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The Political Economy of Climate Change Policies : Political Economy Aspects of Climate Change Mitigation Efforts

by
Nicole A. Mathys and Jaime de Melo

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Political Economy Aspects of Climate Change Mitigation Efforts[1]

Nicole A. Mathys and Jaime de Melo

ABSTRACT

Regardless of the policies used to mitigate climate change, a positive and relatively high price of carbon will have to be established, with slow convergence across regions, leading to huge rents up to capture, way beyond those that have been fought over in the GATT-based international trading system. The paper explores the political-economy, feasibility and desirability implications of the two main alternatives, a carbon tax and a cap-and-trade (CAT) system. Having the same concerns, CAT systems in the EU and the US have accounted for different outcomes in each case. Likely leakages under foreseeable carbon prices are estimated to be small and not of an order of magnitude justifying the special allowances sought across a wide spectrum of industries. The experience of the EU and US reviewed here suggests that mitigation is likely to continue to be carried out under a CAT provided permits are distributed for free to the lobbies whose support is necessary to get adoption of mitigation policies. This quota mechanism, long-used to allocate scarcity in the international trading system both nationally and internationally, would end up with the most powerful receiving the quotas rents, giving them the leverage and resources to maintain allocation schemes favourable to them.

Keywords: Climate change; mitigation, cap-and-trade, political economy

JEL Codes: F18, Q54, Q56

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1. INTRODUCTION

Global warming is arguably the leading challenge to our capacity for global governance and its associated collective action. Very little agreement has been reached so far, the only really agreed-upon decision being "common but differentiated responsibility" (CBDR) which calls for financial transfers from rich to poor countries to compensate for the accumulated Green House Gases (GHGs) due to rich countries contributions to the stock since the early 1990s. Yet compensation amounts (between 0.5 per cent and 1 per cent of GDP of OECD countries) and modalities (e.g. a global green fund) are yet to be decided. The estimated magnitude of the costs of mitigation (estimated to be up to 35 per cent of GDP by 2200 according to the Stern report) make minimizing costs an important objective of any collective action. Efficiency calls for more abatement to take place in poor countries where marginal abatement costs are lowest and also for the elimination of subsidies to fossil fuels, estimated to account for up to ten per cent of global emissions by 2050 (OECD, 2009). The dual criteria of efficiency and fairness call for some separation of the location of the mitigation activities from the absorption of cost.

Whichever approach is adopted to limit CO2 emissions, under current knowledge it is estimated that a tax of $100 per ton of CO2 will be necessary to keep temperature rise to around two degrees Celsius generating annual rents close to a trillion dollars.[2] And annual fossil fuel subsidies that should be eliminated are estimated at around $500 billion. Both measures have faced and continue to face strong opposition and any serious action against climate change will have to face up to contestable rents far beyond those that have ever been at stake in the world trading system. Dealing with rent transfers nationally and internationally will dominate efficiency considerations both because the electorate is opposed to tax increases and because high GHG emitters are powerful groups in the energy, construction, transportation and manufacturing sectors. Even though coping with these rent transfers has not yet really started, the storm is on the horizon. This paper discusses aspects of the political-economy unravelling so far.

By way of introduction, consider the promotion of bio fuels as an alternative to fossil fuels. It exemplifies the political difficulties faced by governments too weak to address mitigation by efficient means. Recently, the US set objectives for renewable energy by subsidizing bio fuels

[2] According to a business as usual (BAU) scenario, average CO2 emissions will be around 10 giga tons in 2025. A recent survey of 18 models comes up with a $100 per ton tax on carbon as necessary to limit temperature change to two degree Celsius implying close to $1 trillion in revenues at the global level (Weyant et al., 2006). Hufbauer et al. (2009, table 1.2) also come up with a revenue estimate of $0.98 trillion for a $100 tax per ton of carbon equivalent applied to all countries and greenhouse gases.

because the alternative of raising the price of fossil fuels continues to be perceived as politically too risky. Bio fuels are produced mainly by Brazil from sugar cane and by the US from corn. Altogether, bio fuels account for about two per cent of global transport fuel. Estimates suggest that sugarcane-produced ethanol reduces GHG emissions by 80 per cent over the cycle of production and when produced by corn by only 30 per cent. Furthermore, 1.12 (1.38) kcal of ethanol from corn (sugarcane) is produced per 1.0 kcal of fossil fuel energy expended. According to Hufbauer and Kim (2010), 200 support measures costing $5.5billion to $7.3 billion are given each year to bio fuel producers in the US. The US also imposes a 46 per cent ad-valorem tariff on imported ethanol as part of US agricultural policy with supporters invoking the infant industry argument. In the EU, to respond to the desire to substitute fossil by vegetal fuel, a producer of ethanol is protected by a tariff of 42.9 per cent on imported ethanol.

The paper explores the political economy of climate policies and their interaction with the international trade system. Section two examines the resistance to the adoption of a carbon tax at the national level. Section three elaborates on the alternative of a carbon credit trading system (CCTS) which allows one to dissociate where emission reductions take place from who pays for it and it reviews the experience with permit trading under the Kyoto protocol. Section four draws lessons from cap-and-trade (CAT) systems in the EU and the US as it is clear that the 'bottom-up' approach to reduction in GHGs will lead to some form of linking across different CAT systems. Finally, section five turns to the issue of 'leakage' and the pressure for border tax adjustments as not all countries will participate in treaties or they will progress at different speeds.

2. A CARBON TAX

A carbon tax has often been advocated and is the preferable option on economic grounds (see e.g. Cooper, 2008; for a discussion of the appeals of this approach). First, millions, if not billions of agents take energy-related decisions so the surest way to reach them all is through the transparency of the price system. This is the strongest, and a very compelling reason, in favour of a tax as a single price which even at the national level reduces lobbying activity.

Second, a carbon tax corrects the problem at its source, although under enough assumptions, several not likely to be met for reasons discussed below, it is equivalent to a CAT system in which carbon credits are traded freely and competitively to establish the equivalent tax.

Third, a carbon tax is much more easily verifiable than most other approaches which aim to put a ceiling on all six GHGs whose emissions are difficult to verify.[3] Indeed, a major difficulty with the favoured CAT system is that substantial up-front costs will have to be paid to make it verifiable whereas a tax on gasoline and electricity, making up roughly half of all CO2 emissions, is easy to verify and monitor.

Fourth, if the tax is the same, or it is agreed that the different tax rates will converge across countries, the leakage problem would be largely resolved. In the case that taxes are different and leakage is found to be important, transparent levers (i.e. differences in tax rates) are known and hence there to help negotiate compensation. For example, a carbon tax on the CO2 content of imports could be imposed on countries that do not levy a carbon tax on their exports, though it should be avoided for reasons discussed in section five.

Fifth, the thorny issue of the mechanisms for burden sharing is lessened since governments rather than lobbies will get the revenue from the tax.

Sixth, even though there is all-round uncertainty, it is likely that the marginal benefits from reductions in the flow of emissions are quite elastic, if only because the damage depends on the stock of emissions. On the other hand, uncertainties about the marginal costs of abatement are large. Under that configuration, as first shown by Weitzman (1974) and confirmed in later studies (see Karp and Zhao, 2009; for a summary), the welfare benefits of using the price mechanism are greater than those associated with using a quantity target.

Seventh, and most importantly, similarly to a move towards tariff uniformity, moving towards a uniform carbon content tax has the advantage that it reduces greatly the incentive and possibility for lobbying activity.

In spite of these advantages, few countries have adopted carbon taxes. British Columbia has set a carbon tax of $20 per ton on fossil fuels. Norway and other Scandinavian countries have also put in place a tax, but many exemptions have limited its effectiveness as lobbying activity to avoid the tax was great (Metcalf and Weisbach, 2010). Following a long debate, France abandoned its plan to introduce a carbon tax. After failing to introduce a CAT scheme to limit GHG emissions, Australia, a leading emitter of GHGs on a per capita basis, is contemplating introducing a $23 ton carbon tax in 2012. The government is facing strong reactions across the board, the coal

[3] The six main greenhouse gases are: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride.

industry predicting a loss of 20,000 jobs, and taking out ads in the press that Australia would be the only major coal exporter with a carbon tax, while the oil industry objects that the rate should be higher and wind producers hail it as a "game changer". Lobbying activity is expected to be intensive.

In the US, a nation-wide representative poll taken in 2010 showed that 75 per cent of Americans responded that global temperature was on the rise due to human activity, with 86 per cent wanting the US government to curb air pollution and 76 per cent wanting the government to limit GHG emissions by businesses. However, confirming the general image that taxes are literally a "tax", 78 per cent opposed taxes on electricity and 72 per cent opposed taxes on gasoline, showing the importance of political pressures against internalization (Krosnick, 2010). And of the major bills under consideration in the 110th US Congress, only two propose a carbon tax, all the others favouring a CAT system.

Notwithstanding backing by many economists (e.g. Cooper, 2008; Nordhaus, 2008), the prospects for adoption of a carbon tax are still poor, justifying the view by some opponents that pushing for a carbon tax is a form of procrastination. The lack of understanding of economics by the majority of the electorate leads Karp and Zhao to propose a CCTS even though it is inferior to a tax on the grounds that it would be "a major mistake to base a proposal for an international climate agreement on the ability to raise this public understanding" (Karp and Zhao, 2009; p.16).

3. A TARGET SYSTEM WITH A CARBON CREDIT TRADING SYSTEM (CCTS*)*

The foremost argument in favour of a stringent cap is that, if the science is correct, we will have to reduce emissions of GHG close to zero because GHGs are long-lasting (about 30 per cent of emissions in 1850 were still airborne a century later (Wheeler and Ummel, 2007). The safest way to concentrate on this objective is to agree on a cap on emissions that, if taken seriously, will focus on objectives and mobilize effort towards exploring the alternatives to move out of the dependency on CO2-intensive energy. In comparison, the tax alternative examined above is inherently more uncertain as to its ultimate effects on emissions even though the past oil spikes have shown that emissions are responsive to large increases in the price of fossil fuel.

A second and equally compelling argument in favour of a cap is that if it is extended to a cap-and-trade (CAT) system it leads to an efficient outcome regardless of the initial allocation of permits (given several conditions that Hahn and Stavins (2010) call the *independence property* in

reference to the Coase theorem*)*.[4] In that case, the government (or regional entity) decides on the overall level of emissions and distributes the corresponding amount of permits allowing recipients to exploit all potential gains from trade. In a well-functioning market, the permit price will be independent of the allocation across firms or regions thereby separating efficiency from equity. Thus a well-functioning global CCTS could then solve a challenging problem: (i) insure efficiency by having mitigation take place in low-income countries and (ii) take care of distributional equity to CBDR by the initial allocation of credits across countries.

From a political-economy standpoint, the CAT system has worked well to eliminate acid rain in the US (and served as inspiration for the EU ETS). During the 1990 legislative debate in the US on the Clean Air Act to reduce SO2 emissions, "bonus allowances" were distributed to electricity generators in Ohio that used high-sulphur coal and all allowances were grandfathered to plants in operation in 1990. The distribution of bonus allowances contributed to get the necessary support for bi-partisan support even if it resulted in lower trading prices for permits. In the end, the objective of cutting SO2 and NOx of power plants to 50 per cent of their levels in 1980 between 1990 and 2000 was met with success as compliance rates were 100 per cent in 2006. It is estimated that costs have been decreased by half relative to a pure cap with no trading (Ellerman et al., 2000).

When proposed on an international scale, CAT systems have had less success. In the EU's recent plan to regulate carbon emissions from planes (airlines account for two per cent of global CO2 emissions) flying in and out of the EU starting in 2012, the CAT has met with strong opposition from China threatening a trade war and the US Air Transport Association has filed a lawsuit to stop the rules before the European Court of Justice.[5] The vehement opposition so far may subside, but it is indicative of the difficulties ahead in any measures that will amount to altering comparative costs.

Besides the conflicts over transnational sharing of rents, several disadvantages are associated with a CCTS. First, it is likely to lead to greater price volatility. This happened under the SO2 trading system in the US and under the ETS, at least in the initial stages (Ellerman and Joskow, 2008; Nordstrom, 2009) .Volatility of the price of carbon would be particularly problematic. For households and firms, energy would become an important budgetary item. Energy perspectives

[4] In a nutshell the conditions that must be satisfied are; (i) constant marginal transaction costs, (ii) absence of market power and liquidity constraints, (iii) no limitation on transferability related with uncertainty, (iv) unconditional allowance allocations, (v) cost-minimizing behavior, (vi) no differential regulatory treatment.

[5] The proposal is to cut emissions by three per cent in 2012 from their levels in 2004-06, airlines being forced to buy permits to cover emissions that exceed their target. The International Air Transport Association estimates that the average fare in and out of Europe would rise in the range of 2.2-4.6 per cent (IATA, 2007).

are also crucial for long-term investment decisions in the building and energy sector. [6] Second, there is possibility of strategic behaviour, especially in a system where not all participants face a cap. This was the case under the Clean Development Mechanism (CDM) permitted by article 17 of the Kyoto protocol. Third, when governments, rather than firms, are the actors in the markets for permits (as under article 17), efficiency is likely to be low. Hahn and Stavins note (2010, p. 19) that "unlike firms, governments are unlikely to have the incentive or the capability to act in a cost minimizing way", observation that is corroborated by the negotiations under the EU-ETS (see below) and the storm on the horizon regarding the proposed EU regulation of emissions from planes.

After surveying eight cap and trade systems, Hahn and Stavins conclude that some CAT systems like the SO2 allowance trading have performed well while others, like article 17 of the Kyoto protocol have yet to prove they are effective.[7] In particular, the 'additionality' principle which requires the exclusion of 'win-win' or 'no-regret' projects has been heavily criticized as a large number of projects in the industrial gas sector have been close to "win-win" projects and have allegedly been subject to gaming with consequential transfers, but little abatement taking place.[8] Lack of transparency and lack of predictability by the Board, and long delays in taking decisions, have contributed to the high transaction costs. Problems of governance have also been pointed out. For example, until recently, the «designated operational entity» (DOE) first audited the projects for approval, then verified the emissions reductions for these same projects, to which the DOE had contributed to approve, creating a conflict of interest (Karp and Zhao, 2009).

4. CAP AND TRADE IN THE EU AND THE US

Following the ministerial conferences in Copenhagen (December 2009) and Cancun (December 2010) where countries agreed to pledge unilateral cuts, some form of CCTS will emerge at

[6] Various proposals suggest that in the presence of abatement cost uncertainty, permit trading with a safety valve established at the negotiation stage can increase efficiency without decreasing equilibrium participation (Karp and Zhao, 2009). Such safety valves with a price floor and price ceiling on the price of carbon have also been proposed as a 'collar' to prevent the large fluctuations experienced in the early days of the ETS.

[7] Under joint implementation (JI), the distribution of abatement levels is decided by firms through trade in permits that leads to the equalization of marginal abatement costs with the permit price across firms. An example is the EU ETS. The same efficiency effects are at work under the CDM which takes place between Annex-1 countries under a cap and those outside the cap (non-Annex 1 countries). The operation of the CDM also leads to a transfer of funds between the two groups of countries as firms in Annex-1 purchase Certified Emission Reductions (CERs) from developing countries for emission-reducing activities taken in developing countries.

[8] Ostrom (2009, p.29.) describes the gaming under the CDM. Manufacturers of refrigerants gained 'lucrative' Certified Emission Reductions (CERs) who started producing refrigerants that released trifluoromethane-CFC-23 (a GHG) just to offset it. According to Wara and Victor (2008), Annex 1 countries paid €4.7 billion for CERs related to CFC-23 a GHG gas whose abatement only costs around €100 million.

regional levels, if only because distributing quotas allows to muster the necessary support to adopt mitigation policies. We review the experiences of the EU and US.

European Union. Since 1990, Europe has taken the lead in Climate negotiations, being the first to commit to a stabilization target in 1990, then assuming the toughest target in the KP1 negotiations in 1997, and then offering the most ambitious reductions in 2008. With a relatively large disparity in energy policies (according to Nordstrom, 2009; in 2008, the ratio of tax revenues to energy consumption varied by a factor of five across the EU), implementation between sovereign states was a challenge.

First, although the Maastricht Treaty extended treaty-making power to the EU with decision-making on a qualified-majority basis, decisions on energy sources and on taxation remain in the hands of member States. Hence the EU cannot impose a cap or a CAT unless there is agreement of all members, nor can it order member states to phase out fossil fuel in favour of renewable energy. Moreover, echoing the principles agreed upon at the UNFCC, Community policy on the environment has relied on the principle of 'precaution and polluters pay' with CBDR since the Council can and has laid down temporary derogation and/or financial support.

Second, linkage between ETS and non-ETS markets within Europe has not taken place, suggesting the difficulty to linking CAT systems across countries/regions.[9] The EU Emissions Trading System (EU ETS), inspired from the trading system under title IV of the US Clean Air Act[10], covers 11,000 firms accounting for about half of CO2 emissions, with a sharing formula for residential heating, transport, agriculture and waste management. Cuts range from +20 to -20 per cent from 2005 levels based on a close to linear relation with per-capita income. A mild sanction carrying a penalty of eight per cent to borrow against future allocations when a target was not met was established. While countries and stakeholders requested maximum flexibility, a carbon market was also established for non-ETS emissions, but the possibility of transferring abatement between the two markets was denied so that there might be two prices in the carbon market. In addition, free permits were available for new projects permits lost when closing

[9] Metcalf and Weisbach (2010) discuss linking across independently-designed systems and the distribution of gains across countries (those with high abatement costs will gain most from linkage). At the end of 2010 negotiations were opened on linking the EU ETS with Switzerland's domestic trading system. While Norway, Iceland and Liechtenstein are already covered by the EU emissions trading system through their membership of the European Economic Area agreement, this would be the first formal process to link the EU system with the emissions trading system of a third country

[10] Under Title IV of the Clean Air Act of the US a cap was put on SO2 emissions by all large US plants in 1990 calling for a 50 per cent reduction by 1995 with permits distributed for free across plants based on emissions in 1987, preventing the gaming that took place under the ETS. Tradable permits were always distributed for free only to designated recipients in 1990. These were issued yearly and were valid for a period of thirty years giving a long time horizon for, and grandfathering taking place on the basis of. Also, abatement under Title IV was compulsory with a severe penalty.

down plants (to prevent leakage).Both measures contributed to a multiplicity of prices in the carbon market.

Third, short time periods for each phase combined with the lack of bankability across phases have contributed to volatility in the price of permits. In phase I (2005-07), emission allowances were grandfathered, i.e. allocated for free, for a short two-year period not to exceed seven years by phase III (2013-2020). Through gaming, this contributed to an over-allocation by three per cent, as firms overstated their needs and to a market price converging to zero in 2007. According to measurements at the installations covered by the cap, emissions went up by an average of 0.24 per cent over 2005-07 (Nordstrom, 2009). In the second phase covering 2008-12 fewer allowances were issued and the price of CO2 equivalents has been fluctuating between €15 and 25 per ton, far less than the €60-90 per ton needed for capture and storage investments to be profitable. This low price has raised concerns that greater attention should be placed on providing mechanisms for a price floor rather than (or in addition to) for a price ceiling in any CCTS. A dilemma arises here since high uncertainty about the science of climate change calls for short time periods while price stability in the permit market which is important for long-gestation investments, calls for long time-periods in the permit market.[11]
Fourth, moving from free distribution to auctioning has been difficult. On the proposals for ETS reforms, close to 90 per cent of industry associations were against auctioning permits (with the strongest opposition amongst energy-intensive industries) and, if auctioning were to take place, over half were in favour of distributing revenues within industries. After tortuous negotiations, a final compromise was reached by December 2008 with the EU proposing for COP-15 (COP: Conference of the Parties) a 20 per cent reduction by 2020 from 1990 levels (up to 30 per cent if significant effort is made by others) with sectors exposed to risk (i.e. high trade intensity and energy intensive) getting 100 per cent free allocation up to 2020. The distribution across countries is almost in proportion to their verified emissions and 50 per cent of the proceeds are to be earmarked for mitigation efforts in the EU and in developing countries.

Several aspects of the EU experience are noteworthy. First, in spite of several attempts by the Commission, a carbon tax could not be adapted and efforts at convergence have still a long way to go, since countries are unwilling to give up sovereignty on taxation. Second, moral hazard resulting from firms obtaining too many licenses has resulted in low carbon prices, far below

[11] Schelling (2007) estimates that the range of uncertainty has remained constant and equal to a factor of three. Tirole (2009) suggests several measures (intertemporal smoothing, indexation of permit issuance to climate variables, risk coverage and the creation of a supra-national agency to decide on permit allocation). While laudable, these measures have not even been accepted within the EU, so their applicability across countries is even more unlikely. As to countries emitting contingent obligations to repurchase permits at a pre-specified floor price, would increase credibility but would not solve the necessity of flexibility in the face of uncertainty.

threshold levels needed for profitable R&D in alternative energy sources.[12] Third, an equitable burden-sharing formula largely based on per-capita income (that included 'comparability of efforts') was necessary with the simultaneous negotiation on the cap and the distribution of adjustment across countries. The negotiation process also showed that countries were well aware of their interests, an observation that applies as well to the US voting patterns on carbon legislation (see below).[13] Fourth, much like in the SO2 case, financial support and compensation was integral (through the free allocation of permits to firms and the redistribution of auction rights under the EU ETS with 12 per cent of auction rights redistributed to States). Fifth, provisions for the 'leakage issue' (see below) had to be addressed. Once the option of applying a border tax adjustment on imports from non-participants like the US was dropped, this opened the door to free allowances for many sectors. Permits were grandfathered for existing coal-fired plants but not distributed to firms investing in wind-power. Auctioning with compensation via tightly controlled subsidies would solve these issues, except for the successful lobbying by firms to qualify on the allocation-free list.

United States. In the US also, and for the same reasons as in the EU, a CAT system enjoys much more support than carbon taxes. Indeed, the majority of bills under consideration reflect this fact (see Hufbauer et al., 2009) with free allowances for critical sectors deemed subject to leakage. As a result, they are painted as entailing little sacrifice from the general public. More importantly, in view of the estimated rents up for attribution under any meaningful restriction on carbon emissions, the holders of licences will have in hand "quota rents" worth hundreds of billions of dollars (estimated at $187 billion for the US for $100 per metric ton of carbon equivalent, see Hufbauer et al., 2009, table 1.2).

In view of the amounts of rents up for capture, a reflection of the need to 'buy support', it is not surprising that the June 2009 version of the Waxman-Markey legislation was 1426 pages long. This lengthy legislation is reminiscent of Krueger's observation that in the NAFTA treaty over 800 pages were devoted to detailing the criteria that would establish origin, i.e. that would detail qualification for preferential access and the associated rents (Krueger, 1997). This reflects the fact that resources expended to obtain a fixed rent increases with the number of participants.[14]

[12] Interestingly, the Waxman-Markey proposal also allows the EPA to build up a "strategic reserve of permits" to be able to sell them if permit prices were to rise too quickly.

[13] As discussed in Nordstrom (2009, sec. 6.4), member states always spoke in their interests (e.g. the reallocation of quota rights to low-income members was welcomed by the low-income members and viewed suspiciously by others).

[14] In a Cournot set-up n symmetric contestants compete and pledge X=nx resources to obtain a fixed rent, R, with probability p. The amount expended per participant increases with the number of participants. Total expenditures are given by X=R(n-1)/n.

In the US as well, the public and politicians have been well aware of how the political economy plays out. The failed Warner-Lieberman bill (viewed as 'cap and tax' rather than 'cap and trade' because, unlike under the SO2 system, permits would not have been entirely grandfathered) offers further thoughts on the political-economy of raising the price of energy. In June 2008, the bill failed a cloture vote (i.e. it fell short of obtaining 60 votes in the Senate). Many observers said that this reflected suppression of evidence on global warming, conservatism, and the lack of public education. However, Wheeler (2008) finds strong econometric support for two concerns evident in the climate change debate: states with heavy fossil dependence ('brown' states) will be opposed to the Warner-Lieberman bill; and carbon legislation imposed by the rich will inflict a disproportionate burden on poor regions ('brown' states). [15] His estimates of the determinants of the vote strongly support these priors with legislators from 'brown' states in opposition and legislators from 'green' states in support. His simulations suggest that, holding other factors constant, raising income and reducing fossil-fuel dependence would have been sufficient to shift the Senate vote to acceptance. Wheeler estimated that a redistribution of 30 per cent of the proceeds through what he calls CASH share certificates (CASH for Certified Atmospheric Share) from the tax proceeds would have been sufficient to compensate all families for the rise in energy costs (transportation and housing) and therefore to gain support for the bill. People being aware of how they would be impacted by a tax, it is likely that the votes reflected citizens fears that the political process would lead to rent capture by lobbies.

In a follow-up, using the same categorization of States, Wheeler (2010) explored the reasons why Europe succeeded in regulating carbon emissions through the ETS while the US did not. He argues that interregional carbon mitigation negotiations such as those in the US North East under the RGGI (Regional Greenhouse Gas Initiative) and the EU ETS, have been guided by differences in mitigation costs and the strength of the region's incentives to join the agreement. He shows that emission intensity fell drastically in the EU before the start of the ETS and more importantly that the disparity in carbon intensity across the EU-15 States was much less than between US 'green' and 'brown' States while the 'brown' EU-12 newcomers had to join the ETS as a precondition for EU membership and its associated benefits. In the US however, interregional disparities in carbon intensity are large and compensating incentives have been modest at best, leading Wheeler to conclude that 'Green' States will have to pursue mitigation policies on their own, policies whose mitigation intensity will be limited by free-riding by 'brown' states even in the presence of some form of carbon-added taxation.

[15] 'Brown' States (those 19 US States that do not participate in a regional CAT and who had a majority of representatives voting Waxman-Markey) had emission intensities over twice as high and per capita income 20 per cent below the 15 Green States. See Wheeler (2010).

5. CARBON LEAKAGE

As countries will not be converging rapidly towards a unique price of carbon, if the industries that are intensive in GHG emissions are "footloose", they will relocate towards countries that do not tax carbon and there will be leakage. The possibility of leakage is a powerful argument in favour of a 'broad then deep' architecture replacing the 'deep and shallow' agreement under the Kyoto Protocol (KP). With close to full, or full participation, a well-designed CCTS would eliminate leakage Two aspects are critical in determining the extent of leakage.

First how different are emission intensities across sectors within a country and within a sector across countries? The answer to the first part of the question is straightforward: only a handful of sectors are heavy emitters of CO2 (energy transformation, some industrial sectors like petroleum & products, paper & products, aluminium and steel). As to differences in emission intensities, these can be greater across countries within a sector than within a country across sectors (Dong and Whalley, 2010) so there is potential for 'leakage' and border measures to address leakage should be country rather than sector-oriented creating a clash with the WTO's MFN clause.[16]

Second, take note that CO2 and SO2 emission intensities are highly correlated across industries (the coefficient of correlation is higher than 0.9 for the UK industries over the period 1990-2000). This allows us to draw on the experience of worldwide reductions in SO2 emissions which have been widely studied. Two conclusions emerge from these SO2 studies. First, the more tradable among these heavy SO2 (and hence GHG emitting) sectors are largely weight-reducing industries. Smelting non-ferrous metals (and the processing of paper from wood) usually takes place close to extraction sites to avoid transport costs. Grether and de Melo (2004) and Ederington et al. (2005) conclude that the heavy SO2 polluters are not footloose. This is particularly noteworthy for the US where sharp reductions in SO2 emissions took place between 1990 and 2000.[17] The conclusion from these studies is that the energy-intensive sectors (including those relying on extraction in natural-resource-based industries) are not footloose as

[16] carbon leakage rate = (increase in emissions due to climate policy *outside* enacting country)/(decrease in emissions due to climate policy *in* enacting country). Almost all estimates are ex-ante estimates from simulation models (see de Melo and Mathys, 2010; for a survey of results).

[17] Applying decomposition techniques on production, emission and trade data for 62 countries and 7 sectors overt the period 1990-2000, Grether et al. (2010) estimate that for the US the technique effect is the most important one, followed by the within-sector and the scale effect. The between-country effect has been small suggesting that if sulfur leakage had taken place, it would have been small.

transport costs deter relocation of much processing to countries with lower regulation standards.[18]

In spite of these estimates suggesting small potential for leakage, the leakage issue is raised in the political debate and viewed as a major strain on the World Trading System. Early on, in 1997, the US Senate passed the Byrd-Hagel Resolution by a vote of 95-0 which stated that "the disparity of treatment between Annex-1 parties and Developing Countries and the level of required emission reductions, could result in serious harm to the United States economy, including significant job loss, trade disadvantages, increased energy and consumer costs, or any combination thereof [.]".

The exceptional sensitivity of the carbon leakage issue was also apparent in final legislation on the reform of the EU ETS system. Nordstrom (2009) notes that the leakage issue was so sensitive that the final compromise allows for heads-of-state involvement and that every year the Commission could, at the request of a country, add a sector or sub-sector to the sensitive list (those exposed to risk) that would be eligible to get 100 per cent free allowances. Messerlin (2010) gives the list of 164 sectors and sub-sectors being considered by the Commission as exposed to "significant risk of carbon leakage" while only a handful are recognized as carbon-intensive emitters by experts. He also notes that the same protectionist vested interests that have called upon the panoply of contingent protection measures at the WTO are also on the list under consideration for significant risk of carbon leakage (Messerlin, 2011; table 5).

In conclusion, just as anti-dumping was the price to pay for countries to sign up to the Single Undertaking as part of the Uruguay round grand package, free allowances (or very limited auctioning) may be the political price to get enough support for climate mitigation policies under a cap. However, it results in large transfers from consumers to producers. In a study that covers 75 per cent of CO2 emissions covered by the ETS cap (cement, electricity and steel plus aluminium not covered by the cap but highly intensive in electricity), Demailly and Quirion (2008) estimate that a 15 per cent reduction in CO2 emissions under free allowances would raise the net profit margin of industries under the cap by seven percentage points, an increase coming from a 10 per cent fall in consumer surplus. Of course, aluminium which is highly

[18] It could be objected that costs associated with energy or environmental regulation are small in overall costs explaining the negligible relocation effects for SO2, costs that would be much higher with any realistic carbon price under CO2 mitigation. Yet, other ex-post econometric estimates trying to disentangle the environmental effects from other determinants of bilateral trade volumes across a broad range of manufacturing activities have also failed to detect large net effects. In a gravity-type framework separating "fundamental" from environment-related factors influencing the volume of bilateral trade, Grether et al. (2011) estimate that for a large number of pollutants (SO2 included), pollution haven and factor endowment effects mostly cancel each other out.

tradable (i.e. very substitutable across suppliers) is not covered by the CAP since, even with free allowances, the possibility to raise prices and pass on the costs to consumers would be very limited. As to total leakage estimates, including those from the aluminium and electricity sectors, these are small and estimated at eight per cent.

6. CARBON TARIFFS AND BORDER TAX ADJUSTMENTS

If the evidence suggests that the nature of comparative advantage in CO2-intensive industries greatly reduces the likely extent of leakage, the magnitude of contestable rents generated by a cap on emissions will generate active lobbying for these rents and the associated waste of resources similar to those observed when quotas instead of tariffs were used to distribute imports (Krueger, 1974). One channel discussed above is a resistance to auctioning permits (which would approximate a carbon tax) in favor of a free distribution of permits thereby shifting much of the burden of adjustment from producers to consumers (ultimately producers are consumers but, because of free-riding in lobbying activities, only producers are, in effect, organized). The other is border tax adjustments on the carbon content of imports from countries that have not introduced climate change policies. As pointed out in the literature, this approach to compensate for differences in fossil fuel prices is fraught with implementation difficulties since its informational requirements are onerous and easily contestable, making application near impossible and certainly one that will contested at the WTO.

Confirming earlier estimates, Atkinson et al. (2010) find that the main net exporters of carbon are China, Russia, and other middle-income countries while the main net importers are the EU, US and Japan. In a Leontief-type multi-region input-output model, they estimate that applying a $50 per ton tax on the carbon content of imports across all countries would amount to an export tax rate of around ten per cent for China's exports across destinations. In comparison, EU exports would face an average export tax rate of 1.2 per cent and the US of 3.1 per cent. In conclusion, while taxing a bad is potentially welfare-improving at the global level, its financing by low-income countries would go against the all-around accepted principle of CBDR.

In addition to this ethical issue, implementation of a carbon border tax would also be difficult for a number of reasons outlined by Moore (2010). He illustrates the difficulties with an application to the steel industry where it is difficult to evaluate the carbon footprint in the final product. He shows that none among the possible border adjustments would meet the necessary economic, political, environmental, legal, and administrative constraints needed to gain the support for implementation. These constraints are: (i) domestic firm buy-in; (ii) foreign firm buy-in; (iii)

administrative capability; (iv) adherence to WTO rules (articles I on non-discrimination and III on national treatment), and; (v) incentives for CO2 reduction by foreign firms. Since several technologies are available to produce steel, it will be necessary for the country wishing to impose a border adjustment to firms in foreign countries to distinguish among foreign firm types. The complicated administrative procedures implied by any choice of border adjustment raises the spectre of adopting a system of rules of origin that would attempt through bureaucratic means to identify the true source of products whose origin is unclear from their physical characteristics. Moving in this direction would open the door to capture by lobbies. This is exactly what happened when a full range of product-specific rules of origin were established to confer preferential status under preferential trade agreements. Indeed, the EU has over 500 different product-specific tailor-made rules of origin helping EU firms to capture rents that would otherwise accrue to foreign firms as a result of preferential market access (see Cadot and de Melo, 2007).

7. CONCLUDING REMARKS

Scientists are increasingly referring to the world we live in as the 'anthropocene' in recognition of the overriding influence of human activity on the earth's climate and ecosystems. Providing for the public good of a suitable climate is now recognized as the biggest challenge of global governance displacing in importance the provision of an open trading system as a universal public good. Reciprocity in trade relations along with a few general principles (non-discrimination, binding of tariff reductions, a weak dispute settlement process at the GATT) and a "live and let live" philosophy contributed to the enormous success under the GATT-led multilateral negotiations. Unfortunately, such reciprocity is absent when it comes to climate change and countries that do not mitigate cannot be deprived of clean air. In addition, though this is changing rapidly, the responsibility for global warming has largely rested on the shoulders of developed countries requiring costly measures whose burden across countries and across generations must be taken along with form of compensation to deal with the "common but differentiated responsibilities" (CBDR) as accepted, but not yet implemented under the aegis of the UNFCC.

The paper has examined the alternatives of carbon taxation and of a cap and trade (CAT) system on emissions, either alternative likely to be pursued from a 'bottom-up' approach where countries/regions pledge reductions in GHG emissions. While neither alternative addresses non-compliance, on efficiency grounds a carbon tax would be preferable, but it is likely that several

CAT systems with some form of linking across them will emerge as carbon taxation is likely to be resisted, at least until the scientific evidence becomes much stronger. CAT systems have the added advantage of separating the location of mitigation activity from the absorption of cost, helping to carry out the financial transfers from rich to poor countries.

The experience of the EU and US reviewed here suggests that mitigation is politically easier to carry out under a CAT provided permits are distributed for free and whose distribution is dominated by the powerful lobbying interests necessary to get the support to adopt mitigation policies. This quota mechanism was long-used to allocate scarcity in the international trading system both nationally and internationally ending up with the most powerful receiving the quotas rents. This gave them massive leverage (power and money) that they used to keep unchanged the initial scheme while conditions were changing. And, as recognized by Whalley (2011), in the international context, it is the strongest that get the upper hand in the bargaining process. One can only but fear that the same will happen with border taxes since taxing virtual carbon for competitiveness would result in a redistribution to rich countries that would, in any case, be challenged at the WTO.

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