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Addressing Carbon Leakage by Border Adjustment Measures

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1. Introduction

The Kyoto Protocol to the United Nations Framework Convention on Climate Change calls for industrialized countries and economies in transition (listed in the Annex B) to reduce their aggregate carbon equivalent emissions of greenhouse gases by 5.5 percent of their 1990 levels. To fulfil domestic mitigation targets efficiently, policymakers have typically focused on two market-based regulatory mechanisms: taxes and caps with trading. Both policy measures will create a similar carbon price on the combustion of fossil fuels and therefore increase the domestic production costs of energy-intensive industries. Because the Kyoto Protocol does not require mitigation from developing countries, such asymmetric climate policies will lead to changes in terms of trade. Firms located in countries which implement carbon pricing policies will bear an additional production cost and are placed at a disadvantageous position comparing with their competitors in countries which do not internalise the carbon costs in production.

Facing an increase in production cost, firms can choose to pass carbon related costs onto their downstream consumers or to cut their profit margins in order to keep the market share. Both options will however lead to losses in both international competitiveness and employment. An alternative way of produce domestically is to relocate production to countries with less stringent climate policies. Relocation may help to address losses in competitiveness but in employment.

Another concern closely related to the competitiveness losses and relocation is "carbon leakage", which generally refers to an increase of emissions in countries without climate policies that are attributable to emission reductions in countries with climate policies. The effectiveness of climate polices on reducing global emissions will be undermined if the leakage is high.

The competitiveness and leakage concerns have centred in the climate policy debates first in EU when EU Emissions Trading System was introduced and implemented, then in US and Australia when a cap-and-trade system is being considered (Houser et al., 2008; Reinaud, 2008; Carbon Trust 2010; van Asselt & Brewer, 2010). The best way to address these concerns in implementing carbon pricing policies would be the completion of a harmonized international climate policy (Stern, 2006; Manders & Veenendaal, 2008). However differences between countries in the level of economic development, political conditions, obligations stemming from historic emissions, and responsibilities arising from current and future emissions mean that harmonization is still a long way off. Among other policy

alternatives, the use of offsetting measures at the border to level the playing field is getting popular in policy proposals.

Climate change related border adjustment measures (BAMs) are aimed at restoring international competitiveness through internalising the carbon cost globally, combating carbon leakage, enabling wider and deeper emission cuts domestically and incentivising other countries to join international efforts to cut emissions. Except for the good will of using a BAM, however BAMs implemented unilaterally may invoke political repercussions, harm trade relations and international relations in future climate negotiations and are likely to be challenged by the World Trade Organization (WTO) law. Taking account of the risks and costs of applying strong trade measures in climate policies, it is therefore very important to demonstrate that whether BAMs at issue can effectively deliver the expected economic and environmental benefits and overweight the potential risks and costs.

Although there is little empirical analysis to date, many economic analyses focusing on the economic and environmental effectiveness of different border measures (such as the inclusion of importers to surrender carbon allowances in a cap-and-trade system, import tariffs, and export rebates) have been conducted since last decade (e.g., Babiker et al., 2000; Babiker & Rutherford, 2005; Peterson & Schleich, 2007; Manders & Veenendaal, 2008; Fischer & Fox, 2009; McKibbin & Wilcoxen, 2009; Monjon & Quirion, 2010; Takeda et al., 2010, 2011; Winchester et al., 2010). By conducting a comprehensive literature review, we found that there is disagreement among researchers on both the quantitative importance of leakage and the effectiveness of policy instruments proposed to limit leakage and competitiveness impacts. Many studies indicated that how effective the various options will be in reducing competitiveness and leakage impacts depends, among others, on the differences in GHG emissions among like products from different origins. In turn, measuring the carbon content of imported goods is critical in assessing policy effectiveness. However calculating embodied emissions by tracing the origin of production at product or firm level is a challenge in both technical and practical terms.

Based on these observations, this chapter aims at assessing the economic and environmental effectiveness of selected BAMs, in particular import tariffs. We focus on a carbon tax system in Japan. Based on the Kyoto Protocol, Japan committed to reduce GHG emissions by 6 percent below the base year 1990, during the period of 2008-2012. In 1998, Japan promulgated the Law Concerning the Promotion of the Measures to Cope with Global Warming to determine the national framework to cope with global warming (Ministry of the Environment of Japan, 1998). In 2005, the Kyoto Protocol Target Achievement Plan was formulated (Government of Japan, 2005). More recently the government of Japan announced a plan to impose carbon tax from 2011 (Ministry of the Environment of Japan, 2010). The implementation of the carbon tax system has caused political and business concerns on domestic competitiveness and carbon leakage. For this analysis, a recursive dynamic global computable general equilibrium (CGE) model is employed. Not just adding one more similar economic analysis to current CGE literature on border adjustment, we take account of the nationally appropriate mitigation actions (NAMAs), of which implementation in the selected developing countries could shorten the gap in the production costs of carbon-intensive industries between countries which implement carbon pricing policies and developing countries. These two points has yet been well addressed in the existing literature.

The rest of this chapter consists of four sections. Section 2 explains the model and data. Section 3 presents simulation results. Section 4 provides conclusions. Section 5 (the Appendix) discusses the WTO compatibility of BAMs.

2. The framework

2.1 The model

The model employed in this chapter is a multi-region CGE model which is based on the GTAP6inGAMS (Rutherford, 2005). In the model, a representative firm produces goods by using intermediate goods and production factors (skilled labour, unskilled labour, capital stock, land and natural resources). Inputs of intermediate goods and composite factors are described by the Leontief formulation while composite factors are formed by the constant-elasticity-of-substitution (CES) function. Household behaviour is modelled by employing the Cobb-Douglas utility maximisation. Allocation of demands (for both firms and household) between domestic goods and imported goods is formulated by the Armington approach (Armington, 1969). Sectoral investment is treated as an exogenous variable: hence, savings are not formulated in this model.

In order to do post-sample simulation, a recursive dynamics is introduced. Specifically, given the growth rates of population, skilled labour input, unskilled labour input and capital stock, we derive the future paths (from the year 2004 to 2020) of these three inputs.

Moreover, we add an embodied emission module to the original GTAP6inGAMS model by using the emission coefficients computed in Zhou et al. (2010).

2.2 Data

The main dataset of this analysis is GTAP Database version 7 (base year is 2004). Since the embodied emission coefficients in Zhou et al. (2010) are obtained by using the Asian International Input-Output (AIIO) Table 2000 (Institute of Developing Economies, 2006), the sector aggregation of our dataset basically follows the 24-sector-classification in the AIIO Table. Sector classification and matching between the AIIO Table and GTAP Database are presented in Table 1. The world economy is divided into thirteen regions in this model. The regional classification is described in Table 2.

As shown in Table 1, the chemical products and rubber products sectors are separated in the AIIO Table whereas they are aggregated in the GTAP Database. In this analysis, we disaggregate the chemical and rubber products sector in the GTAP Database by using sectoral output shares in India's 2004 input-output table (for India), EU KLEMS gross output data (for EU) and the AIIO Table 2000 (for the other ten economies) with the program SplitCom[1].

For constructing their future paths until 2020, the growth rates of population, skilled labour input, unskilled labour input and capital stock are taken from Dimaranan et al. (2007).

3. Simulation analysis

Applying the model described in the previous section, we analyse the economic and environmental effects of BAMs. Particularly, we focus on changes in international carbon leakage, global embodied emissions, output in energy-intensive sectors and GDP towards the year 2020. All results from 2011 are presented in this section since Japan's carbon tax will be put into practice from the year 2011.

3. Simulation analysis and results

In order to quantify the effects of BAMs and NAMAs, we prepare the following four simulation scenarios: BAU, Cases 1, 2 and 3. The BAU scenario is the baseline scenario of

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[1] Regarding SplitCom, see http://www.monash.edu.au/policy/splitcom.htm.

2004 without the introduction of carbon tax. In Case 1 scenario, carbon tax is levied on Japan's imports of fossil fuels. According to the Ministry of the Environment of Japan (2010), the carbon tax levied on fossil fuels (coal, crude oil, petroleum products and natural gas) will be JPY289/t-CO_2, which is equivalent to US$2.671/t-$CO_2$[3]. Although the Government of Japan will levy the carbon tax from 2011 and increase the rate gradually to the level of US$2.671/t-$CO_2$, we assume that Japan will implement a carbon tax of US$2.671/t-$CO_2$ from 2011 in our analysis. The carbon tax will be introduced as an additional tax to the current Petroleum and Coal Tax. Since most of fossil fuels used in Japan are imported, we assume that the carbon tax is levied on the imports of fossil fuels to Japan[2]. In addition to carbon tax

		AIIO 24 sector classification	GTAP 57 sector classification
	Symbol	Description	Code
1	PDR	Paddy	pdr
2	XAG	Other agricultural products	wht, gro, v_f, osd, c_b, pfb, ocr
3	LSP	Livestock and poultry	ctl, oap, rmk, wol
4	FRS	Forestry	frs
5	FSH	Fishery	fsh
6	CPG	Crude petroleum and natural gas	oil, gas
7	XMN	Other mining	coa, omn
8	FBT	Food, beverage and tobacco	cmt, omt, vol, mil, pcr, sgr, ofd, b_t
9	TEX	Textile, leather and the their products	tex, wap, lea
10	WDP	Timber and wooden products	lum
11	PPP	Pulp, paper and printing	ppp
12	CHM	Chemical products	crp
13	PTR	Petroleum and petro products	p_c
14	RBP	Rubber products	crp
15	NMM	Non-metallic mineral products	nmm
16	XMP	Metal products	i_s, nfm, fmp
17	MCN	Machinery	ele, ome
18	TRE	Transport equipment	mvh, otn
19	XMF	Other manufacturing products	omf
20	EGW	Electricity, gas, and water supply	ely, gdt, wtr
21	CNS	Construction	cns
22	TRT	Trade and transport	trd, otp, wtp, atp
23	SRV	Services	cmn, ofi, isr, obs, ros, dwe
24	PBA	Public administration	osg

Table 1. Sector classification

[2] Based on the energy balance table for Japan (Energy Data and Modelling Centre, Institute of Energy Economics, 2011), Japan's imports of coal, crude oil, petroleum products and natural gas in 2009 accounted for 99.4 percent, 99.6 percent, 100 percent and 96.0 percent of primary supply, respectively.

in Japan, the Case 2 scenario includes import tariff levied on all imports of Japan from other economies[3]. This border adjustment tariff rate is computed by embodied emission coefficients (carbon contents) of exporting countries. Emissions embodied in imports include emissions emitted from all upstream production stages wherever they are in order to produce the goods. Embodied emission coefficients for imports are emissions embodied in per unit imports, which are calculated at sectoral level using the multi-region input-output model. The formulation of the tariff rate basically follows that in Winchester et al. (2010). The Case 3 scenario consists of the Case 2 scenario and NAMAs for China and India. Based on the Copenhagen Accord, China and India proposed to decrease CO_2 emissions per GDP in the year 2020 by 40-45 percent and 20-25 percent from the 2005 levels, respectively. In this scenario, we introduce linear-cuts of embodied emission coefficients in China and India which satisfy the corresponding reduction targets in 2020.

1	Indonesia (IDN)
2	Malaysia (MYS)
3	Philippines (PHL)
4	Singapore (SGP)
5	Thailand (THA)
6	China (CHN)
7	Taiwan (TWN)
8	South Korea (KOR)
9	Japan (JPN)
10	United States (USA)
11	India (IND)
12	European Union (EU)
13	Rest of the world (ROW)

Table 2. Regional classification

Case 1	Carbon tax in Japan
Case 2	Carbon tax and import-tariff-based border adjustments in Japan
Case 3	Carbon tax and import-tariff-based border adjustments in Japan plus nationally appropriate mitigation actions in China and India

Table 3. Simulation scenarios

3.2 Global emissions

Percentage changes in global emissions from BAU are shown in Table 4. By introducing carbon tax in Japan, global emissions rise slightly. In contrast, emissions decrease by the

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[3] Since Japan will levy carbon tax on the imports of fossil fuels, it is reasonable to apply border adjustment to the carbon contents of energy in other countries. Since Japan's carbon tax on fossil fuels will influence all downstream stages which use energy, we assume that border adjustment will be applied to all imported goods to Japan in this analysis.

application of Japan's border adjustment. Shifts of production between Japan and other economies result in these outcomes. Energy efficiency of Japan is one of the highest in the world. Due to the carbon tax, imports of Japan from other countries, which are usually less energy efficient, increase and substitute part of Japan's domestic production. This will contribute to an increase in global emissions. For Case 2, the reverse results occur because border adjustments will help resume Japan's domestic production and constrain carbon-intensive imports to Japan which will contribute to the decrease in global emissions. In Case 3, global emissions decline substantially. This result indicates that NAMAs of China and India have great potential impacts on the generation of global emissions[4].

	Case 1	Case 2	Case 3
2011	0.00001	-0.00122	-6.69720
2012	0.00001	-0.00112	-7.65082
2013	0.00002	-0.00103	-8.60368
2014	0.00002	-0.00092	-9.55537
2015	0.00003	-0.00082	-10.50530
2016	0.00003	-0.00071	-11.45266
2017	0.00004	-0.00060	-12.39637
2018	0.00004	-0.00051	-13.33499
2019	0.00004	-0.00042	-14.26663
2020	0.00005	-0.00036	-15.18883

Table 4. Percentage change of global emissions from BAU

3.3 Carbon leakage

The impacts of BAMs on international carbon leakage are the main concern of this analysis. Deviations of national emissions from BAU are illustrated in Table 5. For Case 1, Japan's national emissions decline while emissions from other countries' increase. From these results, we can observe carbon leakage from Japan to other countries due to the carbon tax system. Also, the effect of carbon tax on emission reduction is quite limited because the proposed carbon tax rate is not enough to make it an effective incentive. In order to satisfy its own emission reduction target, Japan might need other effective abatement policies.

In contrast to Case 1, we can find that national emissions in Japan will increase while emissions from other countries will decrease for Case 2. Due to the introduction of BAMs, imports of Japan from other countries are expected to decrease.

For Case 3, we can see similar results as Case 2 although the magnitude for other countries is different. By decreases in embodied emission coefficients in China and India, we can expect that Japan's national emissions will also decline due to global supply chains and international trade of intermediate goods. Because we fix the emission coefficients for Japan, the propaganda effects of changes in the emission coefficients of China and India are not taken into account in this analysis. The increase of Japan's national emissions indicated by Case 3 is mainly the effect of BAMs, which contributes to resuming domestic production

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[4] Changes of embodied emission coefficients in other countries due to less carbon intensity in China and India attributable to their NAMAs is not considered in the analysis. If this propaganda effect is included, we could expect more reductions in global emissions.

and substituting carbon-intensive imports. If we update Japan's embodied emission coefficients based on the changes in the emissions coefficients in China and India, we can see both the effect of BAMs and the effect of NAMAs implemented by China and India. Two effects will impact Japan's national emissions in two opposite directions.

	Japan			Other countries		
	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
2011	-0.000004	0.000129	0.000112	0.000011	-0.000900	-4.234302
2012	-0.000004	0.000125	0.000106	0.000013	-0.000852	-4.944332
2013	-0.000004	0.000120	0.000100	0.000016	-0.000797	-5.682395
2014	-0.000004	0.000114	0.000093	0.000019	-0.000737	-6.448525
2015	-0.000005	0.000108	0.000085	0.000023	-0.000670	-7.242434
2016	-0.000005	0.000100	0.000077	0.000027	-0.000599	-8.063437
2017	-0.000005	0.000092	0.000067	0.000031	-0.000525	-8.910348
2018	-0.000006	0.000081	0.000057	0.000036	-0.000452	-9.781361
2019	-0.000006	0.000070	0.000045	0.000040	-0.000386	-10.673914
2020	-0.000007	0.000057	0.000033	0.000042	-0.000332	-11.584544

Table 5. Deviation of national emissions from BAU (Billion ton-CO_2)

3.4 Output effects

In this chapter, changes in output are examined for the following energy-intensive sectors which are usually considered more vulnerable to the competitiveness effects: the pulp, paper and printing, chemical products and metal products sectors. Although the magnitudes differ, Japan's output in the selected sectors declines for Case 1 (the introduction of carbon tax in Japan) throughout the simulation period. From the results for output changes in the chemical products sector, border adjustments do not necessarily improve the output. It depends on input-output and trade structure of an industrial sector.

3.4.1 Pulp, paper and printing sector

Percentage changes in output for the pulp, paper and printing sector are presented in Table 6. For this sector, border adjustments greatly improve its output. Despite an increase of price due to border adjustments, China and India also experience an output increase. By contrast, output in the rest of the countries declines. It can be considered that Japan's output increase will stimulate output increase in both China and India through trade.

	Case	2011	2015	2016	2017	2018	2019	2020
JPN	1	-0.00019	-0.00022	-0.00023	-0.00023	-0.00024	-0.00025	-0.00025
	2	0.01389	0.01370	0.01366	0.01363	0.01362	0.01361	0.01362
	3	0.01306	0.01234	0.01215	0.01196	0.01177	0.01158	0.01140
CHN	1	-0.00003	-0.00004	-0.00004	-0.00004	-0.00004	-0.00004	-0.00004
	2	0.01440	0.01224	0.01164	0.01101	0.01036	0.00968	0.00897
	3	0.01035	0.00721	0.00651	0.00584	0.00520	0.00458	0.00399
IND	1	0.00003	0.00004	0.00004	0.00005	0.00005	0.00005	0.00005
	2	0.00389	0.00441	0.00459	0.00479	0.00502	0.00525	0.00551
	3	0.00309	0.00325	0.00334	0.00345	0.00358	0.00372	0.00388
The rest	1	0.00001	0.00001	0.00002	0.00002	0.00002	0.00002	0.00002
	2	-0.00207	-0.00211	-0.00213	-0.00214	-0.00215	-0.00217	-0.00219
	3	-0.00180	-0.00171	-0.00169	-0.00167	-0.00166	-0.00165	-0.00165

Table 6. Percentage change of output in the pulp, paper and printing sector from BAU

3.4.2 Chemical products sector

Table 7 shows percentage change of output in the chemical products sector from BAU. Contrary to the results for the pulp, paper and printing sector, border adjustments will not have the expected effects. For all three cases, Japan's chemical output declines. We find more output decrease in Cases 2 and 3 for Japan. In contrast, outputs for the rest of the twelve regions rise. Particularly, outputs of countries other than China increase. To explain the reasons, we need to conduct a decomposition analysis which is beyond the scope of this work.

	Case	2011	2015	2016	2017	2018	2019	2020
JPN	1	-0.00135	-0.00139	-0.00141	-0.00143	-0.00145	-0.00147	-0.00149
	2	-0.02825	-0.04574	-0.05138	-0.05761	-0.06448	-0.07202	-0.08025
	3	-0.03058	-0.04838	-0.05389	-0.05989	-0.06641	-0.07347	-0.08109
CHN	1	0.00007	0.00012	0.00014	0.00016	0.00018	0.00020	0.00021
	2	0.00066	0.00015	0.00015	0.00023	0.00037	0.00058	0.00086
	3	0.00182	0.00256	0.00290	0.00331	0.00376	0.00424	0.00474
IND	1	-0.00002	-0.00005	-0.00006	-0.00006	-0.00007	-0.00008	-0.00009
	2	0.00424	0.00648	0.00711	0.00775	0.00841	0.00908	0.00978
	3	0.00444	0.00676	0.00739	0.00803	0.00869	0.00935	0.01002
The rest	1	0.00016	0.00017	0.00017	0.00017	0.00017	0.00017	0.00018
	2	0.00290	0.00498	0.00564	0.00637	0.00716	0.00802	0.00895
	3	0.00295	0.00488	0.00547	0.00611	0.00681	0.00758	0.00841

Table 7. Percentage change of output in the chemical products sector from BAU

3.4.3 Metal products sector

As illustrated in Table 8, Japan's output changes in the metal products sector have the same trend as for the pulp, paper and printing sector (i.e. decrease in the case of carbon tax and increase in the case of border adjustments). As a consequence of border adjustments, we find a decrease in output for China and countries other than Japan, China and India. By contrast, India's output rises. Interestingly, the sign of output changes for China under Case 3 turns into positive from 2019. NAMAs are included in Case 3 and the level of border adjustments depend on carbon price and the embodied emission coefficients of exporting countries. Thus, we can observe that NAMAs enable China to lower its export price of metal products gradually and increase its output as a consequence.

	Case	2011	2015	2016	2017	2018	2019	2020
JPN	1	-0.00228	-0.00251	-0.00259	-0.00267	-0.00277	-0.00288	-0.00301
	2	0.10326	0.09094	0.08654	0.08154	0.07593	0.06971	0.06292
	3	0.09445	0.07974	0.07529	0.07052	0.06541	0.05998	0.05425
CHN	1	0.00032	0.00046	0.00051	0.00056	0.00060	0.00064	0.00066
	2	-0.01117	-0.00862	-0.00762	-0.00648	-0.00523	-0.00389	-0.00253
	3	-0.00632	-0.00281	-0.00191	-0.00103	-0.00021	0.00051	0.00109
IND	1	0.00016	0.00019	0.00021	0.00022	0.00024	0.00026	0.00028
	2	0.00100	0.00281	0.00352	0.00435	0.00530	0.00639	0.00760
	3	0.00025	0.00156	0.00211	0.00277	0.00353	0.00439	0.00535
The rest	1	0.00033	0.00034	0.00035	0.00036	0.00037	0.00038	0.00040
	2	-0.01075	-0.00981	-0.00955	-0.00929	-0.00903	-0.00878	-0.00854
	3	-0.01048	-0.00943	-0.00914	-0.00885	-0.00853	-0.00821	-0.00787

Table 8. Percentage change of output in the metal products sector from BAU

3.5 Welfare effects

Table 9 demonstrates percentage change of welfare from BAU. Although carbon tax is a factor for price increase, Japan's welfare rises from BAU for Case 1. It can be explained that a price increase is limited because the carbon tax rate is quite limited and is applied only to energy products. Also, the introduction of carbon tax contributes to government revenue. Thus, it is considered that the positive effects through government behaviour are greater than the negative impacts of carbon tax on national welfare. In contrast, Japan's welfare declines for Cases 2 and 3. Import prices go up by border adjustments and these negative effects are substantial for these cases. According to the results of Japan, border adjustments would not help to improve welfare. In this model, tax revenue from border adjustments is not transferred to household and does not have direct positive impacts on household consumption. This may be a reason for these unexpected results.

Similar changes can be found for China. Welfare changes of China are negative for Cases 2 and 3. This shows that the adoption of border adjustments in Japan may have negative impacts on Chinese economy, particularly on the exports because of higher tariffs. Contrarily, signs of welfare changes for India are opposite to those of Japan and China. Even though India faces border adjustments, its welfare is improved. To explain the reasons, we need decomposition analysis which is not considered in the current analysis. The introduction of NAMAs affects China negatively and India positively compared with BAU. However, compared with Case 2, welfare deterioration will be less for China and India's welfare will improve more.

	Case	2011	2015	2016	2017	2018	2019	2020
JPN	1	0.00124	0.00135	0.00140	0.00145	0.00151	0.00159	0.00168
	2	-0.05537	-0.06042	-0.06213	-0.06407	-0.06627	-0.06876	-0.07157
	3	-0.05166	-0.05473	-0.05595	-0.05739	-0.05909	-0.06107	-0.06336
CHN	1	0.00000	0.00004	0.00006	0.00007	0.00009	0.00010	0.00012
	2	-0.03426	-0.03011	-0.02953	-0.02913	-0.02895	-0.02902	-0.02937
	3	-0.02528	-0.01837	-0.01713	-0.01606	-0.01517	-0.01445	-0.01392
IND	1	-0.00004	-0.00004	-0.00004	-0.00004	-0.00004	-0.00004	-0.00004
	2	0.00146	0.00218	0.00240	0.00265	0.00291	0.00319	0.00350
	3	0.00176	0.00263	0.00288	0.00316	0.00346	0.00379	0.00414

Table 9. Percentage change of welfare from BAU

4. Conclusions

In this chapter, we quantified the economic and environmental effects of CO_2 abatement policy as well as border adjustments by applying a global CGE model with 13 regions and 24 sectors. In particular, we focused on Japan's proposed carbon tax and border adjustments in the form of import tariffs. Major findings are as follows:

• Due to the implementation of carbon tax in Japan, international carbon leakage will occur.
• Border adjustments (e.g. by Japan in this analysis) can help mitigate international carbon leakage and global emissions.
• However, border adjustments do not necessarily contribute to output increase of energy-intensive sectors, which is related to the concern on industrial competitiveness of the implementing country. In addition, BAMs may have negative impacts on the national welfare of the implementing country.
• Nationally appropriate mitigation actions (NAMAs) have great potential impacts to reduce global emissions and to improve national welfare in both the implementing country of a BAM and its target countries.

Although we analysed the impacts of Japan's carbon tax and import-tariff-based border adjustments, several improvements can be expected. First, the embodied emission coefficients are calculated based on the data of 2000. Updating the data is necessary. Second, the embodied emission coefficients for all selected countries should be re-calculated based on the changes of emission intensities in China and India. Third, we showed some positive and substantial impacts of NAMAs on both economy and the environment. However, specific approaches and policies to implement NAMAs in China and India are not reflected and should be examined further. Finally, we only analysed Japan's climate policy and BAMs. The inclusion of EU Emissions Trading System (EU-ETS) and US cap-and-trade system will provide more comprehensive insights.

5. Appendix: WTO compatibility of border adjustments

Any BAM with a serious trade impact may be challenged before the WTO. Given the vague nature of WTO law in this respect, the WTO may either uphold or strike down the BAM provision. In principle, a trade measure needs to be justified by the non-discrimination principle, i.e. national treatment and the most-favoured nation clauses, provided under GATT (Articles I, II, and III). Therefore, a climate change-related trade provision that applies only to imports is suspect to be protectionist. A measure that applies to both imports and

domestic products is accepted as long as it does not discriminate against imports from domestic products or against imports from particular countries. In addition, under trade law, price-based measures such as taxes are regarded as more transparent and economically more efficient than regulations. Hence, generally speaking, WTO rules push countries to adopt price-based measures such as tariffs or taxies, rather than quantitative import restrictions or trade restrictive regulations.

Depending on the form they take, trade measures to address competitiveness and carbon leakage concerns associated with the implementation of unilateral climate policy may be very different in both economic terms and legal terms. The choice of instrument is therefore crucial to their fate of WTO compatibility. As indicated by some legal analyses (e.g., Pauwelyn, 2007), an import restriction provision in the form of an import ban or punitive tariffs on imports from free-riding countries, anti-dumping duties against "environmental dumping", or counterveiling duties offset the "subsidy" of not imposing carbon restrictions would have little chance of survival before the WTO challenge. While border tax adjustment based on a domestic carbon tax or a cap-and-trade system would have better chance to survive WTO scrutiny.

5.1 Border tax adjustments on imported products

In its examination of BTAs, the 1970 GATT Working Party distinguished that taxes directly levied on products, the so-called indirect taxes (such as excise duties, sales taxes and the tax on value added), were eligible for adjustment, while certain taxes that were levied on producers, the so-called direct taxes (such as payroll, taxes on income, property and profits, social security charges, or interests), were normally not eligible for adjustment.

Pursuant to GATT Article II.2 (a) allows WTO members to impose a charge equivalent to an internal tax on the importation of i) products that are like domestic products; or ii) articles from which the imported product has been manufactured or produced in whole or in part.

Based on these rules, however there is long-standing legal debate focusing on i) the eligibility of domestic carbon/energy taxes as indirect taxes for border adjustment; ii) the qualification of the allowance price under a cap-and trade system as an "internal tax"; and iii) the extent to which the energy inputs and fossil fuels could be considered to be articles from which the imported product has been manufactured or produced in whole or in part, related to the requirement of physically incorporated into the final product and the explanation of "direct" and "indirect" physical incorporation (Biermann & Brohm, 2005; Pauwelyn, 2007).

If the price-based climate policy takes the form of a carbon tax, it needs to pass two critical eligibility tests for being adjustable under GATT: (i) carbon/energy taxes are indirect taxes; and (ii) energy/carbon emissions are articles incorporated in whole or in part of imported product. On the one hand, following the definitions of "direct" versus "indirect" taxes in the WTO Agreement on Subsidies and Countervailing Measures (SCM), a carbon tax can be justified as an "indirect tax" and thus eligible for adjustment (Pauwelyn, 2007). On the other hand, it remains unclear whether input or process-related taxes on physical inputs (such as energy or carbon emissions), the so-called "taxes occultes", can be adjusted at the border. Therefore energy/carbon taxes to be defined as "indirect taxes" that are "indirectly" applied to products lacks clear legal basis for justification (Biermann & Brohm, 2005).

If the climate policy takes the form of a cap-and-trade system, in general, its qualification for adjustment is more complicated than the policy designed in the form of a carbon tax. The fundamental concern is whether the obligation to hold emission allowances can be qualified as an "internal tax or other internal charge of any kind". In addition, the complication is further under the situations: (i) when all or part of the allowances is allocated for free; and

(ii) when the adjustment also takes the form, not of a tax, but of a requirement to importers to surrender emission allowances.

Even if border adjustment were permitted for a carbon tax or a cap-and-trade system, one more critical question is the definition of "likeness" of domestic and imported products in its relations to the non-discrimination principle. The WTO Appellate Body in the EC-Asbestos case provided four "characteristics" for assessing the "likeness" including: (i) the physical properties of the products; (ii) the extent to which the products are capable of serving the same or similar end-uses: (iii) the extent to which consumers perceive and treat the products as alternative means of performing particular functions in order to satisfy a particular want or demand; and (iv) the international classification of the products for tariff purposes. However whether steel from China made with coal (high carbon-intensity), for example, is "like" steel from US using natural gas (low carbon-intensity) may remain unclear.

5.2 Border tax adjustments on exported products

GATT (Article XVI on Subsidies and Ad Article XVI, 1994) and WTO SCM Annex I Item (g) permit, under certain conditions, the use of border tax adjustments on exported products. However, export Border Tax Adjustment (BTA) cannot be subject to anti-dumping duties aimed at exports at less than domestic market price, nor to countervailing duties aimed at offsetting certain subsidies provided in the exporting country. In addition, the rebate should not be larger than the actual indirect tax levied on "like" products "when sold for domestic consumption".

5.3 GATT Article XX on the general exceptions clause

More related to climate change measures is GATT Article XX, which provides a number of specific exemptions from GATT rules, in particular related to the protection of human, animal and plant life or health (paragraph (b)) and the conservation of exhaustible natural resources (paragraph (g)). However, there are many debates on its application to climate-oriented trade measures. Several case laws (US-Shrimp case, Brazil-Retreaded Tyres case, EC-Asbestos case, etc.) indicated the importance for the trade measure at issue to show (i) the satisfaction in the requirements of the "chapeau" of Article XX on the manner in which trade measures are applied; (ii) the necessity of the trade measure and the availability of alternative options in achieving the environmental objective related to Article XX (b) and (g); and (iii) substantial link between the trade measure and the stated climate change policy objective (means and ends relationship).

On the one hand, the opponent to the justifiability of BAMs by WTO law must prove that the policy is not worthy of an exception under Article XX and show that a less trade-restrictive policy option is available and effective (related to (ii)), or that the policy does not contribute toward achieving a reasonable climate goal at all (related to (iii)). In this regard, Manders & Veenendaal (2008) reveal that alternative measures, in particular recycling part of permit auction revenues to exposed ETS-sectors and greater reliance on the Clean Development Mechanism, could be more effective than a border measure. In addition, several economic analyses (e.g. Babiker & Rutherford, 2005; Fischer & Fox, 2009) reveal that BAMs' contribution to the conservation of the climate is not assured. On the other hand, the proponent to a trade measure needs to demonstrate that it has been well tailored to achieve a legitimate environmental objective in a least trade restrictive manner. Protecting domestic producers from foreign competition may therefore not be recognized as a legitimate policy objective under WTO law (Houser et al, 2008).

5.4 Practical challenges

Once border adjustments were permitted by the WTO, collecting the relevant data for the process-based calculation of a border adjustment, that is, tracing the proper amount of taxed input in the production process in the respective country of origin is still difficult. There are several proposals to reducing complexity. One is to limit the number of products subject to BAMs to a manageable level. As for exports, an energy-added tax method, similar to invoice methods for value-added tax can be used. In the case of imports where the necessary information on the production process is limited or not provided by the exporter, the use of a benchmark of "the best available technology" seems to be a feasible approach compatible with world trade law (Pauwelyn, 2007; Ismer & Neuhoff, 2004), however is weaker adjustment factor and would therefore be less effective (Takeda et al., 2010).

Another challenge is permit allocation. Auctioning may be a prerequisite for border adjustment, since the free allocation of permits through grandfathering might be an unfair subsidy (Pauwelyn, 2007).

6. Acknowledgment

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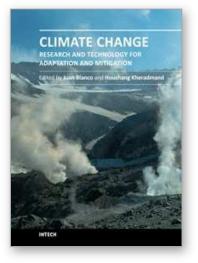
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Climate Change - Research and Technology for Adaptation and Mitigation
Edited by Dr Juan Blanco

This book provides an interdisciplinary view of how to prepare the ecological and socio-economic systems to the reality of climate change. Scientifically sound tools are needed to predict its effects on regional, rather than global, scales, as it is the level at which socio-economic plans are designed and natural ecosystem reacts. The first section of this book describes a series of methods and models to downscale the global predictions of climate change, estimate its effects on biophysical systems and monitor the changes as they occur. To reduce the magnitude of these changes, new ways of economic activity must be implemented. The second section of this book explores different options to reduce greenhouse emissions from activities such as forestry, industry and urban development. However, it is becoming increasingly clear that climate change can be minimized, but not avoided, and therefore the socio-economic systems around the world will have to adapt to the new conditions to reduce the adverse impacts to the minimum. The last section of this book explores some options for adaptation.

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