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ABSTRACT

Emissions Trading Regimes and Incentives to Participate in International Climate Agreements*

This Paper analyses whether different emission trading regimes provide different incentives to participate in a cooperative climate agreement. Different incentive structures are discussed for those countries, namely the US, Russia and China, that are most important in the climate negotiation process. Our analysis confirms the conjecture that, by appropriately designing the emission-trading regime, it is possible to enhance the incentives to participate in a climate agreement. Therefore, participation and optimal policy should be jointly analysed. Moreover, our results show that the US, Russia and China have different most preferred climate coalitions and therefore adopt conflicting negotiation strategies.

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EMISSIONS TRADING REGIMES AND INCENTIVES TO PARTICIPATE IN INTERNATIONAL CLIMATE AGREEMENTS

1. Introduction

A key issue – perhaps the key issue – in the design and implementation of regional and global international agreements is the participation incentive facing those nations that are considering ratification. For the key nation states involved, it is important that the benefits – economic, environmental, political and social – of ratification and subsequent implementation exceed the costs. In analysing the likely outcome of a given or proposed international environmental agreement, it is useful for those in the policy process to have a means of identifying and assessing the benefits and costs of key actors to a proposal or set of proposals. This requires the development of a model that allows those in the policy process to see some approximation of these outcomes, and to interpret their implications.

This paper uses the area of Climate Change and the associated policy context to demonstrate how this 'incentive mapping' can be used to inform the likely positioning of key players to the choices they face, or those options they may create for themselves. In this context, climate change is of course of great interest in its own right, but the approach can be generalised to other international environmental agreements.

The costs and benefits of climate change policies – as well as those of other international environmental policies – depend upon two main features of the international regime: the set of signatories and the size of their quantitative commitment to control emissions (GHG emissions in the case of climate). It is therefore impossible to assess the costs and benefits of the Kyoto Protocol, or of other potential agreements on climate change, independently of the set of signatories in the agreement and of the way in which the abatement burden is distributed among them. However, the number of signatories is also endogenous and depends on the abatement targets and mitigation polices adopted in various countries.[1]

The link between the design of an international environmental agreement and countries' decision about whether and which coalition they will join has been widely recognised in the game theory literature on coalition formation, though the characterisation is still incomplete (see Carraro, 2003 and Finus and Rundshagen, 2002 for recent surveys of the literature). In particular, several authors (see again Finus and Rundshagen, 2002 for a survey) explore the

[1] Hence the weakness of most of the available literature on costs and benefits of climate change policies, which widely neglects the full interdependency between policies, costs/benefits and membership (more generally, the structure of international agreements).

participation incentives that different policy measures provide to the negotiating countries. This paper focuses exactly on these incentives in the case of climate change and discusses under which conditions it is possible for a climate policy – and in particular for different emission trading regimes – to provide the right incentives for a large number of countries to sign a climate agreement.

Even though it is true that in some cases a partial coalition may achieve more – in terms of emission control – than a global coalition (see Finus and Rundshagen, 1998; Barrett, 2002), the current state of climate negotiations is clearly characterised by an insufficient number of signatories, by an insufficient commitment to climate control and by an uneven distribution of the burden of controlling climate change. Therefore, it is important to identify policy strategies designed not to directly reduce the cost of abating emissions, but mainly to provide the right incentives to join the group of countries committed to climate control (even though not necessarily the grand coalition). In this way, the cost of abating emissions would also be reduced.

Among the possible policy strategies, we focus on emissions trading. The reason is that this is likely to be the most relevant economic policy measure that most countries are going to adopt to control GHG emissions in the coming years (Cf. the EU directive of emission trading or the recent proposal by the US Senate). Therefore, we want to analyse whether different emission trading regimes provide different incentives to participate in a cooperative climate agreement. In particular, this issue will be discussed for those countries, namely the US, Russia and China, that are most important in the climate negotiation process and, for different reasons, are also somehow reluctant to adopt the Kyoto framework.

2. Methodology and Assumptions

The analysis summarised in this paper has been carried out using FEEM-RICE, a modified version of Nordhaus' RICE model (Cf. Nordhaus and Yang, 1996), in which technical change is endogenous and affects both factor productivity and the emission-output ratio. In addition, international technological spillovers are explicitly modelled. In the FEEM-RICE model, six countries/regions (US, EU, Japan, Former Soviet Union, China and the Rest of the World) optimally set the intertemporal values of four strategic variables: investments, R&D, abatement effort and demand for permits. Given the interdependency of countries' decisions, the equilibrium values of these variables are the solution of a dynamic open-loop Nash game between the six countries/regions.[2]

[2] A detailed presentation of the model can be found in Buonanno, Carraro and Galeotti (2002). The results presented in this paper are discussed in more detail in Buchner and Carraro (2003a, b).

Some important assumptions qualify our results. First, it is assumed that all countries/regions which adhere to the Kyoto/Bonn agreement will meet the Kyoto constraints from 2010 to 2050. We therefore adopt the so-called "Kyoto forever" hypothesis (Cf. Manne and Richels, 1999 and many others).[3] Second, our analysis focuses only on CO2. There are other man-made greenhouse gases and the Kyoto Protocol takes some of them into account. In particular, both the Bonn agreement and the subsequent Marrakech deal emphasise the role of sinks in meeting the Kyoto targets. Third, results depend on the GHG allocation given to China, and the associated ensuing volume of 'hot air' accruing thereto. In this paper, we assume that China's emission target coincides with its business as usual emissions, consistently with the claim that developing countries are unlikely to accept binding reduction targets. Therefore, whenever China enters a coalition and reduces emissions below its non-cooperative level, it becomes a net seller of permits.

To analyse the incentives to participation provided by different emission trading regimes, we used the FEEM-RICE model under different assumptions on the number of countries that buy and sell emission permits. Changes in the number of traders modify the equilibrium price and the amount of resources transferred from buyers to sellers. These changes affect all other economic variables in the model, including investments in physical capital and in environmental R&D, which in turn affect the speed of technological change. All these changes and spillovers, both nationally and internationally, modify the incentives for countries to comply with the Kyoto/Bonn agreement and therefore may modify their decision to sign and ratify it.[4]

The particular specification of technological change adopted in this paper and some tests of its robustness are presented in Buonanno, Carraro and Galeotti (2002). It is clear that our results also depend on this specification of technical change – namely on the production function relating price signals emerging from emissions trading, investment in R&D and subsequent innovation – as well as on the magnitude and (especially) the distribution in space and time of costs and benefits of climate change as captured by the FEEM-RICE model. More information on the features of the model are also in Carraro and Galeotti (2003).

[3] The use of the "Kyoto forever" hypothesis is a strong assumption. However, the CO2 concentration levels implicit in this assumption (if RICE is a good description of the world) coincide with those in the A1B scenario (IPCC, 2001) which can be considered the "median" scenario among those currently proposed. In a recent companion paper, we test the robustness of part of our results to different scenarios on emission targets beyond 2012 (Cf. Buchner and Carraro, 2003c).

[4] Our reference to the Kyoto/Bonn agreement is partly imprecise since, for the sake of brevity, we will sometimes call "Kyoto Protocol" or "Kyoto/Bonn agreement" a "Kyoto forever" scenario.

Finally, when assessing the plausibility of our results, please keep in mind that economic incentives are computed within a long-run time horizon (2000-2050) and that this crucially affects the climate strategies of different countries/regions.

In the next section, we analyse how participation incentives are modified, in particular for the US, Russia and China, when the emissions trading regime changes. The analysis presented in the next section is meant to be a specific application of a more general methodological approach designed to identify the links between emission trading and participation in international environmental agreements.

3. Emissions Trading Regimes and Incentives to Participation

3.1 The case of the United States

Let us use, as a benchmark, the original coalition defined by the Kyoto Protocol in 1997, i.e. a group of countries – consisting basically of the EU, the US, Japan and Russia – that cooperate on climate-change control. In this situation, our game-theoretical simulation results show that the US faces very high free-riding incentives, due to very high abatement costs, notwithstanding the possibility to make unrestricted use of emissions trading, which is meant to lower the costs of climate-change control.

These high free-riding incentives have actually led to the US decision to withdraw from the Kyoto Protocol in its current form, blaming it for incurring significant costs on the US economy and for failing to involve the developing countries. The climate coalition therefore became smaller, including the remaining Annex B countries (basically the EU, Japan and Russia).

At first sight, the incentives for the US to rejoin an emissions trading scheme among the Annex B countries are obviously very low. However, the change of the emissions trading regime induced by the US defection has important effects on both the US and the remaining Annex B countries. These effects may induce other policy changes and thus further modify the incentives to participate in a climate agreement.

As a consequence of the US withdrawal from the Kyoto Protocol, the demand, and thus the permit price in the emissions market, fall and induce lower incentives to invest in energy saving R&D in all countries.[5] The US R&D sector therefore suffers from the decision not to participate in the Kyoto Protocol and these lower investments spill over onto the world economy. In addition, the lower total emission abatement induced by the US defection (i.e.

[5] See Buchner, Carraro and Cersosimo (2002) for a detailed analysis.

the higher environmental damage) reduces output below its optimal level. This reduction is further enhanced by the presence of endogenous and induced technical change. A lower R&D effort, in combination with the increased emissions, implies both more damages from climate change and a lower growth rate of output in all countries.

Despite these negative effects, on the whole, welfare in the US and the other Annex B countries increase after the US withdrawal. The reason is that the US strongly reduces its abatement levels, whereas the other Annex B countries maintain their abatement levels, but pay very low abatement costs, thanks to the fall of the permit price.

The current situation, however, is not environmentally sound. Any type of effective strategy to tackle the global problem of climate change ought to be based on a global approach, involving as many countries as possible, and accounting in particular for the large producers of greenhouse gases. Therefore, incentives need to be found in order to induce the US, the world's largest CO2 producer, and other key players, to participate in the international efforts to control climate change.

Let us analyse the participation incentives provided by other, presently counterfactual, climate regimes. It is clear that the US is more likely to participate if abatement costs are smaller and if the main developing countries also participate. Therefore, US participation may be favoured by the participation of a large, low-abatement cost, developing country. As an example, let us evaluate the impact on the US economy of China's decision to ratify the Kyoto Protocol and of China's (counterfactual) possible participation in a permit market with the EU, Japan and Russia.[6] In this scenario, we assume that China's emission targets coincide with its BAU emission levels. Let us start with the case in which China participates but the US does not.

The participation of China in the emission market (without the US) further reduces the permit price and thus abatement costs in all participating countries. Hence, incentives to abate are smaller and investments in climate-related technical change become smaller. This has two negative impacts on the US economy. First, the US experiences higher damages from climate change because of the total higher GHG emissions. Second, the US misses the opportunity to abate its own emissions at the much lower marginal cost (permit price) that the participation of China yields. Are these two effects sufficient to induce the US to change its mind and ratify the Kyoto Protocol?

[6] Only the EU and Japan have already ratified the Kyoto Protocol. Russia's climate policy is more ambiguous. See Section 3.2 below. As it stands now, 119 countries have ratified the Kyoto Protocol. The 119 countries account for 44.2 percent of carbon dioxide emissions, and Russia's 17.4 percent would push the tally over the 55 percent requirement.

If the US participates, the emissions trading regime includes the EU, Japan, Russia, China and the US. In this scenario, the two negative effects previously emphasised are offset. On the one hand, the US participates in a permit market where the equilibrium price is quite low (even though slightly larger than in the absence of the US participation). On the other hand, total emissions are much lower and therefore the US suffers smaller damages from climate change. However, the US total welfare does not increase. The net loss is small because China supplies permits at a low price and because total emissions decrease. However, this is not sufficient to increase US total welfare with respect to the case in which the US free-rides. Therefore, the decision of China to ratify the Kyoto Protocol creates indeed a new environment in which it could be easier for the US to re-join the Kyoto climate coalition. However, the new incentives provided by China's participation are not sufficient to yield a positive change of US welfare when they commit to their "Kyoto forever" target.

Nonetheless, being the loss quite small, political reasons could induce the US to move back to the Kyoto negotiations in order to reap the benefits of low short-term abatement costs and to negotiate less demanding abatement targets in the second commitment period. However, having recognised that China's participation is very beneficial to the US, this country could be tempted to negotiate directly with China a deal to reduce GHG emissions through a bilateral trading market. The same incentives exist for a bilateral deal with Russia.

The next step in the US climate strategy could thus consist in offering a partnership to large emission permit suppliers, e.g. Russia or China. In order to improve their performance in the emission market, the US could offer Russia or China better conditions than the ones offered by the EU and Japan. Let us therefore analyse these two scenarios.[7]

Let us first focus on a fragmented emissions trading regime in which two permit markets form. In the first one, the US trades with Russia, whereas in the second one the EU trades with Japan. For the moment, it is assumed that China does not participate. In this trading regime, EU and Japan are worse off, because they pay a much higher permit price and therefore suffer high abatement costs. Russia is also worse off, because the permit price in its own permit market becomes smaller than in the current regime. And the US is worse off because, even at lower costs, high abatement levels are not profitable. Therefore, even though the US can take advantage from Russia's "hot air" in the first commitment period, its costs increase because they increase their abatement effort with respect to the free-riding abatement effort in the current situation. A climate regime based on this fragmented emissions trading scheme is thus unlikely to emerge, because of the lack of economic incentives, even though

[7] A more detailed analysis is in Buchner and Carraro (2003b).

the global impact on GHG emissions of the two blocs of countries is larger than the one achieved by the Annex B_{-US} coalition (Cf. Buchner and Carraro, 2003b).

Let us analyse the other scenario in which the US and China participate in a bilateral trading market, whereas the EU, Japan and Russia remain committed to their Kyoto obligations and trade among themselves.

From a political perspective, this emissions trading regime appears to have a higher probability of emerging, because the US is unlikely to break the Annex B_{-US} bloc – both for political reasons and for the lack of economic incentives – and in addition they consider the involvement of developing countries in a cooperative climate regime as crucial to achieving long term goals. Without binding commitments, China is a very attractive partner in climate change control activities. The US could thus negotiate an agreement with China, in order to trade emission permits at a low price, thus reducing abatement costs.[8]

The fragmented emission trading regime in which the US and China sign a bilateral deal leaves the Annex B_{-US} countries fairly indifferent. In the Annex B_{-US} permit market the price is only slightly modified by the presence of the other permit market and thus the incentives to invest in climate-friendly technology are not modified. In the permit market where the US and China trade, the permit price is smaller and therefore abatement costs are also smaller. However, both the US and China lose with respect to the case in which they free-ride. The reason is that, albeit small, abatement costs are still above benefits.[9] However, the loss for the US is small and could be largely compensated by some ancillary benefits from GHG emission abatement. In addition, due to the overall lower emissions than in previous climate regimes, the consequent welfare loss would be the smallest among those attained by the US when it participates in a climate coalition.

Summing up, our results suggest that no emission trading regime is likely to provide the US with the right incentives to participate in a cooperative effort to control GHG emissions. However, the US's best strategy would be to offer China a bilateral deal to cooperatively reduce GHG emissions through the bilateral trading of emission permits.

[8] There is some evidence that a bilateral cooperation between China and the US may not be unrealistic. Ever since the US and China normalised their diplomatic relations in the late 70s, cooperation on environment, science and technology matters has been a mainstay of U.S.-China relations (For more information see http://www.usembassy-china.org.cn/sandt/BilateralActivities.html). In February 2002, Presidents George W. Bush and Jiang Zemin agreed to establish a U.S.-China Working Group on Climate Change which now promotes and monitors bilateral research cooperation on climate change focusing on various key areas of policy and science.

[9] At least as far as benefits are correctly assessed by the FEEM-RICE model. See Buchner and Carraro (2003b) for a discussion.

3.2 The case of Russia

Russia's behaviour in the recent climate negotiations constitutes a good example of the important effects that different emissions trading regimes may have on participation incentives. It is well-known that the emission limits set by the Kyoto Protocol imply excess emission rights for Russia, which are commonly called "hot air". Provisions in the protocol allow the sale of these rights to countries in search for low-cost abatement options. Furthermore, they can also be "banked" for later periods. Russia represents thus the main seller of emission permits in the Kyoto regime, at least in the first commitment period.

It can be argued that "hot air" is nothing more than a participation incentive provided by the implementation of emission trading. In the scenario that emerged from the Kyoto Protocol – a climate coalition formed by the EU, the US, Japan and Russia – emissions trading reduces Russia's incentives to free-ride, because Russia can gain from the windfall profits resulting from the permit sales. The permit price in this emissions trading regime is high due to the strong demand from the US. As a consequence, being the only permit seller, this high permit price induces Russia to over-invest in emission abatement, e.g. through R&D investments, in order to increase its supply of emission permits.

However, after the US withdrawal from the Kyoto Protocol, the situation changed drastically for the Annex B_{-US} countries, and in particular for Russia. The defection of the largest CO2 producer and thus greatest permit demander had two relevant consequences. First, the permit price has fallen, thus reducing Russia's benefits from participation in a climate regime. Second, the 55% provision of the Kyoto Protocol has become increasingly binding[10]. As a consequence, Russia's bargaining power in the negotiations has increased and at the last Conferences of the Parties, notably in Marrakech, Russia was able to exploit this increased bargaining power by further reducing its obligations and/or the related costs. Russia thus faces different incentives with respect to the participation in the agreement than some months ago. And these incentives depend on its bargaining power and on the carbon abatement costs resulting from the US withdrawal from the Kyoto/Bonn agreement and the related emissions permit market.

The change in Russia's incentives to participate is also proved by the continuous delay in the decision to ratify the Kyoto Protocol. In March 2002, the Russian Energy Minister Igor Yusufov announced that Russia intends to ratify the Kyoto Protocol soon (RBC network, March 11th, 2002). However, some weeks after this announcement, Russia emphasised that its ratification is far from ensured and depends heavily on both the EU and Japan's future

[10] A precondition for the Kyoto Protocol to come into force is that at least 55 Parties to the Convention, representing at the same time at least 55% of 1990 carbon dioxide emissions of Annex I Parties, must have ratified the treaty.

strategies. Russian government officials said that Russia may delay ratification of the Kyoto Protocol until these countries give their official consent to buy carbon dioxide emission credits from Russia (Financial Times, March 22nd, 2002; Yomiuri Shimbun, March 28th, 2002). More recently, several contradictory statements have characterised the position of the Russian government on the time and conditions for Russia's ratification of the Kyoto Protocol. On April 22, 2003, the Russian Ministry of Economic Development and Trade concluded that the Kyoto Protocol would yield no economic benefits for Russia, hinting that Moscow has no economic grounds for ratifying the treaty.[11]

This was confirmed at the recent Climate Change Conference, held in Moscow from September 29th to October 3rd, 2003. President Putin's opening address explained that Russia's position had considerably changed during the last year. Putin said that Russia has not made a decision on whether to ratify the Kyoto Protocol and will not do so until it had finished studying the implications that ratification would have for the country, looking also at the benefits that could arise from global warming to a northern country like Russia: "The government is thoroughly considering and studying the entire complex of difficult problems linked with it. A decision will be made only after this work has been completed and it will be made in accordance with the national interest of the Russian Federation." (RFE/RL, Sept. 29th, 2003). The insistence that more research is needed seems to represent a further piece of Russia's strategic bargaining strategy, rather than indicating that it does not intend to ratify the Kyoto Protocol at all[12]. The debate on Kyoto is still ongoing in Russia, as recent official announcements that Kyoto will be ratified in 2004 clearly indicate (Dow Jones Newswires, Oct. 28th, 2003), This is also because Russia's industry and NGOs both seem to be in favour of ratification[13].

The above contradictory signals can be interpreted as a lack of a clear strategy in view of the missing incentives provided by the current perspectives on emissions trading and on the permit price. Alternatively, they can be interpreted as a strategy designed to increase the price for Russia's participation, given the absence of transfers through the permit market. In both cases, the functioning of the permit market is strongly affecting Russia's participation incentives.

[11] Japan Today, 22.4.2004 (http://www.japantoday.com/e/?content=news&cat=1&id=257445).

[12] The link between Russian emission credits and the European emission trading system appears to play a key role vis-à-vis Russia's official position.

[13] In particular, Russian industries see the potential benefits arising from joint projects where European countries invest in the introduction of cleaner technologies in Russian plants (see e.g. The International Herald Tribune, Oct. 28th, 2003).

Is there a scenario that could be more in favour of Russia's participation? Can Russia be induced to ratify by the participation of other countries in the emission permit market? Let us analyse the incentives emerging from the climate coalition consisting of the EU, Japan, Russia and China. The participation by China implies a lower permit price in the emission market and the presence of a second, even larger, permit supplier. As a consequence, Russia reduces its revenue from selling "hot air", and the lower profits imply a decrease in its welfare. Furthermore, due to the entry of China, Russia faces lower incentives to undertake strategic R&D. As a consequence, Russia lowers its investments in R&D by more than 60%.

If the participation of China could induce the US to rejoin the climate coalition – which would be formed by the EU, the US, Japan, Russia and China – Russia could profit from the larger emission market. The demand for permits increases because of the US participation in the trading market, resulting in a net increase of the permit price. However, China increases the supply of permits as well, and replaces Russia as the main permit seller. Notwithstanding a permit price higher than in the previous climate coalition – which implies higher profits from "hot air" sales – Russia is the main loser in this enlarged climate coalition. The participation of China in the trading regime is sufficient to induce Russia not to participate.

Russia could be tempted to adopt other strategic reactions, because it is aware that its defection would imply a large increase in the abatement costs of the two key players, EU and Japan. In particular, Russia could try to offset the decline of profits from selling permits by establishing bilateral deals with some other countries.[14] For example, since the EU and Japan are highly penalised by an eventual defection by Russia, they have a strong incentive to adopt policies to keep Russia in the coalition. This is particularly true for the EU which suffers much more from the FSU defection than from the Japanese one[15]. Russia has also a strong interest in intensifying its relationships with Europe, not only in order to improve its economic performance, but also to strengthen its political role within the larger European unification. A cooperation on climate policy could demonstrate that Russia is indeed willing and prepared to bear responsibility and could thus constitute an important step into the direction of Western Europe. Therefore, a scenario in which the EU and Russia closely cooperate on climate seems to be likely, whereas there is increasing emphasis in Japan in favour of regional economic cooperation in East Asia and above all with China. Therefore, Japan, within its efforts to foster cooperation with China, could also propose a deal concerning GHG emission reduction.

[14] Recent studies suggest that bilateral deals -- in the form of early Joint Implementation -- between Russia and the EU or Japan could occur in order to maximise Russia's welfare and thus ensure its participation in the climate coalition even after the US defection. For further details see e.g., Egenhofer, Hager and Legge (2001) and Egenhofer and Legge (2001).

Let us therefore analyse the incentives set by a scenario in which the European Union and Russia establish a bilateral deal, whereas Japan cooperates with China. The lack of Japan's demand for permit implies that Russia becomes the main loser of this fragmented emissions trading regime. Facing a low demand, the permit price declines strongly and Russia suffers a significant welfare loss. On the other hand, Japan benefits from cooperation with China, because its abatement costs become lower.

In short, Russia is still facing the strongest incentives to put pressure on the US to come back into the Kyoto framework in order to get the largest demander of their permits back. As a consequence, Russia could be tempted by a US offer to cooperate on climate change activities outside the traditional Kyoto framework.[16] What would be the incentives provided by an emissions trading regime in which the US and Russia cooperate without the EU and Japan, while these two countries remain committed to their Kyoto obligations? Russia's welfare would decrease because marginal abatement costs in the US are lower than in Japan and the EU. Therefore, the permit price in the US-Russia market is lower than in the Annex B_{US} market. As a consequence, Russia reduces its revenue from selling "hot air".

The last scenario worth considering is the one in which the US and China sign a bilateral deal on climate policy, whereas Russia keeps cooperating (and trading permits) with the EU and Japan. This scenario was previously analysed from the view point of US participation incentives and shown to be the most attractive for the US. From Russia's viewpoint this scenario is not very interesting. The inclusion of China in a coalition with the US is beneficial for the European Union, Japan and Russia, because of the enhanced environmental effectiveness of this two bloc emission trading regime. However, the permit price in the EU-Japan-Russia market is slightly affected by the emergence of a second permit market and Russia remains with poor incentives to participate.

Summing up, the best emission trading regime for Russia is the one that would have formed out of the Kyoto agreement. The most profitable situation is indeed the one in which Russia trades with the EU, Japan and the US. In this situation, the permit price is the highest, because of the US high demand for permits, and Russia gets the highest profits from selling its own excess GHG emissions. All emissions trading regimes in which either the US does not participate or China participates are likely to reduce Russia's welfare.

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[15] For further details see e.g. Egenhofer and Legge (2001), Buchner and Carraro (2003a).

[16] The United States and Russia said on January 17th, 2003 that they would seek a common approach to battling global warming (Agence France-Presse, Jan. 17th, 2003).

3.3 The case of China

In August 2002, at the World Summit on Sustainable Development in Johannesburg, China announced its decision to ratify the Kyoto Protocol, confirming thereby its willingness to participate in the Kyoto framework and demonstrating that the country is getting serious about international cooperation to address climate change. Despite the lack of an explicit target for its future GHG emissions[17], China's decision to ratify the Kyoto Protocol is in general considered as an important boost to the domestic and international process to control climate change. What incentives have induced China to join the international efforts to reduce GHG emissions? Are there other emission trading regimes that could provide better participation incentives and a higher level of welfare in China?

The main economic incentive for China to join the climate coalition consisting of the EU, Japan and Russia derives from the incentive to replace Russia as the largest permit seller in the emission permit market. Nonetheless, in this regime China would lose out in comparison to the alternative in which this country free-rides on the other countries' emission reductions. The balance of the two effects – larger abatement costs and profits from selling permits – is a small welfare loss that could easily be overcome by the presence of ancillary benefits, both on the environmental and economic side. This could explain China's decision to ratify the Kyoto Protocol. A peculiar feature of this scenario, which confirms China's interests in participating in this regime, is the large expansion of China's R&D investments. The reason is twofold. Firstly, in order to be consistent with the Kyoto Protocol and prepare for future binding emission targets, China increases its R&D efforts to achieve its desired emission abatement. Secondly, and more importantly from an incentive-based viewpoint, China – like Russia in the Annex B_{-US} coalition – over invests in R&D to increase its sales in the emissions trading market. Indeed, by strongly investing in technological innovations, China can further exploit its position of largest permit seller and can thus make significant profits in the permit market.

However, the scenario in which China joins the coalition formed by the EU, Japan and Russia is not the optimal one for China. This country could highly benefit from trading with the US, because of high US abatement targets and high abatement costs. If the US could be induced to join the emission trading regime, China would be the big winner. China would profit from a very large permit market, where it could supply an even larger amount of permits than in the scenario previously examined. As a consequence, China's permit supply would be enhanced by strong strategic over-investments in R&D. In this emissions trading regime, China would

[17] China demonstrated to be open to exploring possibilities to cooperate under the Kyoto agreement, in the short run primarily with respect to financial and technical aid deals. Chinese officials emphasise that the government will voluntarily try to restrict the growth of CO2 emissions, but is strictly opposing binding GHG reduction targets (The Japan Times, Jan. 26th, 2002).

be the main permit seller on the emission market and would experience the highest welfare gain among the participating countries.

Given the strong incentive for China to cooperate with the US, and the clear political and economic motivations for the US to collaborate with large developing countries like China, a joint climate pact between these two countries could be the optimal option for both of them. We have already seen that this is the best option for the US. However, this is not the case for China, that prefers a larger global coalition and, as a consequence, a larger permit market. Even though permit trading with the US only would benefit China, this country would benefit even more from a coalition in which the EU, Japan and Russia are also included. Under the long run perspective adopted in this paper, this scenario is China's most advantageous one, because in this scenario China could reap the benefits from establishing a large emission permit market.

A final scenario to be examined is related to the increasing emphasis in Asia in favour of regional economic cooperation. China has repeatedly expressed its interests to enhance cooperation with Japan and therefore Japan and China could establish a bilateral deal on climate change control[18]. There would be two emission permit markets. One where China and Japan trade, and one where the EU and the FSU trade. China would benefit from being the unique permit seller in this regional market. However, this benefit is smaller than the one deriving from cooperation with the US and even smaller than the one deriving from the emergence of an almost global climate coalition.

Summing up, the emissions trading regime that provides the highest incentives for China to participate in a climate coalition is the one in which a large coalition forms. In this scenario, China benefits from three incentives. First, given the absence of binding commitments and given the high amount of "hot air" which can be expected from this region, China replaces Russia as the main permit supplier on the emission permit market. Second, China is aware that the benefits from participating in an emissions trading scheme are particularly high if the largest permit demander, the US, also belongs to the climate coalition. Third, China's incentives to join an emissions trading regime depend on whether the scheme has a regional or a global scope. Again the reason lies in its position of largest permit supplier, which implies that China's profits increase with the size of the market.

[18] China has officially demonstrated its "strong expectations of advanced Japanese environmental protection technologies to combat its own environmental problems", and therefore a "win-win case" could be established if China could improve its environmental quality with Japanese assistance, while Japan could reach its Kyoto emissions reduction target at lower costs by cooperating with China (The Japan Times, Jan. 26th, 2002).

4. Conclusions

This paper has discussed the participation incentives provided by different emission trading regimes. In particular, we focused on three countries, the US, Russia and China, whose role is particularly relevant in the negotiation process leading to climate change control.

Our analysis confirmed the conjecture that different emission trading regimes provide different participation incentives, and that participation and optimal policy have to be jointly determined. Moreover, our results showed that the US, Russia and China are characterised by quite different participation incentives.

The emission trading regime that provides the highest economic incentives for the US to participate in a coalition to control climate change is the one in which the US trades with China in a bilateral market, whereas the EU, Japan and Russia trade in a second emission permit market. As for Russia, the highest participation incentives are provided by the original Kyoto coalition, namely an emissions trading regime in which the US, the EU, Japan and Russia participate, and in which Russia is the main permit seller. Finally, China also prefers to participate in emissions trading markets where demand is large and therefore where the US, the EU and Japan trade. However, whereas Russia would be damaged by the presence of China, China would benefit by the presence of Russia, because Russia in the last commitment periods (adopting a long-run policy perspective) becomes a permit buyer.

These differences in participation incentives make it difficult to predict the future evolution of climate negotiations. Whereas the US would benefit from bilateral deals with China and/or Russia, these countries prefer large emission permit markets where they can sell the excess emissions, i.e. a large single coalition. Whereas China would like to participate in the largest possible coalition, Russia would prefer to exclude China from the market and therefore from the climate coalition. Whereas the EU and Japan benefit, from an economic viewpoint, from cooperation with China and/or Russia, without the US in the market, China, and above all Russia, need the US to sell their excess emissions at a high market price.

Therefore, the incentive structure identified using the FEEM-RICE model – and obviously dependent on its assumptions – supports a prospective scenario in which the US will offer bilateral deals to China and Russia and in which these two countries may be tempted to accept the US offer, although this does not represent their first best option. As a consequence, the EU and Japan have a strong interest in implementing strategies that accelerate the commitment process by Russia (and partly by China) in order to achieve an equilibrium, which is not their first best, but prevents the emergence of situations, e.g. the US-Russia or US-China bilateral deal, which could be even worse for the EU and Japan.

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