

Working Paper No 3/03

**Enforcing the Kyoto Protocol:
Sanction design and strategic behaviour**

by

**Cathrine Hagem
Steffen Kallbekken
Ottar Mæstad
Hege Westskog**

SNF project no 1305
“Global climate policy, changes in demand patterns and
new technological developments”

The project is financed by the Research Council of Norway
and the Norwegian Shipowners' Association

SIØS - Centre for International Economics and Shipping

INSTITUTE FOR RESEARCH IN ECONOMICS AND BUSINESS ADMINISTRATION
BERGEN, DECEMBER 2003
ISSN 1503-2140

© Dette eksemplar er fremstilt etter avtale
med KOPINOR, Stenergate 1, 0050 Oslo.
Ytterligere eksemplarfremstilling uten avtale
og i strid med åndsverkloven er straffbart
og kan medføre erstatningsansvar.

SIØS - CENTRE FOR INTERNATIONAL ECONOMICS AND SHIPPING

SIØS – Centre for international economics and shipping – is a joint centre for The Norwegian School of Economics and Business Administration (NHH) and Institute for Research in Economics and Business Administration (SNF). The centre is responsible for research and teaching within the fields of international trade and shipping.

International Trade

The centre works with all types of issues related to international trade and shipping, and has particular expertise in the areas of international real economics (trade, factor mobility, economic integration and industrial policy), international macroeconomics and international tax policy. Research at the centre has in general been dominated by projects aiming to provide increased insight into global, structural issues and the effect of regional economic integration. However, the researchers at the centre also participate actively in projects relating to public economics, industrial policy and competition policy.

International Transport

International transport is another central area of research at the centre. Within this field, studies of the competition between different modes of transport in Europe and the possibilities of increasing sea transport with a view to easing the pressure on the land based transport network on the Continent have been central.

Maritime Research

One of the main tasks of the centre is to act as a link between the maritime industry and the research environment at SNF and NHH. A series of projects that are financed by the Norwegian Shipowners Association and aimed directly at ship owning firms and other maritime companies have been conducted at the centre. These projects include studies of Norwegian Shipowners' multinational activities, shipbuilding in Northern Europe and the competition in the ferry markets.

Human Resources

The centre's human resources include researchers at SNF and affiliated professors at NHH as well as leading international economists who are affiliated to the centre through long-term relations. During the last few years the centre has produced five PhDs within international economics and shipping.

Networks

The centre is involved in several major EU projects and collaborates with central research and educational institutions all over Europe. There is particularly close contact with London School of Economics, University of Glasgow, The Graduate Institute of International Studies in Geneva and The Research Institute of Industrial Economics (IUI) in Stockholm. The staff members participate in international research networks, including Centre for Economic Policy Research (CEPR), London and International Association of Maritime Economists (IAME).

Enforcing the Kyoto Protocol: Sanction design and strategic behavior

by

*Cathrine Hagem (CICERO and Department of Economics, University of Oslo)
Steffen Kallbekken (CICERO)
Ottar Mæstad (Institute for Research in Economics and Business Administration, SNF)
Hege Westskog (CICERO)¹*

Abstract

This paper looks at how strategic considerations may play a role in the decision of whether or not to impose sanctions on non-compliant Parties under the Kyoto Protocol. A member of the Enforcement Branch might have an incentive to vote for sanctions towards one non-compliant country and not another even with the same violation. Hence, a certain composition of the members of the Enforcement Branch could decide to sanction one country and not another for the same violation, while another composition might choose differently. The reason for this is that the current sanction mechanism under the Marrakesh Accords affects the economy of the complying countries, including those that are members of the Enforcement Branch. We discuss an alternative design of the enforcement mechanism that may reduce these economic effects of sanctioning for the complying parties.

¹ Corresponding author: Hege Westskog, Center for International Climate and Environmental Research, P.O. Box 1129, Blindern, N-0318 Oslo Norway. E-mail: hege.westskog@cicero.uio.no

1. Introduction

At the COP7 in Marrakesh, the Parties to the Kyoto Protocol agreed to the design of the enforcement mechanisms, and created two bodies responsible for the implementation of these mechanisms: a Facilitative Branch and an Enforcement Branch.² The objective of the Facilitative Branch is to provide advice and assistance to the Parties of the Protocol to promote compliance. The Enforcement Branch has the authority to apply sanctions to Parties not meeting their commitments. When the enforcement branch has determined that a Party has failed to comply with its emission targets, it shall apply the following sanctions (UNFCCC 2001):

- 1) Deduct from the Party's assigned amount for the second commitment period a number of tonnes equal to 1.3 times the amount in tonnes of excess emissions;
- 2) Develop a compliance action plan;
- 3) Suspend the non-compliant Party's eligibility to sell permits.

Both branches are to be composed of 10 members elected from the Conference of the Parties (serving as the Meeting of the Parties to the Protocol), including one representative from each of the five UN regions,³ one from the small island developing states and two each from Annex I and non-Annex I Parties. Decisions of the Facilitative Branch must be taken by a three-quarters majority. Decisions of the Enforcement Branch require, in addition, a double majority of both Annex I and non-Annex I Parties.⁴

² However, not all Parties agreed on the legal status of these mechanisms. Some countries (especially Japan and Russia) did not want the enforcement mechanisms to be legally binding, they wanted to soften the legal status of the mechanisms. In fact the legal status of the mechanisms is not yet settled.

³ The five regional groups of the United Nations are African States, Asian States, East European States, Latin American States and Western European States and other States.

⁴ A majority in this regard signifies that more than half of the members of these two groups are in favour of carry out the sanctions.

This paper looks at the how the existing enforcement mechanism under the Marrakesh Accords may give the members of the Enforcement Branch the opportunity to take strategic considerations when deciding whether or not to impose sanctions on non-complying Parties. By strategic considerations we mean taking into account the economic interests of one's own country when making decisions in the Enforcement Branch. In the context of this paper, we look particularly at situations where the agreed sanction mechanisms not only affect the non-complying Parties economically, but also the complying countries, including those represented in the Enforcement Branch.⁵ Moreover, we discuss alternatives to the existing enforcement mechanism that might reduce the incentives for taking strategic considerations when deciding whether to carry out sanctions or not towards non-complying countries.

Two of the sanction mechanisms agreed upon under the Protocol lend themselves to strategic considerations, namely the first and third sanction mechanisms mentioned above. This is because deducting from the Party's assigned amount or suspending a Party's eligibility to sell permits may, under certain conditions, affect the complying Parties costs of meeting their commitments. The paper by Hagem and Westskog (2003) discusses these conditions and how these mechanisms will under certain conditions affect both the permit prices and the prices of other goods, especially fossil fuel prices and the prices of emission-intensive goods.

Suspending a country's right to sell permits (the third sanction mechanism mentioned above) affects the cost of compliance for the other Parties of the Kyoto Protocol because such a suspension could alter market prices, especially the international permit price and the international prices of emission-intensive goods and fossil fuels. A suspension of the eligibility to sell permits drives up the international permit price. Complying countries that are

⁵ This fact may undermine the deterrence effect of the system. If a non-complying country sees that it is in the economic interest of the members of the Enforcement Branch to let it continue to sell permits or no pay back of excess emissions is required, the deterrence effect of the sanction mechanism is weakened.

sellers of permits will benefit from a higher international permit price, while buyers of permits will lose.

If a non-compliant country exceeds its emissions target by a significant amount, the costs of the complying countries could be changed by imposing the first sanction mechanism, i.e., deducting from its assigned amount in the following period. The country will then be required to “pay back” its excess emissions times 1.3 according to the Marrakesh Accords. This would affect the prices of permits, emission-intensive goods and fossil fuels when this payback is large because the sanctions will reduce the assigned amounts in the period when the sanction is imposed.

Axelrod and Keohane (1985) discuss the difficulty of preventing defection through decentralized retaliation. They identify three sanctioning problems: (1) the inability to identify the defectors; (2) inability to focus retaliation on defectors; and (3) lack of incentive to punish defectors. It is the second and the third problem that is of relevance for our study. The first and the third sanction mechanism hurt the non-compliant country, but it may also hurt others. Because the sanction mechanisms may be double-edged, Parties to the Protocol may be reluctant to carry it out, and the credibility of the threat to sanction non-compliance may be severely weakened.. If the non-complying Parties believe the sanctions will never be carried out, then they have no effect. Credible threats related to the sanction mechanisms under the Kyoto Protocol are discussed by Hovi and Areklett (2003); they conclude that constructing an effective system for enforcement of the Kyoto Protocol is a formidable task, and one that has only partially been accomplished by the Marrakesh Accords. They propose how a better sanctioning system could be designed. We discuss their proposal in section 5 of this paper.

Strategic considerations during the sanctioning process are likely to be taken into account only if the members of the Enforcement Branch also serve their country in some way. This is in no way a given; the Marrakesh Accords are ambiguous on this point. First, it is underlined that members of the Branches shall serve “in their individual capacity”. This implies that the members are not meant to take instructions from their country of nationality or any others. On the other hand, the composition of the Branches is based on a specific distribution of the members across geographical regions. This could indicate that the Conference of the Parties see a point in selecting representatives from various countries with deviating economic interests in both the agreement on and the implementation of sanctions for non-compliance. If one could be certain that the members of the enforcement branch only “served in their individual capacity”, a complex composition of the Enforcement Branch with respect to the members’ nationality seems unnecessary (and even counterproductive, since the best qualified candidates are not necessarily chosen). (See Ulfstein and Werksman (2003) for a discussion of this issue). Here we are not considering how likely it is that members of the Enforcement Branch will take national interests into account when making their decisions, only what would happen if the members of the Enforcement Branch were to take such interest into account.⁶

In the following discussion we consider a situation where the non-compliant countries, after being sanctioned, choose to comply with their commitments and sanctions. A valid alternative scenario is of course that the non-compliant country chooses to withdraw from the agreement as a result of the sanctions. Such a withdrawal would also affect prices and hence give economic incentives for strategic considerations by the members of the Enforcement Branch. Furthermore, a withdrawal reduces the environmental effect of the agreement. The withdrawal

⁶ The simulations carried out in the paper are most of all meant to serve an illustrative purpose. We illustrate and show the effects of strategic considerations taken by the Enforcement Branch when carrying out sanctions towards non-complying countries. This is not to say that these considerations actually will be taken into account, but the intention is to show the weakness of the Enforcement Mechanisms on these issues, and analyse how these effects could be reduced.

of a country with large emission reduction commitments can significantly reduce the global emission reductions following from the Kyoto Protocol. And if one country chooses to opt out, other countries may then follow if they perceive that the environmental benefits of the agreement no longer exceed their costs. Hence, sanctioning non-compliance may severely undermine the environmental impact of the agreement. Obviously, this will be a concern for the members of the Enforcement Branch. However, in this paper we disregard the danger of withdrawal when we elaborate the strategic interests of the Enforcement Branch in an implementation of the sanctioning mechanisms. By doing this we focus on the fact that even in the case where the members of the Enforcement Branch are certain that the sanctioned country will not withdraw, the enforcement mechanism may hurt some of the complying countries and therefore lead to strategic behavior among the members of the enforcement branch.

We use a general equilibrium model to explore the economic effects of imposing the first and the third sanction mechanisms on non-complying Parties. The structure of the general equilibrium model is described in the next section, and the scenarios we use are described in section 3. In section 4 we discuss the welfare effects of sanctioning a non-complaint party, and in section 5 we discuss the incentives for strategic behavior implied by these welfare effects. We show that a member of the Enforcement Branch might have an incentive to vote for sanctions towards one non-compliant country and not another when they are responsible for the same relative violation, when the members of the Enforcement Branch take economic consequences into considerations when making decisions. This implies that a certain composition of the Enforcement Branch could decide to sanction one country and not another for the same relative non-compliance, while another composition might choose differently. In section 6 we discuss the specific characteristics of the first and the third sanction mechanism

and in light of this discussion, the implications for the design of the sanction mechanisms. We show that the incentive to act strategically could be reduced by introducing a sanction mechanism where part of the amount by which a party has exceeded its allowance could be transferred to other parties.⁷

2. Model

To analyze the incentive structure embedded in the sanctions for non-compliance, we employ a computable general equilibrium (CGE) model. The model is based on the GTAP-EG model (Rutherford and Paltsev 2000), which is a static multi-regional model. The data-input to this model is the GTAP-EG dataset, which is a reconciled database of the Global Trade Analysis Project (GTAP) database (version 5), and International Energy Agency (IEA) energy statistics. The GTAP database contains production and bilateral trade flow data for 1997.

The model is an Arrow-Debreu general equilibrium model in Mathiesen format (Mathiesen 1985), and programmed in GAMS-MPSGE (General Algebraic Modeling System – Mathematical Programming System for General Equilibrium). There are two principal agents in the model: producers and representative agents (consumers). Production is divided into fossil fuel, and non-fossil fuel production, and they have different nesting structures. The output of the fossil fuel production is an aggregate of a resource input and a non-resource input. The non-resource input is a Leontief composite of labor and an Armington aggregation of domestic and imported intermediates. Non-fossil fuel production has a structure where the output is a Leontief composite of intermediate non-energy goods and a composite of energy and primary factors. The representative agent is endowed with all the primary factors, and all

⁷ This kind of sanction mechanism is discussed by Hovi and Areklett (2003).

income goes to the representative agent. This income is allocated between investment (represented by a savings good) and private demand. The private demand is represented by utility maximizing behavior, where utility is a constant elasticity aggregate of non-energy and energy consumption.

Both intermediate demand and final demand are modeled through an Armington aggregation of domestic and imported goods. The Armington supply includes a transport margin which is proportional to the volume of trade (using Leontief technology). The complete nesting structure and functional forms are explained in Rutherford and Paltsev (2000).

The original GTAP-EG database consists of 24 sectors and 63 regions, but the model allows for different regional and sectoral aggregations. We have chosen a sectoral aggregation that focuses on the energy sectors (this is the same aggregation as in the GTAP-EG model). There are eight sectors in the model: crude oil, natural gas, coal, petroleum and coal products, electricity, energy-intensive sectors, other manufactures and services, and a savings good. The choice of regional aggregation was based on two concerns: the main actors in the emissions trading and energy markets should be represented, and all the assumed members of the Enforcement Branch had to be represented. The regional aggregation is shown in table 1.

All the extensions we have made to the GTAP-EG model relate to emissions trading. The only Kyoto Protocol gas that is included in the model is CO₂. Furthermore, no sinks are included, and emission reductions through the Clean Development Mechanism are also not included. We assume that the Kyoto Protocol is implemented through an international emissions trading scheme, such that permits are required to emit CO₂ from the production and use of fossil fuels. In the model this is represented through a zero elasticity of substitution

(Leontief technology) between the fossil fuel and the emission permit inputs to the production (intermediate and final energy demand). The amount of permits required for each unit of fossil fuel is determined through emission coefficients, which are implemented in the GTAP-EG model and calibrated to actual emissions in 1997.

Each region is given an endowment of tradable emission permits. The size of the endowment is equal to the Kyoto commitment of the region. We assume perfect competition in the emission permits market⁸.

3. Scenarios

We use the general equilibrium model to explore the welfare effects of sanctioning a non-compliant country, and what incentives these welfare effects provide for the members of the Enforcement Branch under a variety of scenarios. We generate a baseline scenario where all Annex I countries, with the exception of the US, have ratified the Kyoto Protocol and participate in international emissions trading. The emission projections (for the year 2010) in the scenario are based on results from the Oxford Model for Climate Policy Analysis (Bartsch and Müller 2000) and certain unpublished data from this model⁹. The 2010 emissions are scaled to the 1997 world economic structure that the database contains.

Based on this baseline scenario, we develop four scenarios where we explore the economic incentives that could influence the voting behavior of the Enforcement Branch. Each of the four scenarios represent a situation where one region is not in compliance with its Kyoto emission reduction commitment, and where that region is sanctioned for this non-compliance.

⁸ The market is modelled as an international emissions permit trading pool – where all regions initially sell their permits before the sectors in each region purchase the permits that they need – at a world price.

⁹ Personal communication: Aaheim, A, 2002, Senior Research Fellow CICERO.

The four regions that are in non-compliance in each of the scenarios were chosen based on results from baseline scenarios. The regions represent, respectively, a big and a small permit seller, and a big and a small permit buyer, and comprise the following: the former Soviet Union countries (FSU), Australia (AUS), Japan (JPN) and the EFTA region (EFT). The scenarios have been named after the region that is assumed to be in non-compliance.

We assume that the region that is in non-compliance has exceeded its Kyoto commitment by 10%, so that the punishment in the following period will be a further 13% reduction compared to its original commitment.¹⁰ We have chosen a modest exceeding of commitments because we believe that countries that have already shown a willingness to reduce emissions through signing the Kyoto Protocol, will intend to fulfil a least part of these commitments. However, we have also illustrated the situation with larger exceeding of commitments, see Table 5.

The second part of the punishment is that the region is restricted from selling permits to other regions.¹¹ The region that is being punished can still purchase permits from the international pool. This means that the domestic permit price, in the region that is being suspended from permit exports, is no longer necessarily equal to the world price (though it will be for any country buying permits from the international pool).

While the non-compliance takes place in the first commitment period (Kyoto), the sanctions are imposed in the second commitment period. For simplicity, and so that the economic effects of changed commitments do not overshadow the effects of the sanctions, and thus complicate the analysis of the results, we assume that each region has an emission reduction commitment in the second period that is equal to what it was in the first period.

¹⁰ This is implemented in the model by reducing the region's endowment of permits by 13%.

¹¹ In the model this is done by restricting sales of the region's permit to the international pool so that all its permits have to be used domestically.

We also have to make assumptions about which specific regions will be represented in the Enforcement Branch. We have designed two feasible combinations of members according to the rules under the Marrakesh Accords presented in the introduction to this paper. The assumed Enforcement Branch members are shown in table 1 – where the “E.B. member” column indicates whether or not the region is a member of the enforcement branch. The only difference between the two alternative combinations is that Spain takes the European seat in one combination, and the EFTA region takes the seat in the other.

4. Welfare effects of sanctions

Table 2 shows the welfare results¹² for each region under each of the four scenarios, and the permit price in each scenario. Most of these welfare results are fairly straightforward to explain. There are two effects that dominate the results: the effect on the permit price and the effect on fossil fuel prices.

Sanctioning a region always results in a higher permit price. The demand for permits by the region that is sanctioned increases because of the 30% penalty, which all else being equal increases the permit price. When a permit seller is sanctioned, there is the additional effect of reducing the permit supply, which also has the effect of increasing the permit price. An increased permit price decreases the welfare of permit buyers (because they have to pay more for the permits) and increases the welfare of permit sellers (because they receive more revenue from their permit sales).

¹² Welfare is measured as equivalent variation. Because we are concerned with the voting outcome, we will report welfare changes relative to the baseline scenario.

The other main driving force behind the welfare changes is the change in fossil fuel prices. In all scenarios, because of the 30% penalty, the Annex I ceiling on emissions becomes more stringent and the permit price increases until fossil fuel emissions are limited to the new ceiling, which will decrease the demand for fossil fuels as a whole. This effect, however, is not uniform for all the fossil fuels in all cases. While the overall energy demand measured in CO₂ units falls, the market share of the different fossil fuels can change, and so the effect on each fossil fuel is not always straightforward. However, the effect in our model is for net energy importers to benefit when a region is sanctioned, and for net energy exporters to experience a welfare decrease.

These two price effects (permits and fossil fuels) may work in the same or opposite direction on the welfare of each region. The permit price will of course change more than the prices of fossil fuels (the extreme changes in our scenarios are 200% and 5% respectively). The welfare effect does, of course, also depend on the absolute quantities traded of permit or fossil fuels for each country; in relative terms, the EFTA region is both a large permit buyer and a large net energy exporter, and consequently experiences a welfare loss from both of the dominant price effects. In all scenarios, the EFTA region is the one most significantly negatively affected by punishment of another region. In the scenario where the FSU is sanctioned, the two price effects work in opposite directions on the welfare of Australia: Because of the great increase in the permit price (189%), Australia becomes a permit seller – and benefits from the revenue from permit sales. However, Australia also experiences a loss because the demand for coal decreases significantly (and Australia is a major coal exporter). Overall the welfare of Australia decreases.

The results regarding who are permits sellers and who are permits buyers are generally consistent with the results from other studies. The permit sellers are the FSU, CEA(Central European Associates); Poland, Spain and the “rest of Europe” region, of which the FSU is responsible for around 70% of all sales. All other regions are permit buyers, with Japan, Canada and Germany as the major buyers. In Nordhaus and Boyer (1999), Japan, USA, Europe and “other high income” countries (including Canada and Australia) are permit buyers, while Russia and Eastern Europe are permit sellers. Cooper et al. (1999) has similar results regarding who are the permit buyers and sellers. These results also hold when the USA does not have any commitments according to the Kyoto Protocol. (See for example Böhringer 2002). In both papers, the sizes of the trade flows are, however, somewhat different from our results (Hagem et al 2003). Two significant reasons for the diverging results are the baseline emission scenario and differences in the model structure.

Non-Annex I regions are of course not affected by the changes in the permit price. They do, however, experience all the other price effects, and these are again dominated by the fossil fuel prices. A simple check on the welfare results seems to confirm this: India, a net energy importer, benefits when the FSU is punished, and the OPEC region, a major net energy exporter, loses under this scenario. In most cases, however, the effects of sanctioning a region are insignificant for the non-Annex I countries.

5. Incentives for strategic behavior.

The welfare results give the economic incentives facing the members of the Enforcement Branch.¹³ Tables 3 and 4 show how the economic incentives would affect the casting of the votes of the Enforcement Branch, and what the overall outcome of the vote would be, if these incentives did indeed determine the votes.¹⁴ In table 3 Spain takes the European seat in the branch, while in table 4 the EFTA region takes up that seat.

In table 3 we can see that Australia, Japan and EFTA are sanctioned for their non-compliance, while the FSU is not. The nature of the FSU's non-compliance was the same (their commitment was exceeded by 10%), but the incentives facing the members of the branch differed – as was reflected in their votes. The FSU is not sanctioned because there is not an Annex I majority in favor of sanctioning.

In table 4 EFTA has replaced Spain as the “Western European and other states” member of the Enforcement Branch. The EFTA region is a permit buyer, and is sensitive to changes in fossil fuel prices (oil and gas exports account for approximately 14% of total exports from the region). The EFTA representative therefore faces quite different economic incentives from a Spanish representative when it comes to deciding whether to sanction non-compliance or not.

In all four scenarios, the EFTA region experiences a welfare loss, and the representative votes

¹³ No region specifically representing any small island developing state is represented in the GTAP-EG database. It is therefore not possible to calculate any welfare results – and consequently we do not know how the economic incentives might influence the voting of this member of the branch. We will instead assume that this member of the Enforcement Branch always votes in favour of punishing. This is a reasonable assumption given that the long-term survival of the island states is threatened by global warming, and that the AOSIS group in the UNFCCC negotiations have always favoured a stringent policy regime.

¹⁴ As we would expect, the overall welfare effects of sanctioning are small. This is because the permit market is a small part of countries' total welfare. However the partial effects could be quite large, for example entailing an increase in permit export revenue by as much as 450% for CEA in the case where the FSU is punished. In this paper, we assume that if a region experiences a zero or insignificant welfare change, which we have defined as a welfare effect of less than 0.1%, the member representing that region will vote in favour of sanctioning the non-compliant region.

against sanctioning. This changes the overall outcome in the Australia-scenario by removing the Annex I majority in favor of sanctioning, such that Australia is no longer sanctioned for its non-compliance.

The two voting outcome tables illustrate two important points regarding the incentive structure facing the members of the Enforcement Branch. First, a certain composition of the Enforcement Branch could decide to sanction one country and not another for the same relative non-compliance. Second, two different compositions might choose differently in the same case. These results would apply for both sanction mechanisms. As we can see from Table 6, sanctioning a permit buyer like Australia, to which only the first sanction mechanism apply, would give negative welfare effects for countries like the EFTA group (see Table 4). Imposing only the third sanction mechanism by denying a non-compliant permit seller like FSU the right to sell permits would give rise to negative or positive welfare effects for complying countries and thus possibilities for taking strategic considerations. (See Table 6).

Further, we see that the severity of the non-compliant activity is likely to affect the chances of getting sanctioned for non-compliance. If a country departs only a little from its commitments, the effects on the prices of permits and other goods would be smaller than if their excess emissions are large. This means that it is more likely that the Enforcement Branch sanctions small departures from commitments than large deviations. This is clearly illustrated in Table 5. Japan is initially sanctioned for its non-compliance of 10% according to its commitments with the compositions of the Enforcement Branch considered here (tables 3 and 4). On the other hand, if their excess emissions are larger they would escape sanctions. According to our model calculations, with a 40% deviation from its commitments Japan would not be punished. Australia is not punished in the first place with a 10% deviation under

the EFTA composition of the Enforcement Branch (Table 4). However, if it should only depart a little (3%) it would be sanctioned (Table 5).

Apart from the severity of the non-compliant activity, whether a country is a permit buyer or seller of permits and the amount of permits a seller offers could be decisive for whether a country is sanctioned or not. Obviously, since only sellers are suspended from permit trade, this sanction mechanism could only give rise to changed international market prices and hence give room for strategic considerations by sanctioning permit sellers. The larger the amount of permits a non-compliant country sells, the greater the effect on international market prices, all else being equal. Hence, both the amount of excess emissions, the status of a non-compliant country in the market (seller or buyer and amount of permits sold) and the amount of permits a non-compliant country sells could be of importance for whether non-compliance is sanctioned or not.

6. An alternative design of the sanction mechanism

The current design of the sanction mechanisms is meant to serve two purposes: restitution and deterrence. By requiring that a non-complying country make up for its insufficient emission reductions in the next period, environmental restitution is made. Requiring that the country multiply the amount by which it was deficient by 1.3, serves as a deterrent. Deterrence is also ensured by giving an economic disincentive through the threat of revoking a country's eligibility to sell permits on the international market.

As mentioned in the introduction, because the sanction mechanisms may be double-edged, Parties to the Protocol may be reluctant to carry it out, and the threat to sanction non-compliance may be severely weakened. Hovi and Areklett (2003) discuss a sanction

mechanism that might not only reduce the incentive to act strategically when sanctioning non-compliance, but might also impose environmental restitution and make conditions equal to every non-compliant party. They propose that if a party to the Kyoto Protocol is found to have exceeded its allowance, then part of this allowance could be transferred to other parties. This would reduce the incentive to act strategically since this would make the commitments for the other complying parties lower and hence make it less costly to fulfill the requirements. Hence, to some extent this could offset the negative effects of sanctioning experienced through the effects on market prices. Table 7 illustrates this. Here we have used the FSU as an example:

The FSU is initially not sanctioned for a deviation of 10% from its commitments (tables 3 and 4). However, if the amount of tonnes of excess emissions from the FSU multiplied by 1.3 is deducted from their assigned amount (the first sanction mechanism) and part of this deduction (0.3 times its excess emissions) are transferred to the complying Parties, the FSU would be punished for its non-compliance with the composition of the Enforcement Branch considered in Table 7. In this case (second column of table 7) we have assumed that the third sanction mechanism is not implemented. Only imposing sanctions according to the first sanction mechanism implies that countries are punished equally in the sense that the punishment is set proportional to their excess amount of emissions. If non-compliant countries also would lose their eligibility to sell permits (the third sanction mechanism) the sanctions would no longer lead to an equal economic punishment for non-compliance. Furthermore, we find that if the third mechanism were retained, the sanctions would need to be stricter to achieve sanctioning of FSU (see table 7, third column). Imposing a sanction by multiplying their excess emissions by 1.6 and transferring allowances according to 0.6 multiplied by the FSU's excess emissions, would result in sanctioning.

Hence, by designing an enforcement mechanism that reduces the costs of imposing sanctions for the complying Parties, the incentives for taking strategic considerations are of course reduced, and therefore the credibility of the sanctions increased.

7. Discussion

The significance of these results is that the composition of the Enforcement Branch may influence whether or not it is likely to punish non-compliance or not (both in general and for specific regions). Further that a different design of the sanction mechanism could reduce the incentive to act strategically, for instance by introducing a sanction mechanism where the part of the amount by which a party has exceeded its allowance could be transferred to other parties.

In the scenarios that we have explored, the key players in the branch are the Annex I countries; in all scenarios where a region is not punished, it is the lack of an Annex I majority that determines the overall decision not to sanction. One key question is therefore which countries represent Annex I in the Enforcement Branch. Most likely, but not necessarily, there will be four Annex I members – two representing Annex I as such, and one each from among the East European States and the Western European and other States. All the East European States in Annex I, under our scenarios, have an incentive to vote in favor of sanctioning (unless the non-compliant country is their own). It is therefore the three remaining Annex I representatives that are the crucial players that can block a vote to sanction a non-compliant country. If at least two of these are permit buyers (and/or energy exporters), then they will have not only the incentive, but also the capacity, to effectively block all sanctions.

There are other possible constellations of the Enforcement Branch that would have the incentive to vote against sanctioning. Among the non-Annex I countries only the OPEC countries seem to have any economic incentives to vote against sanctioning (because they are all net energy exporters). The presence of two OPEC countries among the branch members would tip the balance in some scenarios, where the outcome would otherwise have been to sanction the non-compliant country. For example, in the scenario where Australia is in non-compliance (Table 3) and Spain represents the Western European states, the presence of two more “no” votes would preclude the possibility of the required $\frac{3}{4}$ overall majority, and Australia would not be sanctioned. Hypothetically, it is possible to have as many as five OPEC-countries represented in the Enforcement Branch.¹⁵ Such a composition of the branch would have both the incentive and capacity to effectively block any initiatives to sanction a region for non-compliance (as long as the negative welfare effects are not negligible, as they would be in certain cases).

In addition to the possibility of strategic behavior among the members of the Enforcement Branch, it is also possible that the *election* of these members could be influenced by strategic behavior. The members are elected by the governments that are parties to the Protocol. In short, it is likely that the governments will vote for candidates from countries with interests similar to their own. As we have seen from the analysis above, it is the Annex I countries that will tend to be the key players in the Enforcement Branch. A majority of the Annex I countries are net permit buyers,¹⁶ and experience a welfare loss when a country is punished.¹⁷ It would therefore seem likely that the members elected to represent the Annex I countries

¹⁵ It is possible that both non-Annex I members and the members from African States, Latin American and Caribbean States, and Asian States could be OPEC countries.

¹⁶ Given that the EU countries vote separately and not as a group.

¹⁷ Whether that welfare effect is significant or not, will depend on the scale of the violation that is to be sanctioned (or not).

would be from countries that are net permit buyers, and would thus, in general, have incentives to vote against sanctioning.

In all the scenarios considered in this paper, it is assumed that the members of the Enforcement Branch anticipate that the sanctioned country will bring itself back into full compliance with both its commitments and the imposed sanctions. Obviously, there are a number of other possibilities, ranging from being “almost” in compliance to making a complete withdrawal from the agreement. The sanctioned country’s response to the sanctions is crucial for the sanction mechanism’s impact on the economies of the other Parties. For instance, a non-compliant country that is a net buyer of permits in the “Kyoto period” will cause the international permit price to fall if it withdraws from the agreement after facing the sanctions. On the other hand, the country would cause the permit price to rise if it chose to fully comply with its commitments and imposed sanctions. In addition to the impact on world market prices, the non-compliant country’s response has a welfare effect on other countries through the impact on global emission reductions. As discussed in the introduction, a withdrawal, as a response to the sanctions, reduces the global emission reduction following from the Kyoto Protocol and can also induce other countries to withdraw. It is beyond the scope of our model to include the welfare effect of global emission reductions. But there is no doubt that it was the concern about the possible negative environmental effect of global warming that triggered the construction of the Kyoto Protocol. The degree to which the members of the Enforcement Branch believe withdrawal is a likely response to sanctioning is therefore of great importance for the outcome of their decisions when they act in the interest of their own country. Since countries probably have different opinions regarding the benefit of reduced climate change, including the environmental impact of the sanctions would not weaken the conclusion that whether or not a country is sanctioned for non-compliance may

depend on both the composition of the Enforcement Branch and the type of non-compliant country in question.

8. References

- Axelrod, R. and R.O Keohane 1985, Achieving Cooperation under Anarchy: Strategies and Institutions, *World Politics*, 38, 226-54.
- Bartsch U., B. Müller, 2000, Fossil Fuels in a Changing Climate - Impacts of the Kyoto Protocol and Developing Country Participation, Oxford University Press, Oxford.
- Bollen J., A. Gielen and H. Timmer, 1999, Clubs, Ceilings and CDM: Macroeconomics of Compliance with the Kyoto Protocol, *The Energy Journal 1999, Special Issue: the Costs of the Kyoto Protocol : A Multi-Model Evaluation*, pp. 177-206
- Böhringer C., 2002, Climate Politics from Kyoto to Bonn, from Little to Nothing? *The Energy Journal* 23 (2002), pp. 51-73.
- Cooper A., S. Livermore, V. Rossi, A. Wilson and J. Walker, 1999, The Economic Implications of Reducing Carbon Emissions: A Cross-Country Quantitative Investigation using the Oxford Global Macroeconomic and Energy Model, *The Energy Journal 1999, Special Issue: the Costs of the Kyoto Protocol : A Multi-Model Evaluation*, pp. 335-366.
- Hagem, C, S. Kallbekken, O. Mæstad and H. Westskog, 2003, ” Tough justice for small nations: how strategic behavior can influence the enforcement of the Kyoto Protocol”, CICERO Working Paper – 2003:01
- Hagem C. and H. Westskog, 2003, Effective Enforcement and Double-Edged Deterrents: How the Impacts of Sanctions Also Affect Complying Parties. Forthcoming
- Hovi J. and I. Areklett (2003), Enforcing the Climate Regime: Game Theory and the Marrakesh Accords”. Working Paper 2002:06. CICERO, Oslo, Norway.
- Mathiesen L., 1985, Computation of Economic Equilibrium by a Sequence of Linear Complementarity Problems, *Mathematical Programming Study* 23, North-Holland, pp. 144-162.

Nordhaus W. and J. Boyer, 1999, Requiem for Kyoto: An Economic Analysis of the Kyoto Protocol, *Energy Journal 1999, Special Issue: the Costs of the Kyoto Protocol: A Multi-Model Evaluation*, pp.131-156.

Rutherford T.F., S.V. Paltsev, 2000, GTAP-Energy in GAMS: The Dataset and Static Model, Working Paper No. 00-2, Department of Economics, University of Colorado.

UNFCCC (2001): "Marrakesh Accords", <http://unfccc.int/cop7/>

Ulfstein G. and J. Werksman (2003), Hard Enforcement and Due Process. Forthcoming

9. Tables

Table 1: Regional aggregation, region codes and enforcement branch members

Region code and region		E.B. member	
Annex I countries	USA	United States	
	CAN	Canada	
	JPN	Japan	x
	GER	Germany	
	ITA	Italy	
	FRA	France	
	SPN	Spain	(x)
	UK	United Kingdom	
	REU	Rest of European Union	
	EFT	European Free Trade Area (EFTA)	(x)
	AUS	Australia	x
	FSU	Former Soviet Union	
	POL	Poland	x
	CEA	Central European Associates (rest of)	
	RAB	Rest of Annex I	
Non-Annex I	CHN	China (incl. Hong Kong and Taiwan)	x
	IND	India	x
	OPE	OPEC	
	TAN	Tanzania	x
	PER	Peru	x
	MOR	Morocco	x
	ROW	Rest of world	

Note: (x) signifies that this Enforcement Branch member is only included in one of the combinations of the members considered in our scenarios, while x signifies that it is included in both.

Table 2: Welfare results (% change relative to baseline) according to which country that is sanctioned for its non-compliant activity.

	FSU	AUS	JPN	EFT
USA	0	0	0	0
CAN	-0.3	0	-0.1	0
JPN	-0.1	0	0	0
GER	-0.1	0	0	0
ITA	-0.1	0	0	0
FRA	0	0	0	0
SPN	+0.1	0	0	0
UK	-0.1	0	0	0
REU	-0.1	0	0	0
EFT	-0.5	-0.1	-0.2	-0.1
AUS	-0.1	-0.1	0	0
FSU	-0.8	+0.1	+0.2	0
POL	-1.4	0	+0.1	0
CEA	+0.8	0	+0.1	0
RAB	-0.1	0	-0.1	0
CHN	0	0	0	0
IND	+0.1	0	0	0
OPE	-0.1	0	0	0
TAN	0	0	0	0
PER	0	0	0	0
MOR	0	0	0	0
ROW	0	0	0	0
Permit price	2.89	1.08	1.271	1.01

Table 3: Voting outcome with the “Spain” composition

	FSU		AUS		JPN		EFT	
	Vote	$\Delta EV\%$	Vote	$\Delta EV\%$	Vote	$\Delta EV\%$	Vote	$\Delta EV\%$
JPN	no	-0.1	yes	0	yes	0	yes	0
SPN	yes	+0.1	yes	0	yes	0	yes	0
AUS	no	-0.1	no	-0.1	yes	0	yes	0
POL	yes	+1.4	yes	0	yes	+0.1	yes	0
CHN	yes	0	yes	0	yes	0	yes	0
IND	yes	+0.1	yes	0	yes	0	yes	0
TAN	yes	0	yes	0	yes	0	yes	0
PER	yes	0	yes	0	yes	0	yes	0
MOR	yes	0	yes	0	yes	0	yes	0
AOSIS	yes	-	yes	-	yes	-	yes	-
3/4 majority	yes		yes		yes		yes	
Annex I majority	no		yes		yes		yes	
ROW majority	yes		yes		yes		yes	
Outcome	not sanctioned		Sanctioned		Sanctioned		Sanctioned	

ΔEV signifies the welfare change according to the Equivalent Variation measure of welfare.

Table 4: Voting outcome with the “EFTA” composition

	FSU		AUS		JPN		EFT	
	Vote	$\Delta EV\%$	Vote	$\Delta EV\%$	Vote	$\Delta EV\%$	Vote	$\Delta EV\%$
JPN	no	-0.1	yes	0	yes	0	yes	0
EFT	no	-0.5	No	-0.1	no	-0.2	no	-0.1
AUS	no	-0.1	No	-0.1	yes	0	yes	0
POL	yes	+1.4	yes	0	yes	+0.1	yes	0
CHN	yes	0	yes	0	yes	0	yes	0
IND	yes	+0.1	yes	0	yes	0	yes	0
TAN	yes	0	yes	0	yes	0	yes	0
PER	yes	0	yes	0	yes	0	yes	0
MOR	yes	0	yes	0	yes	0	yes	0
AOSIS	yes	-	yes	-	yes	-	yes	-
3/4 majority	no		yes		yes		yes	
Annex I majority	no		no		yes		yes	
ROW majority	yes		yes		yes		yes	
Outcome	not sanctioned		not sanctioned		Sanctioned		Sanctioned	

Table 5 Illustration of the difference between small and large violations: Voting outcomes with Japan 40 % violation and Australia 3 % violation

Voting	Japan		Australia	
	Vote	$\Delta EV\%$	Vote	$\Delta EV\%$
JPN	no	- 0,3	yes	0
AUS	no	- 0,1	yes	0
EFT	no	- 0,5	no	- 0,1
POL	yes	+ 0,7	yes	0
CHN	yes	0	yes	0
IND	yes	+ 0,1	yes	0
TAN	yes	0	yes	0
PER	yes	0	yes	0
MOR	yes	0	yes	0
AOSIS	yes	-	yes	-
3/4 majority	no		yes	
Annex I majority	no		yes	
ROW majority	yes		yes	
Outcome	not sanctioned		sanctioned	

Table 6 Illustration of the isolated effects of each of the two sanction mechanisms on the FSU

Voting	Normal/full sanctioning		Only trading suspension		Only 1.3	
	Vote	$\Delta EV\%$	Vote	$\Delta EV\%$	Vote	$\Delta EV\%$
JPN	no	- 0,1	no	- 0,1	yes	0
SPN	yes	+ 0,1	yes	+ 0,1	yes	+ 0,1
AUS	no	- 0,1	no	- 0,1	no	- 0,1
POL	yes	+ 1,4	yes	+ 1,3	yes	+0.4
CHN	yes	0	yes	0	yes	0
IND	yes	+ 0,1	yes	0	yes	0
TAN	yes	0	yes	0	yes	0
PER	yes	0	yes	0	yes	0
MOR	yes	0	yes	0	yes	0
AOSIS	yes	-	yes	-	yes	-
3/4 majority	yes		yes		yes	
Annex I majority	no		no		yes	
ROW majority	yes		yes		yes	
Outcome	not sanctioned		not sanctioned		sanctioned	

Table 7 Voting outcomes for the FSU with new sanctions

Voting	1.3 with exports		1.6 without exports	
	Vote	$\Delta EV\%$	Vote	$\Delta EV\%$
JPN	Yes	0	yes	0
SPN	Yes	+ 0,1	yes	+ 0,1
AUS	No	- 0,1	no	- 0,1
POL	Yes	+ 0,4	yes	+ 1,0
CHN	Yes	0	yes	0
IND	Yes	0	yes	0
TAN	Yes	0	yes	0
PER	Yes	0	yes	0
MOR	Yes	0	yes	0
AOSIS	yes	-	yes	-
3/4 majority	yes		yes	
Annex I majority	yes		yes	
ROW majority	yes		yes	
Outcome	sanctioned		sanctioned	