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Credibility of Trade Sanctions in Greenhouse Gas Mitigation Agreements in Agriculture and Forestry

by

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Abstract

This study explores under what conditions a trade sanction can be an effective enforcement mechanism used by the US against China in global greenhouse (GHG) mitigation dilemma. The problem has the structure of prisoner's dilemma and hence both the US and China have incentive to free-ride in GHG emissions abatement. It is found that if the US joined the rest of the world (ROW) in emissions abatement, the US could also convince China to comply with abatement using trade sanctions. As long as the carbon prices do not exceed certain threshold values, the trade sanction threat by the US on imports from China is credible.

Introduction

The Emissions Gap Report (UNEP, 2010) by the United Nations Environment Programme shows that the 1997 Kyoto Protocol will not be as effective as expected in moderating climate change. This is an expected result considering the fact that the US and China, the two largest contributors to the global greenhouse gas (GHG) emissions[1], are yet to start controlling their emissions. China is not abating its emissions because the Kyoto protocol exempts China and other developing countries (called non-Annex 1 countries) from abatement responsibilities. The US is not abating its emissions because even though President Clinton signed the protocol in 1997, the Bush administration rejected the treaty because it exempts the non-Annex 1 countries, including China.

The real reason why the US and China are not abating is because the Kyoto protocol (or any other international environmental agreement designed to curb GHG emissions) has the structure of the well-known prisoner's dilemma: while the social optimum is achieved when nobody free-rides, all players have incentives to free-ride. As the world's two largest GHG emitters, the US and China are the two most important players in this dilemma and their actions are consistent with the prediction, i.e., they do not mitigate their emissions. If the US and China

[1] See McKibbin (2008).

both abated their emissions everyone on Earth would be better off. However, if only the US reduced its emissions, the required capital expense would make US-manufactured goods more costly and hence the US would be less competitive in the international marketplace. Similarly, if only China abated its emissions it would face the same problem. As a result, the game between the US and China is nothing but a standard prisoner's dilemma and they both have incentive to free-ride.

To achieve the social optimum some kind of enforcement mechanism is required. Barrett (2003) posits the lack of enforcement mechanism within the Kyoto protocol as a central reason of its ineffectiveness. Trade sanctions might have provided the enforcement mechanism. Indeed trade sanctions have been used as an enforcement mechanism in the case of the Montreal Protocol. Specifically, to control Ozone Depleting Substances (ODS), countries signed the Montreal Protocol which included enforcement mechanisms including trade restrictions on ODS and ODS-containing products with non-parties and the threat to ban trade in products containing ODS. Although the two problems, i.e., control of the ODSs and the GHG mitigation, have fundamental differences[2], herein it is hypothesized that trade sanctions may constitute an effective enforcement mechanism to sustain compliance in the context of agreements to curb global greenhouse gas (GHG) emissions.

Trade sanctions are an effective tool as long as they are incentive compatible for the countries; i.e. as long as their benefits are greater than their costs to the implementing country. In this study, effectiveness of trade sanctions is tested under different abatement policy scenarios using the GTAP-AEZ-GHG model (Golub et al., 2009). Like Barrett (1997), trade sanctions are considered as a deterrent to free-riding. The following questions are answered in this study: if the US accepts to abate its emissions with ROW, can the US use trade sanctions against China to convince her to comply? Under what conditions is a threat of tariff by the US against China credible?

[2] Barrett (2007) lists the differences between the two problems. One difference is that in depletion of the ozone layer problem, everyone on Earth is affected in same way, i.e., they all become worse off. In the global warming problem, on the other hand, different regions are affected by the problem in different ways, at least in the short term. For instance, while some regions become worse off because of sea level rise, some regions become better off with the help of agricultural activities becoming possible in those regions that used to be unqualified for such activities.

2. Literature Review

The existing studies of trade sanctions and international cooperation either utilize a static modeling framework (Barrett, 1997; Alpay, 2000) or Computable General Equilibrium (CGE) models (Kemfert, 2004). Barrett (1997) considers trade sanctions as a deterrent to free-riding and the author shows how trade sanctions in a multilateral environment agreement (MEA) such as the Montreal Protocol can work as a credible threat to deter free-riding and sustain cooperation. Alpay (2000) uses a general equilibrium model with a game theoretic component to show under which conditions international trade can stimulate GHG mitigation.

Kemfert (2004) investigates a mechanism which gives incentives to the biggest GHG emitter, to the USA to reduce its GHG emissions. Kemfert, Lise and Tol (2004) study effects of international trade and carbon leakage[3] on countries' coordination in GHG emissions mitigation efforts. In the first part of the work, the authors build their model which assumes that there are three determinants of the GHG abatement cost of a country: (1) its own abatement efforts, (2) other countries' abatement efforts (because of carbon leakage), and (3) abatement costs of other countries (because of international trade). Since their analytical analyses give ambiguous results, the authors run simulations to estimate the effects of international trade and carbon leakage on carbon emissions efforts and cooperation between countries. To run the simulations, the authors use WAGEM (Kemfert, 2000) which is a static computable general equilibrium (CGE) model based on GTAP data of 1995. Among the 11 regions, it is assumed that only the US, EU, and Japan are involved with the GHG emissions mitigation problem and the rest of the regions which are dummy players do not abate their emissions. 14 simulations are run which differ along two dimensions: number of participants (7 possibilities including full participation of all three regions, single region, and two regions out of three) and abatement target (reducing emissions by 10% or 20% in comparison to the base year emissions, 1990). The simulations, however, do not give crystal clear results because of limitations of the model like building a static model for a dynamic problem, or considering limited number of regions for a global problem. Nonetheless, the authors find that if spillover effects are driven by the abatement costs of other countries, then incentives to cooperate are as weak as if there were no spillovers at all. On the other hand, if spillover effects are driven by the abatement efforts of other countries, then incentives to cooperate are stronger than the case of without spillovers.

[3] See Elliott et al. (2010) for another recent study about carbon tax and leakage.

McKibbin et al. (2008) introduce a mechanism which is called the McKibbin-Wilcoxen Hybrid approach, to allow China both to grow and help prevent the tragedy of GHG commons, at the same time. Naghavi (2010) investigates the impact of a World Trade Organization withdrawal of trade concessions against non-abating countries. The author shows that trade sanctions can be effective when environmental and trade policies are endogenous.

A very recent study by Devarajan, Go, Robinson, and Thierfelder (2011) compares three different tax instruments which are all reducing CO_2 emissions by 15% in South Africa. The instruments are a direct tax on carbon emissions, a proxy tax on energy commodities (coal, petroleum, and electricity) and a proxy tax on emission-intensive commodities. Unlike other study by Fullerton (2001) which is making the same comparison, Devarajan et al. (2011) make their analysis including the preexisting distortions in the labor market of South Africa. The authors find the following three results: (1) a direct tax on emissions causes the least welfare losses. (2) Welfare losses are very sensitive to pre-existing factor market distortions. (3) Three tax instruments order in different rank in terms of effects on equity from the rank they have in terms of welfare losses. Although, the proxy tax on energy commodities is the second best instrument in terms of the welfare loss effects, it is the least regressive one in terms of equity effects.

McEvoy et al. (2008) experimentally investigate problems in maintaining compliance in stable coalitions. The authors' theoretical model suggest that introducing a member-financed enforcement mechanism into a coalition may increase compliance and hence contribution to the public good. The authors test this hypothesis by running a series of experiments and they find that the experimental results reject the hypothesis that member-financed enforcement within a coalition increases contribution to the public good. Another result that the authors find is that increasing participation threshold decreases average contribution to the public good because of decrease in frequency of coalitions to occur. "Improving coalition formation and compliance within coalitions requires a higher participation threshold, perhaps full participation, and more stringent enforcement than suggested by theory."

In the climate change literature[4], there are two distinct approaches commonly used to determine how much action is needed to price or to control GHGs in the short-term and longer

[4] See Aldy et al. (2010) for a literature review.

term in a global level. The first approach is the welfare maximizing emissions pricing approach which weights benefits and costs of slowing global warming and determine the optimal climate policy by comparing their welfare effects. The most popular studies in this field are William D. Nordhaus' "DICE Model" (Nordhaus, 1994) Nicholas Stern's "Stern Review" (Stern, 2007). Unlike other studies in the literature[5] the DICE model and Stern Review consider damages from extreme warming scenarios.

The second approach in climate change literature is the cost-effectiveness approach which looks for the optimal climate policy which is minimizing costs of mitigating GHG emissions to an ultimate target. The "bottom-up", the "top-down" approaches[6] and their hybrids are the approaches used in the cost-effectiveness analyses.

3. Simulations

3.1. The GTAP-AEZ-GHG Model

The GTAP-AEZ-GHG model developed by Golub et al. (2009) is used to investigate the consequences of different abatement policy scenarios. The GTAP-AEZ-GHG model uses the cost-effectiveness approach and is built to analyze computable general equilibrium (CGE) estimates of global land-use and GHG abatement potential between 2000 and 2020. In the model, there are 24 sectors in three regions: USA, China, and the Rest of the World (ROW). The agricultural sectors in the model are Paddy Rice, Other Grains, Other Crops, Ruminants, and Non-Ruminant Livestock. The simulations are run in WinGEM and the equivalent variation (EV) is used to measure changes in welfare of the regions.

3.2. Abatement Policy Scenarios

With the help of the GTAP-AEZ-GHG model, different abatement policy scenarios can be tested. The scenarios considered in this study differ from each other whether a carbon tax is imposed on agricultural and/or non-agricultural goods and whether a forest carbon sequestration subsidy is included or not. Table 1 lists the seven abatement policy scenarios considered. In scenario 1, in addition to forest carbon sequestration subsidy a carbon tax is imposed in both agricultural and non-agricultural goods. In scenarios 2 and 3, the non-agricultural and

[5] Fankhauser (1995), Mendelsohn and Williams (2004, 2007), Tol (1995, 2002).

[6] See Burniaux et al. (2002) for a comparison of the bottom-up and top-down approaches.

agricultural sectors are respectively left out of the taxation. Scenario 4 is representing the case when potential of forest carbon sequestration is ignored while both agricultural and non-agricultural goods are subject to carbon tax. The consequences of each of the three policy elements, namely carbon tax on non-agriculture, carbon tax on agriculture, and forest carbon sequestration, are explored separately in scenarios 5, 6, and 7, respectively.

Table 1 – Description of the Policy Scenarios

Scenarios	Carbon Tax in Non-Agriculture	Carbon Tax in Agriculture	Carbon Sequestration Subsidy
1	+	+	+
2	-	+	+
3	+	-	+
4	+	+	-
5	+	-	-
6	-	+	-
7	-	-	+

3.3 Methodology

At a given carbon price, the EV of the US when China free-rides in global abatement is compared with the EV when China does not free-ride. It is found that cost of abatement to the US is always lower when China does not free-ride. In other words, the simulations show that abatement policies in China always favor US economy. Emissions taxes on agriculture and forestry in China, for instance, favor US farming because emissions intensities of the US are relatively lower than China's, especially in paddy rice and ruminant livestock production (Golub et al, 2009). Therefore, an emissions tax in those sectors in China reduces supply of those goods and hence increases China's food imports from the US which leads to a welfare gain for the US.

Since US benefits from China's climate policies, US has incentives to use enforcement mechanism against China to abate. One option for the US may be to threaten China with tariffs, i.e., the US declares that it is going to impose a certain rate of tariff on the entire tradable commodities imported from China. However, such a threat is credible as long as the cost of abatement to China is less than the welfare loss because of trade barriers built by the US on Chinese commodities. Furthermore, for the US, the cost of the threat should not exceed its benefits.

The methodology of this study is illustrated by using scenario 2 as an example. In scenario 2, i.e., the case of a carbon tax on agriculture and forestry, a credible tariff rate is investigated by initially assuming that the global carbon price is $100 per tons of carbon equivalent (TCE) [7] and by varying the tariff rate, at 1% increments, Figure 1 illustrates China's EV with tariff rate the US imposes on the entire imports coming from China. As the US increases its tariff rate China's EV decreases. However, when the US sets its tariff rate at 21%, China's welfare loss due to abatement ($15,455 US million) becomes less than the welfare loss due to US tariff ($15,628 US million). In other words, under the assumption that both ROW and USA are implementing abatement, US has to impose a tax of 21% on tradable goods imported from China in order to convince China for abatement.

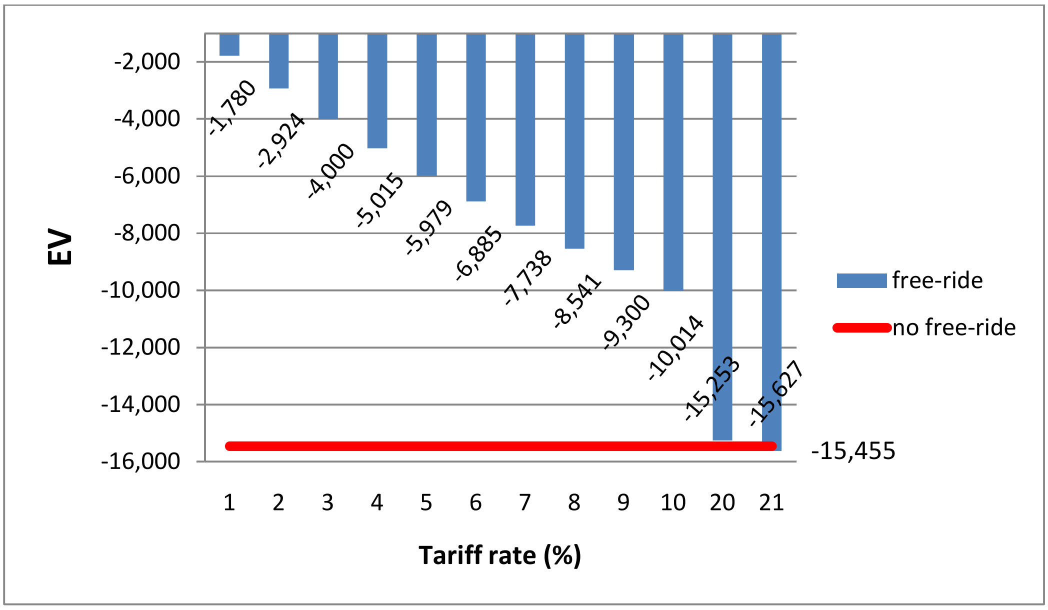

Figure 1 - China's EV under USA tariff ($ US million) and $100/ TCE carbon tax on agriculture and forestry

However, the results illustrated in Figure 2 show that the 21% tariff is not a credible threat. Figure 2 shows how USA's EV changes with the tariff rate imposed on goods imported from China. At 10% tariff rate, the total welfare loss in the US ($4,632 US million) exceeds the welfare loss when there was no trade barrier and China was free-riding ($4,607 US million). This means that, any tariff rate more 10% would reduce the US welfare below the level of welfare where there was no tariff. Therefore, although the US becomes better off with other regions'

[7] To convert $ per ton of carbon to $ per ton of CO2, multiply by the ratio of molecular weights, 44/12=3.67, i.e., $3.67/TCE = $1/TCO2E

abatements, threatening regions with tariff on entire tradable commodities cannot be a credible tool for the US.

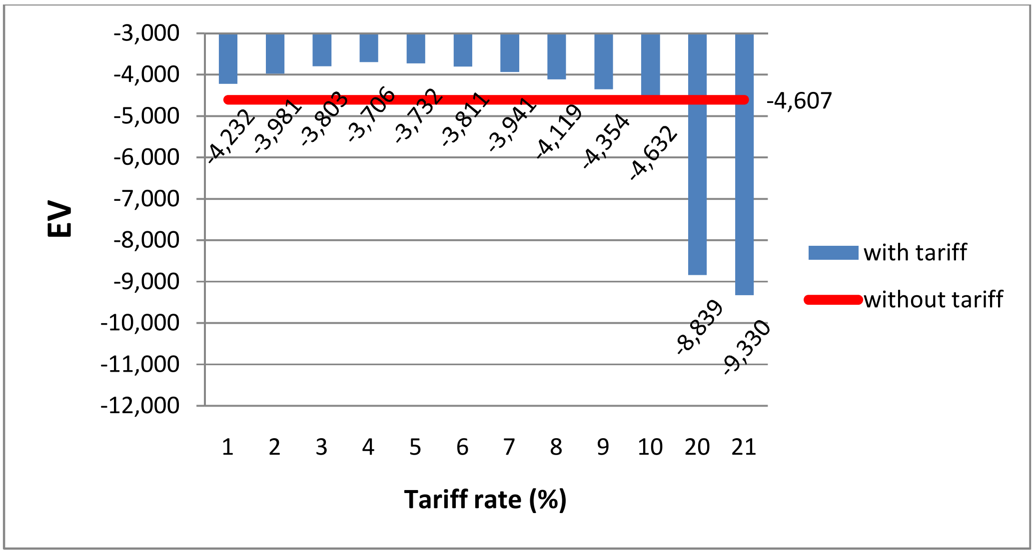

Figure 2 - USA's EV ($ US million) under $100/TCE carbon tax on agriculture and forestry

After finding that there is no credible tariff rate at $100/TCE carbon price, other carbon prices are studied and it is found that $80/TCE is the threshold (maximum) for tariffs to be credible. In other words, it is always possible to find a credible tariff rate as long as carbon taxes do not exceed $80/TCE. It is found that an $80/TCE carbon price causes USA and China to lose $2.809B USD and $8.308B USD, respectively. If China rejects abatement and chooses to free-ride, China's welfare loss is only $336M USD but USA's welfare loss will be $3.175B USD. It is found that to convince China to implement abatement, at $80/TCE carbon price level, the US would to impose 9% tariff on China's all tradable goods. Under such a trade sanction, even though China is free-riding, its welfare loss reaches $8.310B USD while USA's welfare loss becomes $2.692B USD. Therefore, while 9% tariff makes China worse off than complying with abatement, its cost to USA is not as high as letting China free-ride.

4. Results

The thresholds of carbon price for each mitigation policy scenario are given in Table 2. In scenario 1, i.e., a carbon tax on entire production and forestry, it is found that an $39/TCE abatement leads to $1.4B USD welfare gain to the US and $8.7B USD welfare loss to China. If China rejects abatement and chooses to free-ride, China's welfare change becomes $0.6B UDS economic gain but US welfare gain becomes $0.5B USD. It is found that to convince China to implement abatement, the US will need to impose 10% tariff on all tradable goods from China. Under such a trade sanction, even though China is free-riding, its welfare loss reaches $8.9B USD while the US welfare gain stays at $0.5B USD. Therefore, while 10% tariff makes China worse off than complying with abatement, its cost to the US is not as high as letting China free-ride.

In scenario 2 that is when forest carbon sequestrations are subsidized and carbon emissions in agricultural sectors are taxed, as described earlier, a 9% tariff imposed by the US on Chinese imports will be a credible threat to convince China to comply as long as the carbon tax and forest carbon sequestration subsidy do not exceed $80/TCE. When the carbon price is above this threshold, any threat of trade sanction will be not credible and hence Chine will continue to free-ride.

The results in Table 2 also show that the carbon price threshold is very low whenever carbon emissions from the non-agricultural sectors are taxed. The highest threshold occurs when carbon tax is imposed only on agricultural goods without a forest carbon sequestration subsidy.

Table 2 –Results

Scenarios	Carbon Tax in Non-Agriculture	Carbon Tax in Agriculture	Carbon Sequestration Subsidy	Credible Trade Sanction	Carbon Tax ($/TCE)
1	+	+	+	10%	≤ 39
2	-	+	+	9%	≤ 80
3	+	-	+	10%	≤ 40
4	+	+	-	10%	≤ 39
5	+	-	-	10%	≤ 40
6	-	+	-	9%	≤ 185
7	-	-	+	9%	≤ 90

5. Conclusion

As being the two largest GHG emitters, the US and China are two major players in the game of GHG mitigation. The game of GHG mitigation between the US and China is a standard prisoner's dilemma with the current situation being the expected one: neither region abates its emissions. In this study, under the assumption that the US abates its emissions along with ROW (the rest of the world but China), it is investigated under what conditions trade sanctions are effective tools to deter China from free-riding, i.e. to have China agree to abatement.

In a scenario that China is the only region refusing to implement the pollution tax on its GHG emissions; it is shown that USA has incentives to threaten China with trade sanctions in the form of tariff. Furthermore, this study supports the hypothesis that trade sanctions in the form of tariff could be used as an enforcement mechanism to achieve global GHG mitigation. However, the effectiveness of tariffs to support mitigation policies depends on the carbon price. There exist thresholds for carbon price above which tariffs lose their credibility.

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