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by

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Strategic Trade Policy as Response to Climate Change?

The Political Economy of Climate Policy

Andreas Freytag and Leo Wangler*

2007

Abstract

This paper discusses the political economy of the climate change debate. The objective is to come to a better understanding of why at international levels (e. g. the G-8 summit in Heiligendamm) climate change was one of the main topics at the agenda, despite the fact that climate change cannot be solved by only eight participating countries, even if these eight countries are considered as the “biggest” in the world. The problem of climate change is a supranational one and needs supranational cooperation. Using a strategic trade policy framework, the paper theoretically and from a positive perspective explains why countries like Germany are more engaged in policies related to climate change than other industrial countries, which also have signed the Kyoto Protocol.

1 Introduction

The problem of climate change seems to be of anthropological nature. As long as the world population is growing, the use of greenhouse gas emitting technologies is increasing and as long as the problem of deforestation has not been solved, it is likely that the problems will become even worse in the near future. A basic problem is the global nature of climate change; this makes free-riding possible. A solution has to be found which is also able to overcome the problem of free-riding.

One example for international cooperation is the Kyoto Protocol. It is interesting to see that some countries ratified it and some others did

*We gratefully acknowledge helpful comments by Martin Abel, Hannes Koppel, Kristin Reichardt and Simon Renaud.

sign the protocol, but were not able to pass the laws on the national level. It seems that some governments were more “successful” in implementing strict environmental standards and environmental regulations than others. Some governments did also start to restructure their energy policy (e. g. the German government with the law for Renewable Energies). Another observation is that countries are very engaged in using the arguments of climate change to implement high environmental standards on the international level.

On the one hand, climate change can be seen as a costly threat to many industries. The demand for goods may be reduced, and in addition the industry has to bear the costs of all policy measures to reduce the emissions of greenhouse gases. In combination with free-riding behavior of other countries this leads to an disadvantage in international competitiveness at least in the short run. On the other hand, it seems that some industries can gain a lot by high environmental standards. In this paper we focus on those industries that gain by selling their technology which can be considered as “climate friendly”. It appears that these industries strongly cooperate with national governments. The following three arguments support this hypothesis: (1) The export of technologies, which can produce renewable energies, creates national welfare. (2) Industries of the particular sectors make higher profits and increase employment. (3) For politicians it seems to be very attractive to be engaged against global warming, because the issue is very popular and citizens are strongly aware of the problem. These arguments suggest a political policy framework in combination with international trade policy.

The structure of the paper is as follows: the second section is devoted to international policies regarding climate change. After discussing why international policy coordination is necessary, section 2.2 gives a short introduction to international climate policy with the focus on the Kyoto Protocol. We will argue that strategic interaction took place after signing the Kyoto Protocol. Section 2.3 discusses the phenomenon that Germany is going beyond the Kyoto agreement concerning the reduction of greenhouse gases. In section 3, we analyse the political economy of climate protection. The rationale of policy measures will be discussed first in a closed economy setting, after that in a international trade context. It will be shown, that the seemingly irrational policy of e. g. Germany is rational, if other countries also introduce high climate protection standards and other conditions are met. Conclusions round off the paper.

2 Climate Change and International Policy Coordination

2.1 Global environmental problems and the need for policy coordination

In the case of global environmental problems there exists an international prisoners' dilemma. Once the problem of climate change is acknowledged as a global environmental problem, it has to be treated as a global public "bad". This implies that climate protection can be interpreted as a public good.¹ This means that countries have to cooperate in order to find solutions on how to solve the public good problem. A single political action of one country leads to disadvantages concerning international competitiveness, and therefore, there are only weak incentives for implementing environmental standards on the national level without international policy coordination.

Thus, it seems evident that coordination is necessary to solve the prisoners' dilemma. However, international coordination is also associated with a reduction of competition between countries. Competition as an instrument to discover a "social desirable outcome", as outlined by Hayek (1945),² is a kind of necessary condition to overcome the problem of knowledge, which can lead to inefficient market allocations. Under the unrealistic assumption that politicians try to maximize a social welfare function,³ they are confronted with the urgent problem that they do not know what kind of decisions are the best to maximize social welfare.

This problem has led Klodt (1999) to distinguish two criteria for international policy coordination. The first is the degree of certainty about the nature of the problem and its successful solution. The second criterion is the extent of the international spillovers. Only when both criteria are fulfilled, i.e. high certainty and spillovers, international policy coordination is fully justified. Global climate change is characterized by negative international spillover effects.⁴ However, there is a lot of uncertainty about how to solve the environmental problem. Thus, negotiations can only take place about a certain benchmark to limit the inter-

¹A pure public good has two characteristics: the first is jointness in supply and the second is the impossibility to exclude others from its consumption (Musgrave 1959, pp. 9-12).

²See also Hayek (1968, 1976).

³Vanberg (1996), p. 8: "politicians are, like other individuals, leaded by their own interests and have the tendency to do that [...], what leads to their own advantages. Politicians who want to be re-elected – so the public choice argument – will in most of the cases not do such things which welfare economists do recommend" [own translation].

⁴There is already international policy coordination on many topics like the coordination of international sea-traffic or standards in international telecommunication.

national spillovers. The international community seems to be aware of this problem. The Kyoto Protocol (KP) is an agreement about limits of greenhouse gas emissions (GHG) and countries are free to find means to fulfill the limits agreed (the impact of the KP will be explained in the next section).

2.2 The Kyoto Protocol as an instrument of policy coordination

By signing the KP the countries agreed on a reduction of the emission of GHGs under a specified level measured in percentage of the base year 1990. Between 2008 and 2012 the countries are supposed to reduce the average emission of GHG about 5.2% under the reference-level from 1990.⁵ Europe agreed to reduce the emissions of GHG about 8% in comparison to the emissions of 1990.⁶

Other countries, like developing countries or Russia, do not have to reduce GHG emissions, but they agreed not to boost them over the reference point from 1990. After signing the agreement, it was up to each country to ratify the KP on the national level. The KP was coupled with the condition that at least 55 member states, which altogether produce more than 55% of the global emissions of CO₂, have to ratify the protocol in their national parliament before it can enter into force (Kyoto Protocol 1998, p. 19).⁷ The so called 55% rule has important implications: It gives countries the opportunity to free-ride without nullifying the whole agreement. The free-rider problem is thus mitigated and it is more likely that the agreement will be implemented.

The 55% rule was fulfilled when Russia ratified the KP in November 2004. Therefore, the KP could come into force in February 2005. Today, 169 countries and other governmental entities have ratified the KP. The United States, the largest single emitter of GHG has signed, but did not ratify the KP on the national level. Australia, another big emitter of GHG, has not ratified it either. Considering that some countries were not able to ratify the KP on the national level, it is surprising that countries like Germany were able to install high national environmental standards.⁸

The costs for the reduction of GHG, as foreseen in the KP for the U. S., were estimated by a 3% decrease of real GDP (Barker et al. 2006, p. 14). The estimated costs are strongly dependent on the scenarios and the underlying assumptions on which the calculation is based on

⁵The aim is to replace the KP before it runs out in 2012 by a follow-up agreement. First negotiations about the follow-up agreement took place at the United Nations Climate Change Conference in Bali (3-15 December 2007).

⁶Germany agreed to reduce the emissions about 21% (Sachverständigenrat 04/05, p. 121).

⁷Article 25, Paragraph 1 KP.

⁸See section 2.3.

(Klepper and Peterson 2004, 2005).⁹ Because the costs related to climate change also strongly depend on the policy measures implemented, there are very different views on these costs. Cutting GHGs is only one option. As this option is very costly, it might be useful also to consider alternatives how to invest the resources in a more efficient way (Lomborg 2006, pp. 258-324).

The costs for the reduction of GHG also differ significantly between different regions. Even though most of the simulations arrive at the conclusion that there are costs related to environmental policy (measured by a decrease in GDP), it is important to mention that an agreement reducing the emission of GHG to a *sustainable* level will have positive impacts on the global welfare function in the long run. It is also difficult to measure all the costs that might come along with change in climate (e. g. an increase in temperature might cause an increase in environmental catastrophes). One can also argue that it is "cheaper" to react today than in the near future, because doing nothing will increase costs (Kemfert 2005).

If a country does not ratify the protocol, under the assumption that all the other countries ratify the contract, in the short run it will realize a winning margin at the level of international competitiveness. From a static perspective this situation is a prisoners' dilemma.¹⁰ Each single country's best strategy would be not to ratify the KP as this can lead to an increase in international competitiveness for its firms in the short run. From a national point of view, there are strong incentives for free riding.

The question remains why not all countries did free ride. This can partly be explained with the 55% rule. Expressed in dynamic terms (compare figure 1) it might be rational to invest into the reduction of GHG if other countries are free-riding in the short run (and if one speculates about the export of GTs). Only in the case of a static examination a prisoners' dilemma exists. It can also be argued that the free riding behavior of some countries increases the incentives for other countries to invest even more into green technologies (GTs). The logic can be explained when adding the existing of higher subsidies to the analysis and taking exports into account.

⁹This is also true for estimates of the IPCC (compare IPCC (2007) and Barker et al. (2006)).

¹⁰The static game seems to be the most plausible in that case, because the decision not to ratify the KP can be considered as a decision where short run political orientation is stronger than long term considerations.

Figure 1: Quantity sold because of subsidies for green technologies (GT)

		Land B	
		subsidy of GTs	no subsidy of GTs
Land A	subsidy of GTs	<u>250</u> , <u>250</u>	350*, 150*
	no subsidy of GTs	150*, 350*	200, 200

$$350 > 250 > 200 > 150$$

subsidy of GTs: If a country pays subsidies to develop GTs, it can create a new innovative market. The more subsidies are paid, the higher is the quantity of this new technology sold on the national level. If this leads to the result that in the middle and long run the country is very competitive with GTs, there might be a first mover advantage because of the free rider problem in the short run and learning curve effects.

no subsidy of GTs: If a country pays no subsidies for the development of GTs, there will be only a small market for GTs on the national level in the short run. The technology will not be competitive compared to the existing technologies. The more expensive energy is getting, the higher quantities of GTs will be demanded. If this technology can be provided by other countries, the import of GTs will increase as long as the suppliers from other countries are more competitive.

2.3 Germany's policy reaction to global environmental problems

Does this logic apply to Germany, which has chosen a mixed strategy to reduce the emission of GHG? On the one hand, there is the market solution for trade with certificates related to GHG emissions.¹¹ On the other hand, the former "red-green" government coalition¹² passed a law, the so called Erneuerbare Energiengesetz (EEG), to support renewable energies. The main argument for its implementation was the aim to

¹¹Coase (1960) in his article "The Problem of Social Cost", comes to the result that under the assumption that there are no *transaction costs* and property rights are well-defined, private negotiation leads to a Pareto-optimal outcome. Trade with certificates is based on this idea. The creation of property rights for the "right to pollute" together with the possibility to trade the certificates and only low transaction costs, is an efficient way to reduce the emission of GHG. This solution is market-based.

¹²The coalition between the *social democrats* and the *green party* from 1998 to 2005.

foster GTs and to reduce global warming. By examining the effects of the EEG relative to a reduction of GHG emissions, there are good reasons to doubt that it will have a positive impact on the problem of global warming.¹³ Nevertheless, the EEG had the effect that the percentage of renewable energies on the total production of electricity increased from 6.3% in 2001 to 11.8% in 2006 (BMU 2007, p. 8).

Politicians argue that the costs of reducing emissions are lower than the external costs which are associated with climate change, having strong positive impacts on the environment. Notwithstanding, one can expect huge costs related to the subsidies as well as misallocations caused by the EEG. Even though jobs were created in the sectors related to GT, the overall balance of job creation without exports will probably be negative (Hillebrand et al. 2005). All in all it seems to be very difficult to examine the *total costs* and *real effects* related to the KP and the EEG.

3 The political economy of climate policy

Section 2 has set the stage for an analysis of the determinants of German climate policy nationally and incentive structures for governments to apply *solo runs* in climate policy in general. Thereby we do not focus on the demand for subsidies of the GT industry, but concentrate on the government's calculus. For this purpose a strategic trade policy framework is adequate.

We apply this framework in two stages. First, we discuss welfare effects of a policy subsidy on GTs on the national level. These are negative. Without the subsidy, the domestic market would fail as we do not see an intersect between demand and supply. However, as the supply curve falls, i. e. due to learning effects related to the production of GTs, this can may be more than compensated for in the future, if the domestic standard will have become the global standard. In this case, the domestic GT industry has a first mover advantage as it moved rightwards on the learning curve. At least this may be the consideration of the domestic government. Such a policy may would be politically promising, as the demand for both, climate protection and future jobs seems to be satisfied. The political budget constraints of the government is moved. The declining competitiveness of other industries at the lack of ecological effectiveness due to free rider behavior do not effect the political success of the government negatively.

¹³This is because the providers of energy are integrated into the trade with emission certificates. The EEG obliges them to buy the electricity produced by renewable energies (for simplicity we consider renewable energies also as GTs). If the quantity of certificates remains constant, the EEG frees shares of certificates for other sectors and reduces incentives for GHG reduction. Compare (Sachverständigenrat 04/05, pp. 122-123).

3.1 The closed economy

We start in a world where one country (H) implements measures on the national level to fulfill the requirements of the Kyoto Protocol. One important question is why H is able to install GTs and other countries are not. There are two possible explanations:

1. Free-riding behavior of other countries makes it attractive for politicians in H to switch to a long term perspective and support GTs as they expect future exports of GTs.¹⁴
2. It is also possible that there was a kind of “window of opportunity” for the support of GTs. The fact that the German Green Party was in the government between 1998-2005 supports this explanation. There is a very close relationship between the interests of the GT sector and the Green Party, such that a normal lobbying process and short term orientation of politicians had led to a support of the GT sector.

Because there are existing substitutes for producing energy, the creation of the GT sector generates national *costs*.¹⁵ These costs lead to a lower level of GDP growth than it would have been without subsidies to the GT sector. The subsidies enable the GT sector to sell its energy produced because they create an artificial demand for renewable energies. Additionally, we assume learning curve effects for the GT sector, thus the cost curve has a negative slope.¹⁶ The learning curve is depicted in figure 2. c_{pr} represents the production costs and x stands for the demanded quantity of GTs, D_{OS} stands for demand without subsidy and D_{WS} stands for demand with subsidy. Because we assume that H is the first who enters the market of GTs, it moves rightward on the cost curve.¹⁷

If another country (country F) would decide later to enter the GT market, it starts on a higher point on the cost curve than H when the quantity x_F has been produced and sold domestically.

Figure 2 shows that c_{pr}^F would be bigger than c_{pr}^H . Because the ambitious state has not been “exported” so far, the GT sector is still at the beginning and selling domestically with the help of the subsidies. Nevertheless, it has the expectation of future exports. We now show the

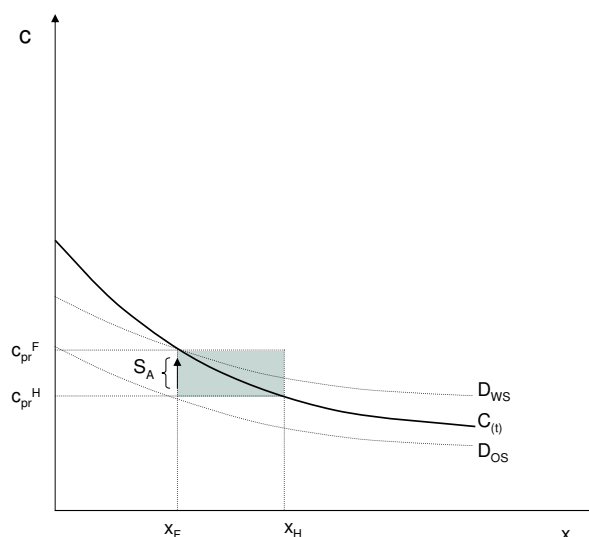
¹⁴This might contradict the general assumption that politicians are always short term oriented. But regarding to GTs, a long term perspective correlates with the interests of the GT sector, with long term strategic interests related to exports of GTs and also voters seem to be highly sensitive with respect to the protection of the environment.

¹⁵This has to be true at least in the short run.

¹⁶There are studies which support this assumption. For photovoltaics and wind mills see Nemet (2006) and Madsen et al. (2005).

¹⁷For a general discussion of learning curve effects and competitive markets see Rasmusen et al. (1997).

Figure 2: Learning curve effect



calculus of domestic politicians in H being interested in higher environmental as politicians in F .

3.2 Open economy considerations

How can domestic politicians increase the export related to the domestic GT sector? To understand their motivation, it is highly sensible to use a model of strategic trade policy. The idea of strategic trade policy can be traced back to Brander and Spencer (1985).¹⁸ The underlying argument is quite simple and can be summarized in the following way. In incomplete markets, where market entrance is characterized by a first mover advantage,¹⁹ a subsidy can help the industry to exploit the rents related to the early market entrance. Even though the terms of trade may deteriorate, the price exceeds the marginal costs of exports and the welfare of the country as a whole will increase. If both countries subsi-

¹⁸This article was influencing trade policy a lot. For a short period the discussion was about if these arguments given in this article could be used against the *free trade paradigm* of David Ricardo.

¹⁹The first mover advantage is characterized in the following way: a firm that is the first who enters into the market with incomplete competition (e. g. because of economies of scale) has the possibility to increase market power. In an extreme case, this industry will end up as a monopolist in the market.

dize their industries in order to be the first to enter into the market, there will be a prisoners' dilemma because both countries would be better off without the subsidy.

Industries producing GTs are not explicitly characterized by static economies of scale. But learning curve effects seem to be important in this context. If learning curve effects are taken into account, there might be a first mover advantage thanks to subsidies for GTs.²⁰ In most cases subsidies for GTs are justified by the argument of *backstop technologies* (Nordhaus 1973). Nevertheless it is very doubtful that politicians know which one will be the best and which technology will have economic success in the near future (Hayek 1945). Politicians in *H* can make use of the instrument to try to set high environmental standards on the supranational level.

Assuming that *H*'s government is successfully with one of these two instruments, we can distinguish between five different scenarios:

1. *F* decides to pay a subsidy per unit of energy produced by the GT sector. We assume that producers located in *F* are also able to produce GTs, but they operate on a higher marginal cost curve. This leads to the case that the GT sector in *H* can enter the market in *F* as a Stackelberg leader.
2. High environmental standards are the result of supranational negotiations. The high environmental standards increase the demand for GTs.
3. *F* decides to support firms which are able to produce GTs (located in *F*). Case (a): *H* is not able to export its technology, because the subsidy to the foreign GT sector is too high.
Case (b): If the GT sector is so competitive that it was already exporting GTs to *F* without any subsidies, in this case it can continue to export, if it is still able to compete with the GT industry_{*j*} located in *F*.²¹
4. *H* competes with the GT sector located in another country (e. g. country *I*) on the "third" market in *F*. In this case, *F* is not able to produce GTs but is forced to buy them (e. g. because of high international environmental standards).

²⁰Especially in the industry of photovoltaics, learning curve effects play an important role (Nemet 2006).

²¹The indicator *j* stands for *Photovoltaics, Wind Mills, . . . , Filter Plants*.

5. There is also the possibility that a firm located in H is making a direct contract with politicians in F :

Case (a): they only buy its technology. In this case, the GT sector would sell a *package* of GTs to F .

Case (b): The contract is combined with a local content clause.²²

Other scenarios are also possible. We restrict the analysis to these five scenarios, because we think that they are both covering relevant cases and sufficient to show the incentives politicians in H have to be engaged to support (1) high environmental standards on a supranational level and (2) to be engaged for the GT sector by bilateral meetings with political representatives from different countries.²³ We start to model the Stackelberg game which represents scenario 1. The general result of the other scenarios are summarized at the end of this section.

Expectations related to exports of GTs (Scenario 1)

Now suppose that H and F are two symmetric countries. Without any support to the GT sector the initial GDP of both countries is the same. This means that $Y_H^i = Y_F^i$ (Y_F^i stands for “initial GDP in the Foreign Country”).²⁴ We model the already discussed free rider problem from section 2 in such a way that H is *faster* by implementing GTs than the other country. If we compare the GDPs of both countries after H has decided to implement the GT sector, in the short run we have the case that $Y_H^{n1} < Y_F^i$ (Y_H^{n1} stands for “new GDP1” with subsidies to the GT sector without any exports).

We do not assume a monopolistic market in the GT sector in H . Because all suppliers of GTs in H are supposed to be symmetric, they are able to supply GTs at the same costs. Finally we model the expected exports of any GT industries $_j$ ($j = Photovoltaics, WindMills, \dots, FilterPlants$) from H to F on an aggregated level. Politicians and representatives of the GT sector in H are aware of their advantage in international competitiveness. The hope of politicians and the GT industries $_j$ is to benefit from an implementing GTs in F . This means that there is an expected gain related to the export of GTs.

We model this expected gain combined with the first mover advantage by using a textbook version for a Stackelberg game.²⁵ H is

²²One example for local content clauses related to the implementation of GTs is the Canadian province Québec. A precondition for obtaining support for the installation of windmills in Québec is that 30% of the wind mills have to be produced locally (FAZ 2007, p. 16).

²³For empirical evidence of this argument see <http://www.exportinitiative.de>.

²⁴ Y^i stands for the GDP without the GT sector.

²⁵A Stackelberg game seems to be the most convincing in this case, because producers of GTs in H are competing about exports. This means that they cannot make use of their cost advantage by setting higher prices. The advantage leads to the export of higher quantities.

modeled as the Stackelberg leader.²⁶ We assume for simplicity that the model only captures the potential quantity sold in the new market for GTs which is expected to be created in F . The price-demand function is given by $p = A - q_{H_j} - q_{F_j}$ (A represents the size of the market, q_{H_j} is standing for the quantity sold by the GT industry $_j$ located in H in the market in F and q_{F_j} is standing for the quantity sold by the GT industries $_j$ located in F at the market in F).²⁷

Expected Profits of the GT sector $_j$ located in H , due to export of its technology to F , are given by

$$\pi_{H_j}^e = q_{H_j}(A - q_{H_j} - q_{F_j} - c_{pr_j} + s_F) - c_{l_j}. \quad (3.1)$$

In this model, s_F represents a subsidy for producers located in H paid by citizens located in F . It remains open how it comes to this subsidy.²⁸ What we can say is that an expectation to earn s_F generates incentives for politicians in H to support the interests of the GT industries $_j$ on an international level.

It is also interesting to mention that once the GT sector has been successful in installing itself on the national level in H , the GT sector and the government in H have very related interests on the international platform.

Both have an interest to export the subsidized GTs, because

- GT industry $_j$ expects higher profits,
- national governments can reduce the costs caused by the subsidies they paid for the support of the GTs.²⁹

In our model, the GT sector in H benefits from s_F and – with respect to our assumptions – it enters the foreign market as a Stackelberg leader. The Stackelberg game can be solved as follows: the GT sector in H assumes the GT sector in F to maximize its profits. We assume that the cost of lobbying (c_{l_j}) are fixed. The profit maximization problem leads to

$$\begin{aligned} \frac{\partial \pi_F^e}{\partial q_{F_j}} &= A - q_{H_j} - 2q_{F_j} - c_{pr_j} + s_F = 0 \\ R_F(q_{H_j}) &= \frac{A - q_{H_j} - c_{pr_j} + s_F}{2}. \end{aligned} \quad (3.2)$$

²⁶The underlying assumption is that F is an industrial country and therefore it is able to produce GTs once there is enough demand for energy produced by the GT sector. Due to the learning curve effects it is not as competitive as H .

²⁷Note that $p > 0 \quad \forall \quad (q_{H_j} + q_{F_j}) < A$.

²⁸The subsidy might be due to an aggravation of the problem of global warming or be indirectly the outcome of international agreements to reduce GHGs.

²⁹The costs were related to a higher overall unemployment rate and a disadvantage for other industrial sectors in the short run.

H maximizes its profits with respect to q_{H_j} by taking equation 3.2 into account. It follows

$$\begin{aligned}\frac{\partial \pi_{H_j}^e}{\partial q_{H_j}} &= A - 2q_{H_j} - \frac{1}{2}A + q_{H_j} + \frac{1}{2}c_{pr_j} - \frac{1}{2}s_F - c_{pr_j} + s_F \\ q_{H_j}^* &= \frac{A - c_{pr_j} + s_F}{2}.\end{aligned}\quad (3.3)$$

Finally we can solve the maximization problem for the industry j in F . The solution for F is given by

$$q_{F_j}^* = \frac{A - c_{pr_j} + s_F}{4}.\quad (3.4)$$

Because $q_{H_j}^* > q_{F_j}^*$, the result can be interpreted as potential extra gains for the GT sector in H – if F decides to pay a subsidy per unit of GTs produced, which is high enough that producers located in H and F can make profits.

This quantity produced enters directly positively into the GDP of H .³⁰ This is one reason why there might be a strong interest for H to start lobbying campaigns on higher levels than the national one.

A welfare analysis for H in the case of the open economy

In the case of the Stackelberg game, the price is given by $p_j = A - q_{H_j} - q_{F_j}$. We can substitute the values for p and $q_{H_j}^*$ into equation 3.1 and obtain

$$\begin{aligned}\pi_{H_j}^e &= \left[\frac{A + 3(c_{pr_j} - s_F)}{4} - c_{pr_j} + s_F \right] \left[\frac{A - c_{pr_j} + s_F}{2} \right] - c_{l_j} \\ \pi_{H_j}^e &= \frac{1}{8}(A - c_{pr_j} + s_F)^2 - c_{l_j}.\end{aligned}\quad (3.5)$$

The *expected* contribution to the national GDP of H through exports of GTs shall be modeled by $y_{H_j}^e$. This leads to

$$y_{H_j}^e = \pi_{H_j}^e = \frac{1}{8}(A - c_{pr_j} + s_F)^2 - c_{l_j}.\quad (3.6)$$

In contrast to the costs which go in hand with subsidies to the GT sector on the national level, $y_{H_j}^e$ enters positively into the GDP of H (because the subsidy is paid by F).³¹ This leads to the result that $y_{H_j}^e > 0$ reduces the welfare loss related to the subsidies to the GT sector without any exports. With exports, the expected new GDP2 $Y_H^{e^{n2}}$ ($Y_H^{e^{n2}} = (Y_H^{n1} + y_{H_j}^e)$)

³⁰Because the subsidy to GTs is paid by F .

³¹This is true as long as $A + s_F > c_{pr_j}$ and $c_{l_j} < (A - c_{pr_j} + s_F)^2$.

is bigger than Y^{n1} (the GDP without any exports of GTs). So far we have the case that $Y_H^i > Y_H^{e^{n2}} > Y_H^{n1}$.

This means that exports of GTs create welfare gains which enter positively into the GDP of H compared to the first case which is described by Y_H^{n1} . Above a certain break-even point, it might be the case that the gains are bigger than the losses, such that $Y_H^{e^{n2}} > Y_H^i > Y_H^{n1}$. Therefore, the national government and the particular industry have great incentives to promote the technology.

As Table 1 page 1 shows, “only” in scenario 3 case (a) the first mover advantage does not lead to higher exports. The political decision of politicians in F to subsidize the GT industries, directly might depend on different aspects. It is difficult to make a prediction how likely this scenario really is. Even though this scenario is possible, if the other scenarios are in total more likely than scenario 3 case (a), the political behavior is still rational because in all other cases H expects to gain from the high environmental standards. The prospects of future exports of GTs explain the rationality of behavior of politicians in H .

The presented model is very simple and does not capture important factors like endogenous growth or gains in productivity of GTs. Nevertheless, the intuition behind the model is to explain political incentives and therefore we do not really need these modifications. The model gives a good explanation why it is rational for politicians in H to be engaged for high environmental standards. Expected gains related to the export of GTs also enter into the political interest function and tend to implement a strategic trade policy. This kind of strategic trade policy is different from the export promotion that was modeled in the strategic trade theories by Brander and Spencer (1985) or Krugman (1989). In our case, strategic trade policy is better described by “exporting lobbying activities” and trying to implement high global environmental standards that are in line with the comparative advantage of H , namely the GT sector.

Table 1: Scenarios 2-5

	Description	Modifications on the model	Expectations
Scenario 2	High environmental standards are the result of supranational negotiations. The high environmental standards increase the demand for GTs.	<p>The price demand function has to be modified in this case. High environmental standards have effects on</p> $p = A - q_{H_j} - q_{F_j}.$ <p>The modification can be done by σ ($\sigma \in (0, 1]$). A low σ indicates high environmental standards. The price demand function is now given by</p> $p = A - \sigma q,$ <p>with $q = q_{H_j} + q_{F_j}$.</p>	Higher exports of GTs.
Scenario 3	<i>F</i> decides to support firms located in <i>F</i> directly to produce GTs	<p>Case (a):</p> $\pi_{H_j}^e = q_{H_j}(A - q_{H_j} - q_{F_j} - c_{pr_j}) - c_{l_j} \leq 0.$ <p>No additional exports.</p>	Case (a): The first mover advantage did not lead to a success in exports.
		<p>Case (b):</p> $\pi_{H_j}^e = q_{H_j}(A - q_{H_j} - q_{F_j} - c_{pr_j}) - c_{l_j} > 0.$ <p>If the GT sector is so competitive that it was already exporting GTs to <i>F</i> without any subsidies → In this case it can continue to export, if it is still able to compete with the GT industries_{<i>j</i>} located in <i>F</i>.</p>	Case (b): Decreasing exports of GTs.
Scenario 4	<i>H</i> competes with the GT sector located in another country (country <i>I</i>) on the “third” market in <i>F</i> . In this case <i>F</i> is not able to produce GTs but is forced to buy them (e. g. because of high international environmental standards).	There is competition between <i>H</i> and <i>I</i> . The underlying game depends on which cost curve <i>H</i> and <i>I</i> are operating. They can play Stackelberg, or if they have the same production costs, the market has the characteristic of a duopoly with simultaneous market entrance.	Higher exports of GTs.
Scenario 5	There is also the possibility that a firm located in <i>H</i> is making a direct contract with politicians in <i>L</i>	<p>Case (a):</p> $\pi_{H_j}^e = \hat{q}_{H_j} \hat{p}_j - c_{pr} \hat{q}_{H_j} - c_{l_j} > 0.$ <p>\hat{q}_{H_j} stands for “agreed quantity of GTs” which the GT industries_{<i>j</i>} located in <i>H</i> can sell at the agreed price \hat{p}_j.</p>	Case (a) <i>F</i> buys the technology from the GT industries _{<i>j</i>} located in <i>H</i> . In this case the GT sector would sell a <i>package</i> of GTs to <i>F</i> → Higher exports of GTs.
		<p>Case (b):</p> $\pi_{H_j}^e = \hat{q}_{H_j} \hat{p}_j - c_{pr} \hat{q}_{H_j} - c_{l_j} - ttr > 0.$ <p><i>ttr</i> stands for “technology transfer”.</p>	Case (b): The contract is combined with a local content clause → Higher exports of GTs, but less than in case (a).

4 Conclusions

This contribution looks at the climate change debate from a perspective of political opportunity and economic rationality. We develop a strategic trade model to explain the political interests behind the climate change debate. We come to the result that politicians and the GT sector have the same interests at the international level, once the GT sector is installed on the national level. The result of our welfare analysis clearly shows the expected gains related to exports of GTs. Politicians might use the problem of climate change as an instrument to support the national GT sector on the international level. From this perspective, high environmental standards are in the political interest of these countries. Environmental standards can be used by a government as an instrument to force other countries to buy domestic GTs. The theoretically shown welfare effects of one country's industrial policy efforts strongly depend on the policy reaction of other countries.

In contrast to the literature, the model does not intent to justify or to nullify strategic trade policy. The model rather shows the incentives for governments to support GTs via industrial policy as well as potential welfare effects and therefore, the model sheds some light on the recent developments in Germany as well as the Canadian province Québec, where a local content rule for the installment of windmills has recently been introduced. This example seems to give support to our model. Nevertheless, it is far too early to derive policy lessons from this theoretical reasoning. We need more empirical evidence to judge normatively the role of GTs for industrialized countries.

References

- Barker, T., Qureshi, M. S. and Köhler, J.: 2006, The Costs of Greenhouse Gas Mitigation with Induced Technological Change: A Meta-Analysis of Estimates in the Literature, *Working Paper, Number 89*, Tyndall Centre, Cambridge.
- BMU: 2007, *Entwicklung der erneuerbaren Energien im Jahr 2006 in Deutschland*. <http://www.erneuerbare-energien.de/files/pdfs/-allgemein/application/pdf/hintergrund_zahlen2006.pdf>.
- Brander, J. A. and Spencer, B. J.: 1985, Export Subsidies and International Market Share Rivalry, *Journal of International Economics*, **Volume 18**, pp. 83–100.
- Coase, R. H.: 1960, The Problem of Social Cost, *Journal of Law and Economics*, **Volume 3**, pp. 1–44.
- FAZ: 2007, Kanada setzt auf Windenergie, *Frankfurter Allgemeine Zeitung*, **Number 253**, p. 16.
- Hayek, F. A. v.: 1945, The use of Knowledge in Society, *American Economic Review* 35, **Volume 4**, pp. 519–530.
- Hayek, F. A. v.: 1968, Der Wettbewerb als Entdeckungsverfahren, *Kieler Vorträge, Number 56*, Institut für Weltwirtschaft, Kiel.
- Hayek, F. A. v.: 1976, *Individualismus und wirtschaftliche Ordnung*, Salzburg.
- Hillebrand, B., Buttermann, H. G., Begringer, J. M. and Bluel, M.: 2005, The expansion of renewable energies and employment effects in Germany, *Energy Policy*, **Volume 34**, pp. 3483–3494.
- IPCC: 2007, *International Panel on Climate Change, 30 April-4 May 2007: Mitigation of Climate Change – Summary for Policymakers*. <<http://www.ipcc.ch/SPM040507.pdf>>.
- Kemfert, C.: 2005, Weltweiter Klimaschutz - Sofortiges Handeln spart hohe Kosten, *DIW-Wochenbericht*, **72. Jahrgang(12-13)**, pp. 209–215.
- Klepper, G. and Peterson, S.: 2004, The EU Emissions Trading Scheme: Allowance Prices, Trade Flows, Competitiveness Effects, *Working Paper, Number 1195*, Kiel Institute for World Economics, Kiel.
- Klepper, G. and Peterson, S.: 2005, Emissions Trading, CDM, JI, and More - The Climate Strategy of the EU, *Working Paper, Number 1238*, Kiel Institute for World Economics, Kiel.

- Klodt, H.: 1999, Internationale Politikkoordination: Leitlinien für den globalen Wirtschaftspolitiker, *Kiel Discussion Papers, Number 343*, Institut für Weltwirtschaft, Kiel.
- Krugman, P.: 1989, Import Protection as Export Promotion: International Competition in the Presence of Oligopoly and Economics of Scale, in H. Kierzkowski (ed.), *Monopolistic Competition and International Trade*, Oxford, pp. 180–193.
- Kyoto Protocol: 1998, *Kyoto Protocol to the United Nations Framework Convention in Climate Change*, United Nations. <<http://unfccc.int/resource/docs/convkp/kpeng.pdf>>.
- Lomborg, B.: 2006, *The skeptical environmentalist: measuring the real state of the world*, Cambridge University Press, Cambridge.
- Madsen, E. S., Jensen, C. and Hansen, J. D.: 2005, Scale in technology and learning-by-doing in the windmill industry, *Journal for International Business and Entrepreneurship Development (JIBED)*, **Volume 1(2)**, pp. 27–35.
- Musgrave, R. A.: 1959, *The Theory of Public Finance*, McGraw-Hill, New-York.
- Nemet, G.: 2006, Beyond the learning curve: factors influencing cost reductions in photovoltaics, *Energy Policy*, **Volume 34**, pp. 3218–3232.
- Nordhaus, W.: 1973, The Allocation of Energy Reserves, *Brookings Papers on Economic Activity*, **Volume 3**, pp. 529–570.
- Rasmusen, E. B., Petrakis, E. and Roy, S.: 1997, The Learning Curve in a Competitive Industry, *The RAND Journal of Economics*, **Volume 28**, pp. 248–268.
- Sachverständigenrat: 04/05, *Erfolge im Ausland - Herausforderungen im Inland*. <http://www.sachverstaendigenrat-wirtschaft.de/download/gutachten/04_ges.pdf>.
- Vanberg, V.: 1996, Ökonomische Rationalität und politische Opportunität, *Schriftenreihe des Max-Planck-Instituts zur Erforschung von Wirtschaftssystemen*, **Heft 8**, pp. 3–32.