the implications of the global climate change issues. Supporting policy analysis, a major aim of this model is to provide a consistent evaluation of the distributional effects of emissions trading accross countries. We give a necessary brief overview of the key features of the GEM-E3 world model underlying this study. Marginal abatement costs curves are used to compute how the initial distribution affects carbon price and the resulting emissions.

In the case of a dominant country, we implement new conditions for permits market clearing in the model. The implementing into GEM-E3 imposes two steps:

1. ensuiring that for each country exerting market power, the marginal abatement cost is equal tothe permit price plus the correction for the price elasticity, which means computing its mark-up,

2. computing the permit price elasticity.

Factors for criteria or tests, for market power could be taken into account, are based on the percentage of total carbon emissions or of the initial amount of quotas for a country. However, as it is analytically not possible to evaluate the change in permits price due to a change in the overall emission reduction target; no iteration is done for the computation of the price elasticity (the change in price from a change in their reduction target is computed once) but a re-evaluation is done for each period. The mark-up is computed through the formula above and the price of the permit transmitted to each branch in the country for their reduction effort, is computed as the sum of the international price plus the mark-up.

With the US withdrawal from the Kyoto protocol and the latest decisions in Bonn and Marrakech, the potential for market power for the Former Soviet Union and Eastern Europe remains very high and it can have a large impact on the cost of reaching the Kyoto target for the countries participating in the Protocol. This is illustrated with some simulations with GEM-E3 world model, in which the countries are aggregated in 16 regions.

To provide insights for the international emission trading, we compare three

[1] GEM-E3 (General Equilibrium Model for Energy-Economy-Environment interactions)

scenarios under different emissions reduction strategies. The main focus lies on the potential market power exerting by dominant countries. We develop:

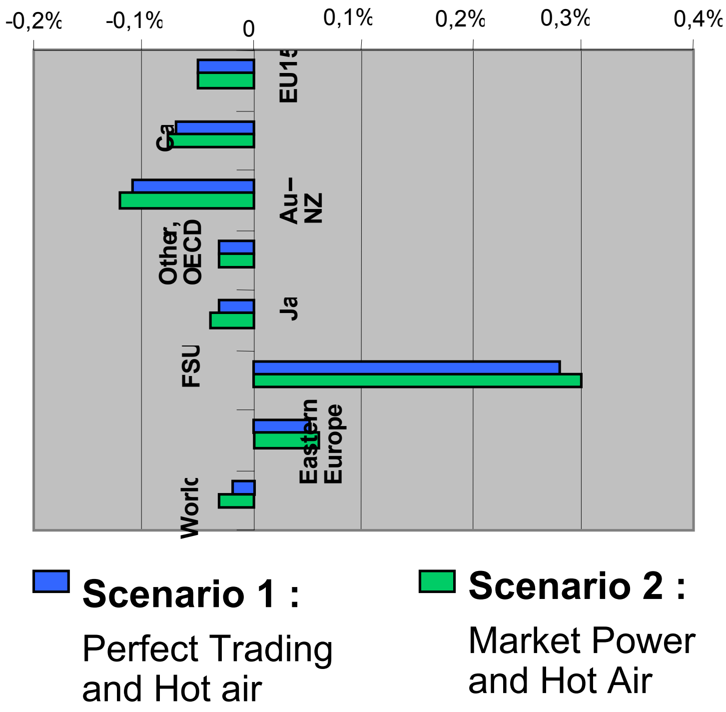
1. The 'Kyoto' target with a perfect competitive permit market
2. The 'Kyoto' target with the Former Soviet Union exerting market power

4.2 Numerical results

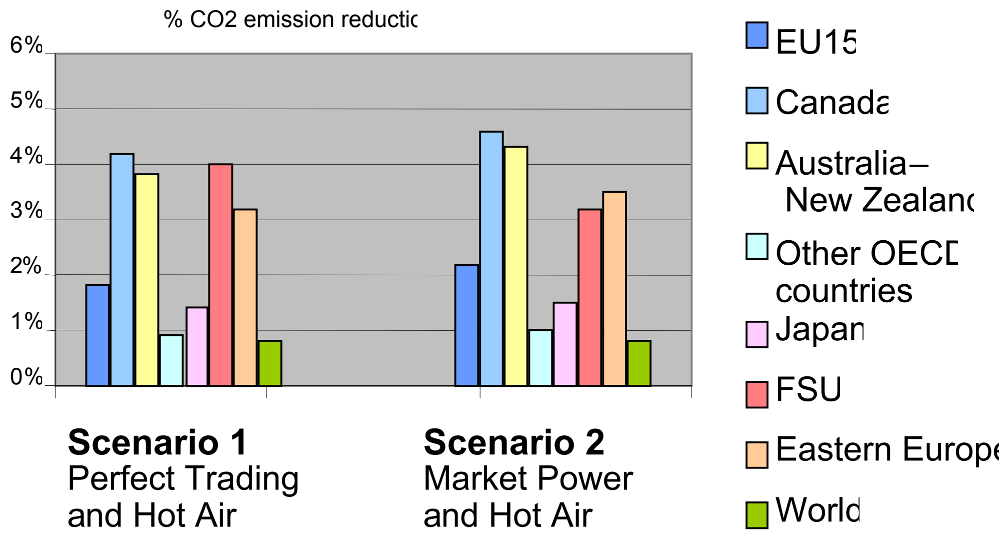
In all scenarios, the US are not participating in the international permits market and there is no limit imposed on the use of "Hot Air". The emission endowments per regions are given by the reduction target for each region, derived from the Kyoto Protocol. The revenue from "Hot Air" are allocated for half to the household, the other half is contributing to the public revenue.

Under the assumption of perfect Kyoto emission trading, the equilibrium carbon price would be US$ 2,6 per ton CO_2 equivalent in 2010. Indeed, this result emphasizes a sharp fall in permit price owning to the lower demand for emission quotas as a result of the US withdrawal and a much higher supply induced by "Hot Air". From comparison, Böhringer (2001) estimates the international permit price to only US $1,9 with the US defection from the Kyoto protocol under perfect emission trading. Therefore, as permits price decreases, the remaining Annex B countries face low costs to comply with the Kyoto objectives. Environmental effectiveness is, then, worsen because virtual emissions in Annex B countries are covered at "no costs".

Here, as the Former Soviet Union sells its emission quotas corresponding to the virtual emissions from "Hot Air", it implies zero abatement efforts. Therefore, the environmental effectiveness of the Kyoto Protocol is loosened because the remaining Annex-B countries have no more incentive to abate their own domestic emissions.



In addition, we explore the implications for the price-setting behavior from the FSU. A substancial concern is the oligopolistic power exerted by the FSU leads to social welfare loss. When the FSU use its market power, the supply of permits to the market is reduced and this increases the international permit price from 2.6 to 2.9 US \$ per ton CO_2 equivalent in 2010 compared to the perfect competition case. We can point out that the transaction price in 2010 would be about 12% higher than under corresponding competitive scenario. It also remains from this excessive pricing a mark-up on the marginal abatement costs.



Since the FSU abate less than under perfect trading, which provides less permits sold, the other Annex B countries reduce their emissions by more than it would be cost-efficient. Then the domestic reduction efforts are increased, except in FSU and this implies an overall efficiency loss . The total welfare loss is therefore slightly increased. For the FSU, there is a slight increase in terms of welfare. The Eastern European countries are also gaining in terms of welfare as they benefit as fringe permit supplier from the higher international permits price. As a consequence, it prevents the other Annex-B countries to face low abatement costs for meeting their Kyoto objectives. Indeed, since the US defection from the Kyoto Protocol, market power exerting by the Former Soviet Union may greatly enhance the effectiveness of the international cooperation on climate change.

5 Final comments

This first results with the extended GEM-E3 World model show that the impact of market power can be important and there is possibility of strategic behaviour by the regions of the Former Soviet Union. These results are still rather preliminary and need to be further examined taking account of possibilities for banking and cheating in the remaining Annex B countries.

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