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Carbon Taxation in Europe: Expanding the EU Carbon Price

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Abstract

The current pricing mechanism for carbon in the EU, the EU emissions trading system, only covers 40 percent of emissions. Carbon taxation currently plays no role. The Commission has recently proposed to revise the energy tax system in the EU to include a carbon tax component. This paper evaluates the Commission proposal and considers the possible expansion of the EU carbon pricing base either by expanding emissions trading to cover more sectors or by enacting a carbon tax. It concludes that there are strong arguments for expanding the carbon pricing base, as suggested by the Commission. Nevertheless, expanding the base should done through a unified system, such as expanding the coverage of the emissions trading system or enacting an economy-wide carbon tax rather than through having side-by-side taxes and trading, as in the Commission proposal.

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The EU has set an ambitious goal of reducing greenhouse gas emissions by 20 percent below 1990 levels by 2020.[1] To achieve these reductions, the EU has put in place a portfolio of policies. The centerpiece is an emissions trading system, the EU ETS. The ETS requires large industrial plants to buy and sell permits to release carbon dioxide into the atmosphere, with the number of permits declining over time to meet specified emissions goals for the covered sectors.[2] The ETS covers only 40 percent of greenhouse gas emissions, however. It does not include key polluting sectors such as households, most commercial facilities, transport, and agriculture. Emissions from these sectors are instead subject to command-and-control regulations, such as fuel economy standards for transport and efficiency codes for buildings.

Carbon taxation does not yet play a role in the EU emissions reductions strategy. Since the early 1990s, there have been several attempts to introduce a unitary carbon tax across all EU member states. These attempts failed. Member states objected to ceding taxing authority to Brussels and were concerned about the economic impact of carbon taxation. Instead, in 2003, the Commission enacted the Energy Tax Directive.[3] The ETD focuses on improving the functioning of the internal market by imposing common and low rates of tax on fuel uses of energy, such as transport and heating, and on electricity. Rates are not related to carbon dioxide emissions (and would be too low in any event) and the base does not cover many large sources of emissions.

In April 2011, the Commission proposed to modify the ETD so that it includes an explicit carbon tax. The Commission argued that the existing structure, with a carbon price covering only 40 percent of emissions, will make it difficult for the EU to reach its ambitious carbon reduction goals. Moreover, the existing structure covers some sectors twice and others not at all, creating inefficiencies. The Commission concluded that it is time to revisit the ETD to make it better align with the EU's climate policy.

The proposed revision divides the ETD into two components: an explicit carbon tax based on the carbon content of fuels and a separate tax on energy use based on the caloric content of fuels. The carbon component would cover most uses of fossil fuels not already part of the ETS. In doing so, it would expand the carbon-pricing base to around 80 percent of EU emissions. The rate would be €20/ton of CO_2 as of 2013.

The Commission's proposal provides an opportunity to rethink the role of carbon taxation in the EU. The standard objection to an EU carbon tax is that it cannot overcome

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[1] Commission, '20 20 by 2020: Europe's climate change opportunity' (Communication) COM (2008) 30 final.

[2] The major sectors in the ETS are large combustion installations such as power generation facilities, mineral installations, and pulp and paper production. It excludes transport, households, and agriculture.

[3] Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity [2003] OJ L 283/51.

the unanimity requirements needed to enact an EU-wide tax. If the Commission's proposal is to be accepted, however, the unanimity problem must be overcome. Once we assume that this is a possibility, however, we can consider a wider set of possibilities. That is, once we allow for the possibility of passing an EU-wide tax, the set of possible carbon pricing systems opens up. The goal of this paper, therefore, is to evaluate the possible role of carbon pricing in the EU generally, to evaluate the Commission's proposal, and to consider alternatives.

The conclusions are as follow. The proposed revision would expand the carbon tax base and, as a result, is a clear improvement over the current system. A broad carbon-tax base ensures that the lowest-cost mitigation options are pursued, thereby lowering the overall cost and likelihood of meeting the EU's targets. Going from a base of 40 percent of emissions to 80 percent of emissions has the potential to significantly lower costs. Member states seeking to minimize the cost of meeting their emissions reductions targets should support it.

Nevertheless, there are a number of problems with the proposal. First, the ETS and related agreements (such as the Burden Sharing Agreement) were negotiated with careful attention to the distributive effects across member states. Adding a carbon tax alongside the ETS has the potential to change these effects, hurting poor states. Second, the proposal creates a dual system, with some emissions covered under a trading system and others under a tax. Coordinating these systems will be difficult. The price of carbon will inevitably be different in the two systems. In addition, the administrative costs of running two separate systems will be high. And, for reasons discussed below, a dual system has to be implemented midstream, further increasing administrative and compliance costs.

All of these problems would be solved by using a single, unified pricing system, whether it is a tax or a trading system, rather than the side-by-side tax and trading system envisioned by the Commission. A single system would ensure that all sectors face the same carbon, a basic condition of efficiency. It could be implemented far more easily than a dual system. There would only be one set of rules and one administrative agency needed to enforce them. And a single system, unlike a dual system, could be imposed upstream. Finally, it would enhance rather than offset the distributive effects of the ETS. Put simply, why have two systems with all of the attendant coordination and administrative problems when the EU could simply expand the ETS? And once the ETS is expanded, its design could be greatly simplified to improve compliance and lower administrative costs.

The ETS was recently modified for its third phase. It would be difficult to modify it again in the immediate future along the lines suggested here. Perhaps the Commission's proposal can be justified because it is the only feasible way to expand the carbon pricing base. While this may be true for the short term, carbon pricing is likely with us for the indefinite future, and if there are substantial gains from better system design, they are worth pursuing even if it takes some time to implement them. We might think of the proposals discussed here as being for the fourth phase of the ETS.

Section 1 describes the current system in the EU including data on emissions, the ETS, Energy Tax Directive, and the proposed revision. Section 2 considers the benefits to broadening the pricing base. Section 3 considers whether a broadened base should be achieved through a dual system, as is currently being contemplated, or a unified system. Section 4 considers whether a unified system should be a tax or an emissions trading system. Section 5 considers issues in the design of a unified system, focusing on the use of upstream and downstream systems and how they relate to one another. Section 6 considers the problem of implicit subsidies. Section 7 concludes.

1. The current regulatory structure

Before considering changes to the EU energy taxes and its emissions reduction strategy, it is important to understand the EU's current set of policies and the reasons they were adopted. The current energy tax scheme is embodied in the Energy Tax Directive, while the centerpiece of the EU's emissions reduction strategy is the Emissions Trading System. This section reviews both these initiatives.

1.1 The Energy Taxation Directive

The Energy Taxation Directive was enacted in 2003 after a long and complex negotiation going back to 1992.[4] It requires minimum taxes on all energy products used as motor fuels or for heating, as well as electricity consumed in similar situations. The base does not include energy products used as material in production processes, such as chemical reduction, electrolytic, metallurgical, and mineralogical processes. In addition, it does not apply to electricity when electricity accounts for more than 50 percent of the cost of the product.

The rates are relatively low. Most of the EU15 member states except for Greece already had taxes on energy sources (other than coal) which exceeded the taxes required by the ETD. Most new member states, however, had rates that were lower than the minimums, in some cases by wide margins, so the major effect of the ETD was on accession states (plus coal in the EU15). Table 1 summarizes the ETD and compares it to

[4] Detailed histories can be found in a number of sources. Key papers include Jacob Klok, 'Energy Taxation in the European Union. Past Negotiations and Future Perspectives' (2005) Instituto de Estudios Fiscales Working Paper 21/05 <http://www.ief.es/documentos/recursos/publicaciones/documentos_trabajo/2005_21.pdf> accessed 26 July 2011; Stefan Speck, 'The Design of Carbon and Broad-Based Energy Taxes in European Countries' (2008) 10 Vermont J of Environmental L 31; Henrik Hasselknippe and Atle Christer Christiansen, 'Energy Taxation in Europe: Current Status - Drivers and Barriers - Future Prospects' (2003) Fridtjof Hansen Institute Report 14/2003 <http://www.fni.no/doc&pdf/FNI-R1403.pdf> accessed 26 July 2011.

tax rates in member states prior to its enactment.[5] The white fields indicate that actual taxes are less than the minimum taxes.

Table 1: Comparison of minimum and actual taxation in 2002

Energy Tax Directive			Actual taxation in member states (2002)																		
Energy Carriers	euro per….	Rate	AT	BE	DK	FI	FR	DE	GR	IE	IT	LU	NL	PT	ES	SE	UK	CZ	HU	PL	SI
Unleaded petrol	1000 l	359	414	507	548	559	581	624	296	401	542	372	628	470	396	504	729	351	409	381	276
Diesel (Transp.)	1000 l	302/330	290	304	370	304	383	440	245	304	403	253	344	269	294	341	729	264	336	255	276
LFO	1000 l	21	76	13	279	68	49	61	166	47	403	5	198	33	85	279	50	0	0	42	0
Heavy Fuel Oil	1000kg	15	36	6	52	57	19	18	19	14	31	6	32	27	14	…	44	0	0	0	0
Nat. Gas	GJ gcv	0.3 a)	1.0	0.3	7.2	0.5	0	1.0	0	0	4.3	0	2.5	0	0	4.5	0	0	0	0	0
Coal coke	GJ gcv	0.3 a)	0	0	7.3	2.1	0	0	0	0	0	0	0.6	0	0	10	0	0	0	0	0
Electricity	MWh	1 b)	20	1.4	89	7.0	7.3	17.9	0	0	40	2.4	45	0	5.1	22	0	0	0	0	0.3

Notes : a) 0.15 euros for business use; b) 0.5 euros for business use; all taxes without sulphur tax and VAT, Source: Kohlhaas et al (2004)

There does not appear to be a sound rationale for the ETD as currently structured. The rates are not connected to any identifiable externality from energy use. The minimum rates in the ETD do not reflect the carbon content of taxed fuels. For example, if we translate the minimum rates into euros per tonne of CO_2, petrol is taxed at €159 per tonne, natural gas used as motor fuel at €46, natural gas in for heating at €5, and coal used for non-business heating at €3.[6] The rates are also not connected to the relative energy content of the fuels. Nor do the rates and base relate to other potential externalities from fuel use, such as congestion externalities, local pollutants, or national security problems.

The history of the ETD indicates that it was enacted at the behest of member states which, for domestic reasons, wished to impose high energy taxes but were worried about competition from states with low tax rates. The language used was “internal market coordination.” Absent externalities that cross borders, however, it is not clear why this is needed. Suppose, for example, there is a local externality from energy use, such as the pollution of a local resource. A member state may, as a result, want to impose a Pigouvian tax on the externality. If the energy use shifts to a second member state, the pollution would now be within the boundaries of the second member state, and it is not clear why the first member state should care. If the pollution crosses borders or has other effects on the first member state, then it may make sense to impose a mandatory tax

[5] Table 1 is taken from Michael Kohlhaas and others, ‘Economic, Environmental and International Trade Effects of the EU Directive on Energy Tax Harmonization’ (2004) German Institute for Economic Research Discussion Papers 462 <http://www.diw.de/documents/publikationen/73/diw_01.c.42775.de/dp462.pdf> accessed 26 July 2011.

[6] Commission, ‘Impact Assessment, Accompanying document to the Proposal for a Council Directive amending Direction 2003/96/EC’ (Impact Assessment) COM (2011) 169 final 9.

system. But as noted, the ETD cannot be tied to any identifiable cross-border externalities.

1.2 The Emissions Trading System

The EU eventually adopted an emissions trading system instead of a carbon tax, as the centerpiece of its emissions reduction strategy of reducing greenhouse gas emissions by 20 percent below 1990 levels by 2020.[7] The ETS is a cap-and-trade system, imposed midstream on large emitters.[8] The emissions trading base is made up of four broad sectors: (1) iron and steel, (2) certain mineral industries (including cement), (3) energy production (including electric power and refining) and (4) pulp and paper. It is limited to combustion facilities with a thermal input of greater than 20MW. Across the EU, this comprises roughly 12,000 facilities.

The ETS covers about half of the EU's CO_2 emissions and about 40 percent of the EU's total greenhouse gas emissions. (CO_2 is about 80 percent of the EU emissions measured on a climate-forcing equivalence basis.) The remaining 60 percent of EU emissions are supposed to be controlled by other policies, which presumably are traditional command-and-control regulations such as fuel economy standards and building codes or subsidies for renewable energy. The major excluded sectors of CO_2 emissions are transport, agriculture, and residential and commercial use of fuels (such as for home heating).

The trading period for the current phase of the ETS is five years, running from 2008 until 2013. The length of the trading period is important because permits issued in the trading period can be used at any time within the trading period. Because permits are issued in February of each year but need not be submitted for the prior year until April,

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[7] COM (2008) 30 final (n 1). Available at <www.energy.eu/directives/com2008_0030en01.pdf>. The second "20" in the title refers to the goal of having 20 percent of energy come from renewable sources.

The EU emissions reductions under the Kyoto Protocol are technically separate from the ETS—the ETS was to be implemented regardless of whether the Kyoto Protocol was ratified, and it continues until 2020, which is after the Kyoto Protocol is set to expire. Nevertheless, the ETS is the main mechanism for complying with the Kyoto Protocol.

[8] Sources describing and evaluating the ETS include A. Denny Ellerman, Frank J. Convery and Christian De Perthuis (eds), *Pricing Carbon: The European Union Emissions Trading Scheme* (CUP 2010); A. Denny Ellerman and Barbara K. Buchner, 'The European Union Emissions Trading Scheme: Origins, Allocation, and Early Results' (2007) 1 Rev of Environmental Economics & Policy 66; Joseph Kruger, Wallace E. Oates and William A. Pizer, 'Decentralization in the EU Emissions Trading Scheme and Lessons for Global Policy' (2007) 1 Rev of Environmental Economics & Policy 112; Jon Birger Skjaerseth and Jorgen Wettestad, 'Fixing the EU Trading System? Understanding the Post-2012 Changes' (2010) 10 Global Environmental Politics 101; Frank J. Convery and Luke Redmond, 'Market and Price Developments in the European Union Emissions Trading Scheme' (2007) 1 Rev of Environmental Economics & Policy 88; A. Denny. Ellerman and Paul L. Joskow, 'The European Union's Emissions Trading System in perspective' (2008) Pew Center on Global Climate Change <http://www.pewclimate.org/docUploads/EU-ETS-In-Perspective-Report.pdf> accessed 26 July 2011.

permits can effectively be borrowed one year in advance. They can also be banked from the time they are issued until the end of the trading period, creating a variable banking period depending on when within a trading period a permit issued. Banking and borrowing of permits is important because it allows users to allocate more permits to periods when they are more in demand and fewer to periods when they are less in demand.[9]

The ETS was designed with distributive goals in mind. The distributive effects are a result of the interaction between the member states' emissions targets and the design of the ETS. The EU members agreed on an overall cap on emissions.[10] Each member state then agreed to its own national emissions target under the EU burden-sharing agreement so that the total met the overall EU goal. The member-state targets were set with explicit distributive goals, on the theory that wealthier states should reduce emissions more than less wealthy states. Given this target, each member state developed a National Allocation Plan or NAP which allocated the state's total emissions reduction target between the trading sector and non-trading sectors. Each member state then allocated permits within the trading sector to individual sources of emissions. Allocations in the first two phases of the ETS were given away freely rather than auctioned. Permit trading is done on member-state registries, and member states also enforce compliance. The member-state systems are coordinated through the emissions trading directive and linked because permits from one country can be used by emitters in other countries. Linking ensures that a single, unified price for carbon dioxide emerges.

To illustrate the effects of this arrangement in a simple setting, imagine that there are only two countries, Rich and Poor, each with equal emissions and equal marginal abatement costs. For example, suppose that each emits 100 units of greenhouse gases. Suppose that the joint target is to reduce emissions by half, but that because of distributive concerns, they decide that Rich should reduce emissions by 70 units and Poor should reduce emissions by 30 units. If they adopt a cap-and-trade system to do this, Rich would get 30 permits (because this is how much it is allowed to emit) and Poor would get 70. If the cap-and-trade system covers the entire economy and trading is allowed freely across countries, the market will equilibrate so that each country actually reduces emissions by 50 because emitters in Rich will find it profitable to purchase permits from Poor until marginal abatement costs equalize. The effect is simply a transfer of the value

[9] The longer the banking and borrowing periods, the more permits look like standard property. An owner of property can decide when to use the property. This leads to efficient utilization of property across time. Short permit periods artificially constrain the choice of when to use them, creating government-mandated and likely inefficient time allocations of permit use.

[10] Although the ETS is a central component of the EU's compliance with the Kyoto Protocol, it operates independently of the Kyoto Protocol. The member states that are part of the ETS are not the same as those subject to the Kyoto Protocol, and the time periods of the ETS and the Kyoto Protocol are different.

of 20 permits from Rich to Poor. Note that Rich will not meet its emissions targets—it will emit 20 too much—while Poor will exceed its targets by 20. The overall target will be met, however, as will the distributive goals so that failure to meet individual member-state goals should not matter in this simple setting.

Now suppose that only part of each country's emissions is covered by the cap-and-trade system and the rest is covered by regulation. Permits will trade in the covered sectors, as above. Rich, trying to meet its targets, has to regulate its non-covered industries more heavily because the covered industries are buying permits from Poor. That is, because of trading, Rich cannot reduce its emissions in the covered sector by more than would occur due to the market mechanisms. Therefore, it has to meet its higher target in the non-covered sectors. As it seeks more emissions reductions in the non-covered sectors through regulation, the marginal abatement costs in Rich go up. Non-covered industries in Poor, however, can be lightly regulated (or possibly not at all regulated) because Poor will tend to exceed its goals for the covered sectors due to the sale of permits to Rich. The result is a partial transfer from Rich to Poor through emissions trading and inefficiency due to differing marginal abatement costs which result from trying to reach member-state targets. With only part of the economy in the cap-and-trade system, we get less redistribution from Rich to Poor and a less efficient set of abatement policies.

Finally, suppose that each country can set its targets for the covered and uncovered sectors under a national allocation plan. (Under the ETS, member states cannot choose which industries are covered, however.) If Rich has to reduce emissions by 70, it can decide how much of the 70 comes from the covered sector.[11] If it knows that the covered sector will simply purchase permits from Poor, which transfers resources to Poor without helping Rich meet its targets, it has an incentive to set a low target in the covered sector; Rich cannot meet its overall emissions targets in the covered sector because of trading, so there is no incentive to set an ambitious target for covered sectors. Rich has to meet its targets in non-covered sectors and therefore has an incentive to set its allocation to allow it to do that. The opposite is true for Poor. This is essentially where the EU is now. By covering only part of its emissions in the ETS and by allowing member states to allocate reductions between the trading and non-trading sectors, the system does not fully achieve its distributive goals and creates inefficiencies both in terms of the regulation of uncovered sectors and the allocation of emissions reductions between sectors.

[11]Kruger, Oates and Pizer, (n 8) argue that because the cap-setting process is done at the national rather than the EU level, it is difficult to estimate likely permit prices. Each nation can allocate emissions reductions to either the trading or non-trading sector, the total supply of permits is determined by the separate decisions of each member state. This makes it difficult for any member state to predict the price of allowances when they set their own NAP. In particular, if a member state wants to set the marginal abatement cost in non-trading sectors equal to the permit price, it will not easily be able to determine the permit price because of the decentralized nature of the process.

Some of this structure will change in 2013 for the third phase of the ETS, which runs from 2013 until 2020.[12] In particular, for the period from 2013 until 2020, there will be a single, EU-wide cap, and allowances will be allocated on a fully harmonized basis, eliminating the National Allocation Plans. This eliminates the incentive discussed above, for nations to set their NAPs in light of the distributive effects of the Burden Sharing Agreement.

The third phase will also feature more auctioning of permits. With some exceptions for large facilities in poorer countries, the power sector will need to purchase all of its permits in 2013 while other industries will need to buy a minimum of 20 percent of their permits in 2013, increasing to 70 percent by 2020. Industries subject to global competition, however, will be allowed to get free allowances; these industries account for about a quarter of total emissions covered by the ETS and about 80 percent of emissions from manufacturing.

The ETS has been studied extensively and been subject to a number of criticisms.[13] Permit prices collapsed during the trial phase. The decentralized cap setting process creates inefficiencies because nations have to set their NAPs in anticipation of other nations simultaneously setting their NAPs.[14] The current phase, Phase II, has had serious problems with permit theft in large part due to the use of member states for local enforcement and trading. Many of these criticisms have been the focus of changes for Phase III. Nevertheless, Phase III will continue to cover only 40 percent emissions, creating pressure for a more robust carbon pricing system.

2. The proposed revision to the ETD

2.1 Problems highlighted by the Commission

An ideal carbon price system would impose the same price on all emissions of greenhouse gases regardless of the source. The current combination of the ETD and ETS does not achieve this. The primary problem is that the carbon pricing base is too narrow. The ETS covers only 50 percent of CO_2 emissions and 40 percent of all greenhouse gas emissions. While the ETD imposes a tax on other sectors, given lack of connection to carbon content, it might be best to think of these other sectors taxed as not having a CO_2 price at all. Even if we think of the ETD as imposing a carbon price because it increases the price of using certain fossil fuels, the system would be inefficient. The price is not coordinated with the price in the sectors covered by the ETS, it is unrelated to carbon content, and in many sectors it is far too low. Moreover, there are sectors such as small

[12] For a description of the changes and the process that led to the changes, see Skjaerseth and Wettestad (n 8).

[13] See sources in n 8.

[14] Kruger, Oates and Pizer (n 8).

combustion installations and agriculture that are not covered under either system.

A second important problem highlighted by the Commission is that the two systems overlap. In particular, both the ETD and the ETS apply to paper and pulp production and parts of the chemical industry. This is likely inefficient. If the overall cap is binding, adding a carbon tax to a set of industries within the cap merely shifts how much various industries reduce emissions so that marginal abatement costs are no longer equalized across industries.

Finally, the details of the systems differ, so that even if the prices were the same and coverage complete, the effective price would differ. For example, the ETS, at least until the auction in the third phase, had free allocation of permits. The ETD had no equivalent grandfathering provision for current emissions. The ETS has special provisions for sectors subject to carbon leakage while the ETD does not. And the ETS includes a carbon offset system, the Clean Development Mechanism, while the ETD does not. These implementation details can greatly affect the true carbon price placed on emitters and cause systems that on the surface level seem to impose a uniform price to differ.

The Commission argued that in light of the stringent emissions reduction goals that have been adopted, these inefficiencies are no longer tolerable. Reaching the goals will be difficult even with the best designed system. A system with substantial inefficiencies may make reaching the goals impossible.

2.2 Description of Proposed Revision

The proposed revision of the Energy Taxation Directive is designed to address these problems. It would attempt to eliminate the overlap with, and gaps between, the ETS and the ETD, and to impose a coherent carbon price on the sectors covered by the ETD. It would also coordinate the prices in the two sectors and provide similar operating rules.[15]

To do this, the taxation of energy products would be divided into two components. One component would be based on the CO_2 emissions from the use of the product. Most uses of energy, other than those subject to the ETS, would be subject to a CO_2 taxation based on carbon content. This means that the ETD base would be expanded to include the use of fuels in agriculture, and small combustion installations excluded from the ETS because of their size.

The initial tax rate would be €20/tonne of CO_2 and, subject to exceptions discussed below, would be uniform across all fuels. The rate was set to be close to the projected price of permits in the ETS. To minimize deviations from the carbon price in the ETS, the

[15] The proposal would also include a separate tax on the energy content of fuels. These provisions are not the subject of the present investigation.

rate is to be monitored in the five-yearly review of the Directive.[16]

There are a number of exceptions to the tax. In particular, the proposal would require tax credits for industries subject to leakage, analogous to the free allocation of permits in ETS. In addition, it includes rules allowing for lower rates in specified circumstances. Member states would also be able to impose additional taxes—the proposal retains the approach taken in the ETD of imposing only a minimum tax rate.

2.3 Evaluation of the proposed system

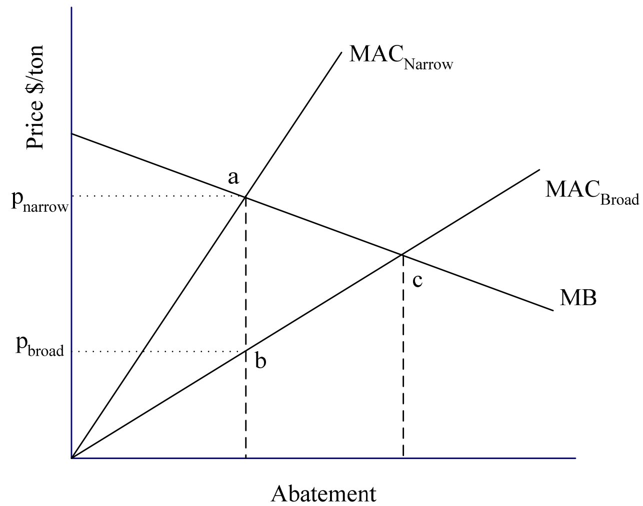
The proposed system addresses the main problems with the existing tax system listed above. It expands the carbon price to include almost all uses of fossil fuels, eliminates double coverage, and to some extent coordinates the prices and other provisions in the two sectors. The revision, therefore, is a clear improvement over the current system. Most centrally, by expanding the base, it should lower the cost of reaching the EU's emissions reduction goals.

The Impact Assessment by the Commission Staff did not try to quantify the benefit of expanding the carbon pricing base because of lower abatement costs. To illustrate the issue, consider Figure 1.[17] It shows an initial marginal abatement cost curve (MAC_{Narrow}) and a marginal benefit curve. The optimal abatement is at point *a*, where the marginal benefit curve equals the marginal cost curve. The cost is p_{narrow}. If the base is broadened so that the marginal abatement cost curve is MAC_{Broad}, the optimal abatement is now at point *c*. Moreover, even if we do not increase the abatement target, the cost of abatement at the initial level goes down to p_{broad}.

[16] The Commission considered whether a lower tax rate should be used in light of the decision to divide the economy into ETS and non-ETS sectors and the subsequent national targets which took into account relative income differences across member states. As a result of this division, the average price of emissions reductions in the non-ETS sectors differed from the price within the ETS and in a 2010 study was found to be only €4-5/t.

[17] Figure 1 is taken from Gilbert E. Metcalf and David A. Weisbach, 'The Design of a Carbon Tax' (2009) 33 Harvard Environmental L Rev 499.

Figure 1: Benefits to Broadening the Base



The size of the reduction in costs depends on how much the MAC curve rotates outward when this base is broadened. This in turn depends on the extent to which there are low-cost abatement options outside the current pricing base. Therefore, to determine whether it is desirable to add any particular item to the tax base, it is necessary to know the marginal abatement costs for the activity generating the emissions and the administrative costs of including them in the pricing base.

There are a number of estimates of the benefits of wide, as compared to narrow, emissions pricing systems. One well-known study which gives a sense of the benefits of expanding the pricing base compares no-trading systems to trading systems, considering three different systems: trading with the energy supply sector only, trading within energy supply sector and energy-intensive industries, and trading for all sectors.[18] Total costs in the energy-only case are €7.158 billion and go down to €5.957 billion for the all-sectors case. Marginal abatement costs go down similarly.

That study is not particularly related to the sectors covered by and excluded from the ETS; it just illustrates the potential benefits from expanding carbon pricing. To know the size of the gains from including the excluded sectors in the pricing base, we need to know what abatement opportunities are available in those sectors. The sectors excluded from the current carbon pricing system are transportation, residential and commercial energy

[18] Pantelis Capros and Leonidas Mantzos, 'The Economic Effect of EU-Wide Industry-Level Emission Trading to Reduce Greenhouse Gases, Results from PRIMES Energy Systems Model' (2000) Institute of Communication and Computer Systems of National Technical University of Athens <http://ec.europa.eu/environment/enveco/climate_change/pdf/primes.pdf> accessed 26 July 2011.

use, and agriculture. We need to know whether there are low-cost abatement opportunities in these sectors in the EU.

A preliminary issue in analyzing mitigation opportunities in building, transportation, and agricultural use of fuels is that these sectors, particularly buildings and transportation, are already highly regulated. Easily identified, low-cost mitigation strategies are already likely being pursued. The advantage of a pricing system over regulation is that a pricing system allows individuals to choose their mitigation strategies. Strategies that regulators do not identify may be best and those chosen by regulators may be dominated by alternatives. Studies attempting to find mitigation opportunities in a regulated market, however, are subject to precisely the same information problems as the regulators are, so we should not expect studies to find a large number of opportunities.

With this in mind, estimates of mitigation costs for individual sectors are available, but there are not a large number of them. For transportation in the EU, the two major studies are a "well-to-wheels" analysis by the Commissioner Joint Research Centre Institute for Environment and Sustainability and a study by the IEA of mitigation potential of the OECD transport sector.[19] The wells-to-wheels analysis report concludes that switching fuels to reduce emissions is likely costly, with a wide variation across fuels. The IEA study considers more general transportation policies including additional use of public transport, improvements in conventional engines, and fuel switching. It finds that a $95/ton tax on carbon (equivalent to about a $26/ton tax on carbon dioxide) would produce a reduction in energy demand of about six percent in 2020. Overall, the potential for mitigation in the EU in the transport sector appears to be modest, which is likely a result of the large number of existing transport policies already in place.

For buildings, the IPCC summarized mitigation potential at various cost levels. They find a significant number of very low-cost (in fact, negative-cost) mitigation opportunities in buildings, even in the EU, which already has a number of building efficiency policies. For the EU-15, the IPCC estimates that an almost 20 percent decline in emissions relative to the baseline is possible at a price of \$40/ton CO_2.[20] Nevertheless, studies of mitigation potential in buildings are fraught with difficulties because of the complexities surrounding alterations to the building stock, such as local zoning rules and complex market interactions between landlords and tenants.

[19] Commission, *Well-to-Wheels Report* (2007) version 2c <http://ies.jrc.ec.europa.eu/uploads/media/WTW_Report_010307.pdf> accessed 26 July 2011; Michael Landwehr and Céline Marie-Lilliu, 'Transportation Projections in the OECD Regions: Detailed Report' (2002) Intl Energy Agency <http://s3.amazonaws.com/zanran_storage/www.iea.org/ContentPages/26167064.pdf> accessed 26 July 2011. See also Bert Metz and others (eds), *Climate Change 2007: Mitigation of Climate Change—Contribution of Working Group III to the Fourth Assessment Report of the IPCC* (CUP 2007). Working Group III, Chapter 5 summarizes the two studies.

[20] Metz and others (n 19) 415.

An additional source of gains from expanding the carbon pricing base, one which would not show up in bottom-up studies, is that many command-and-control regulations could be eliminated. As noted, the EU adopted a portfolio of policies to comply with its climate goals and its Kyoto obligations. Only 40 percent of emissions are controlled through the ETS. Remaining emissions, to the extent they are covered, are under command-and-control regulations. While it would take a separate, detailed study to determine the efficiency of the various command-and-control regulations, it is likely that many are less efficient than a pricing system. By broadening the pricing base and eliminating, some of these command-and-control regulations, costs can likely be reduced, possibly significantly.

The detailed, bottom-up studies of mitigation potential in the sectors omitted from the ETS, therefore, are mixed, showing some potential for mitigation but also showing substantial difficulties. Top-down studies show greater potential. I am not aware of studies estimating the benefits of replacing command-and-control regulations with pricing in the 60 percent of the EU not covered by the ETS, but the gains might be large. At a minimum, it would seem that covering only 40 percent of emissions is very likely too narrow a base.

3. A single system as a better alternative

3.1 Problems with the proposed revision

While the proposed revision to the ETD has many merits, it also has a number of problems. There are two distinct types of problems. The first is that a carbon tax can offset the distributive effects of the ETS. Depending on the level of the tax relative to the abatement costs in different countries, it has the potential to reduce the burden of meeting emissions targets in wealthy countries while increasing costs to poorer countries.

To see this, go back to the example of Rich and Poor where only part of each country's economy was subject to trading. Recall that in that case, Rich had to more heavily regulate its industry to meet its target so that the marginal abatement cost would be higher in Rich than in Poor. Now suppose that a uniform tax is imposed across both countries. There are three possibilities. First, the tax is set below the marginal abatement costs (set implicitly by regulation) in either country. In this case, the tax would have no overall effect on emissions but would allow countries to replace some of their command-and-control regulations with a carbon price. Both countries would be better off. Second, the tax could be above the marginal abatement cost in Poor and below it for Rich. In this case, the effective carbon price is increased in Poor, imposing costs, but is unchanged for Rich, altering the distributive effects of the prior system. Finally, the tax might be above the marginal abatement costs in either country, reducing emissions in both countries but by more in Poor because the increase in the effective carbon price is greater for Poor.

Once again, the tax would disturb the distributive effects of the prior system.

If the tax rate is set to match the trading price of carbon in the ETS, then the second scenario is most likely because the marginal abatement cost will be higher than the trading price in the rich country and lower than the trading price in the poor country. Therefore, the tax has the potential to increase costs (and abatement) in poor countries and reduce costs in rich countries.

The second set of problems stem from the retention of two separate systems for carbon emissions from different sectors of the economy. Under the proposal, the ETS sector would continue to use a cap-and-trade system while the non-ETS sector would use a tax. It is not clear why one would want to combine taxes and permits this way and, conditional on having separate systems, why the dividing lines are drawn where they are.

With two different carbon pricing systems, carbon prices can diverge in the two sectors. The systems are not linked in any manner.[21] The ETS price is determined by the overall cap and the demand for permits. It is highly volatile. The ETD tax rate is fixed except for the possibility of review every five years. This means that the two will be the same only by happenstance and will most often diverge.

If prices diverge, energy users will have incentives to seek abatement opportunities in the sectors with the higher price even if lower-cost opportunities are available elsewhere. If the divergence is significant and long-standing, the resulting efficiency losses might be large. Moreover, divergent prices can affect business choices because the carbon price will be different in different sectors of the economy. For example, combustion installations may choose to stay below or go above the threshold size in order to get into the regime with the lower carbon price. Similarly, capital will tend to flow to the sectors with the lower price.

In addition to efficiency problems, having two systems raises administrative and compliance costs. There are two systems with different sets of rules, each of which has to be designed and enforced. The two systems will have separate administrative agencies in

[21] Linking in general is any method of allowing different pricing systems to interact so as to minimize differences in the systems. The simplest form of linkage is to allow permits in one cap-and-trade system to be used to satisfy permit requirements in a different system. Taxes and cap-and-trade systems can also be linked. For a discussion, see Jane Ellis and Dennis Tirpak, ‘Linking GHG Emission Trading Schemes and Markets’ (2006) OECD/IEA <http://www.oecd.org/dataoecd/45/35/37672298.pdf> accessed 26 July 2011; Judson Jaffe, Matthew Ranson and Robert N. Stavins, ‘Linking Tradable Permit Systems: A Key Element of Emerging International Climate Policy Architecture’ (2009) 36 Ecology LQ 789; Christian Flachsland and others, ‘Developing the International Carbon Market. Linking Options for the EU ETS’ (2008) Potsdam Intitute for Climate Impact Research <http://www.pik-potsdam.de/members/edenh/publications-1/carbon-market-08> accessed 26 July 2011; Gilbert Metcalf and David A. Weisbach, ‘Linking Policies When Tastes Differ: Global Climate Policy in a Heterogeneous World’ (2010) Harvard Project on International Climate Agreements Discussion Paper 10-38 <http://belfercenter.ksg.harvard.edu/files/MetcalfWeisbachFinal.pdf> accessed 26 July 2011.

each of the member states. Regulated entities may be subject to both systems for different types of activities and, therefore, have to comply with both. Advisors, such as accountants and lawyers, will have to know the details of both systems.

Finally, having two systems forces the price to be imposed midstream in the production process. This will be discussed in more detail below, but the basic idea is as follows. Fossil fuels enter the economy at a limited number of points, such as well-heads or places of import. They spread through the economy, touching a greater number of points at each stage in production. For example, crude oil enters the economy at a limited number of spots, is refined and then used for, say, transportation at a very large number of spots. We can think of the process like the roots of a tree, starting out at a single point upstream and spreading out into a large number of tendrils. For this reason, imposing a price upstream is administratively simpler—fewer entities need to be regulated. For example, one study showed that an upstream carbon tax could cover all of the fossil fuel emissions in the United States by taxing fewer than 3,000 entities.[22] A downstream tax just on transportation emissions would require taxing around 250 million vehicles.

If we impose a carbon price upstream, when fuels first enter the economy, the price is embedded in the price of the fuels as they are used downstream. If we want to divide the economy into two sectors and impose a different pricing regime in the two sectors, upstream pricing does not work because it automatically covers the whole economy. Instead, to have two separate pricing systems, we have to impose the price midstream or downstream so that we can divide the economy into the two sectors. This increases the number of regulated points and increases administrative costs.

3.2 Alternative: A single system imposed midstream

The problems with having dual systems—the distributive effects, divergent prices, and added administrative costs—can all be solved by having a single system. At the most basic level, we should ask why the Commission prefers to have two separate carbon pricing systems rather than to expand the ETS. The sectors newly subject to carbon taxation under the expanded ETD could equally well be part of the ETS.

All of the policy goals of the two systems could be met with a single system. The base of the single system could be identical to the proposed base of the two systems. It could be imposed on exactly the same entities. Exceptions and special provisions, such as for industries subject to leakage, could be made the same. Economic concerns such as whether it makes sense to expand the carbon pricing base to new sectors would be the same, as would hurdles to enactment, such as objections by the newly taxed sectors.

The revenue raised by the two systems would be the same as long as the design

[22] Metcalf and Weisbach, 'The Design of a Carbon Tax' (n 17).

choices are made consistently. Auctioning and tax payments are substitutes; if the ETD is intended to raise money through tax payments, the same money can be raised in the same member states and paid by the same entities by auctioning permits. Distributional effects on particular industries could be matched because the revenues and the sources of those revenues would be the same. Each and every design choice of having two systems could be met with a single system.

A single system, however, would be more efficient because it would impose a uniform price on all emissions. It would be less expensive to administer because there would be only one set of rules and no coordination problems. Moreover, the distributive effects of the burden-sharing agreement would be enhanced with a single system rather than reduced. With a single system, we are back to the base case considered above where Rich and Poor have different targets and the entire economy is subject to a cap-and-trade system. In that case, unequal allocation of permits has no effect on efficiency but redistributes from Rich to Poor. That is, a single system better implements the distributive choices made in the Burden Sharing Agreement than either the current system or the Commission's proposed revision.

A single system is more efficient, is cheaper to administer, and better achieves the EU's distributive goals. It is, in short, hard to see the logic behind having both a tax and a permit system operating side-by-side instead of having a single system.

Note also that there is nothing special about expanding emissions trading. If the proposed revision to the ETD is because of a perceived advantage of taxes—see Section 5 below for a discussion—the tax could be made economy-wide and the ETS eliminated. Once again, the core economic issues, such as whether it is appropriate to expand the carbon pricing base, remain the same; but the single system, an economy-wide carbon tax, would be more efficient and less expensive to run than a dual system.

The possibility of having a single carbon pricing system appears not to have been considered as part of the proposed revision of the ETD. The Commission considered six proposals, but none involved the ETS; they were all modifications to the existing tax system that retained the ETS.[23] Because the idea of having a single system is not mentioned in the relevant documents describing the revision of the ETD, we cannot know why it was not considered. A single system would have all of the advantages of the proposed revision, introduce no new disadvantages, and be more efficient and cheaper to administer.

[23] COM (2011) 169 final (n 6).

4. Moving the system upstream

The system discussed in part 3 was a midstream tax or trading system imposed on the same entities as the ETS and proposed ETD would cover. If the EU were to move to a single system, however, it can do even better by shifting the system upstream. This section discusses the issues related to shifting to an upstream system. As noted, the core idea is that an upstream system would be simpler to administer because fewer entities would be regulated, lowering administrative and compliance costs. A dual system cannot be imposed upstream because of the need to divide the economy into sectors. Once we have a single system, however, an upstream shift is worth considering.

4.1 Administrative benefits

The use of fossil fuels spread through the economy in a tree-like structure with the number of branches expanding as we move down. At the top are the relatively small number of fossil fuel sources, places where fuels enter the economy. These can be either extraction sites or places of importation, or, moving one step downstream, refineries and processors. Midstream, there are a large number of places where fuel is combusted, such as industrial facilities, power plants, vehicles, and buildings. Finally, all the way downstream, we can think of consumption of a good that was produced using energy as the ultimate source of emissions.

An upstream price can be administered at a much lower cost than a downstream price. As noted, one study of carbon taxation in the US estimated that an upstream carbon tax could capture all fossil fuel emissions by taxing less than 3,000 entities.[24] A downstream tax would require taxing all 300 million consumers in the U.S., an increase in magnitude of five orders in the number of taxpayers. The number of regulated entities under a midstream system would depend on the precise details of the system, but the EU ETS already includes about 12,000 entities.

In the EU context, broadening while retaining midstream imposition would likely increase the number of covered entities, possibly by a large margin. If the EU instead shifted the system upstream, it could greatly reduce the number of entities that had to comply with the system. For example, there are only 104 oil refineries in the EU.[25] Taxing these refineries plus the import of refined products would capture all of the emissions from petroleum. I have been unable to find the number of natural gas operators or processors in the EU. In the US, which is of comparable size, there were only 530 natural gas processors, and the vast majority of natural gas has to be processed before

[24] Metcalf and Weisbach, 'The Design of a Carbon Tax' (n 17).

[25] Commission, 'Market Observatory—Oil—Refining & Processing' <http://ec.europa.eu/energy/observatory/oil/refining_processing_en.htm> accessed 8 March 2011.

entering the supply.[26] Imposing a price at the processor level would capture most of the natural gas in the system. Alternatively, the top 500 gas operators in the US had 95 percent of the proven reserves and 93 percent of production in 2006, so these operators could be an alternative place to impose a carbon price on natural gas. The EU system is likely similar, although imports of gas are a much larger component of the EU system than the US system.[27]

I have similarly been unable to find the number of coal mines in Europe. In the US there were 1,438 mines in 2006 which supplied essentially 100 percent of the coal in the US, and the mines are a logical place to impose the carbon tax on coal. Unlike the US, however, the EU imports 42 percent of its coal.[28] If the tax on coal is imposed on mines, the carbon price would then also have to be imposed on these imports.

4.2 The prior reasons for rejection of upstream system are no longer applicable

Although there were substantial changes made for the upcoming third phase of to the ETS, expanding the base and moving it upstream appears not to have been considered. It is not clear why the EU opted for a narrow base with midstream coverage in the first place and has not considered changing it. The Green Paper on emissions trading does not discuss the issue and instead simply proposed midstream coverage.[29] One of the background documents to the Green Paper notes that upstream imposition would have been more effective but states that an upstream approach was abandoned because of "vested interests and institutional and political obstacles," but doesn't name names.[30]

Although it is difficult to reconstruct from the available documents, there are three plausible reasons for imposing the ETS midstream. None of these reasons continue to apply when considering an EU carbon tax.

The first reason for a narrow base and midstream imposition was a decision not to cover motor fuels, residential and commercial use of fuels, or agriculture in the ETS. Apparently, some believed that existing taxes on motor fuels were sufficient and that including these fuels in the ETS would have effectively double taxed them. It would have been difficult to exclude these sectors with an upstream system.[31] Moreover, finance ministers in individual member states feared that upstream coverage would create

[26] Metcalf and Weisbach, 'The Design of a Carbon Tax' (n 17).

[27] See Commission, *EU energy and transport in figures: Statistical Pocketbook 2010*.

[28] See Commission, 'The Market for Solid Fuels in the Community in 2008 and Estimates for 2009' (Staff Working Paper) SEC (2010) 996 final.

[29] Commission, 'Green Paper on greenhouse gas emissions trading within the European Union' COM (2000) 87 final.

[30] FIELD, 'Designing Options for Implementing an Emissions Trading Regime for Greenhouse Gases in the EC' (2000) 5 <http://ec.europa.eu/environment/docum/pdf/0087_field.pdf> accessed 26 July 2011.

[31] Metcalf and Weisbach, 'The Design of a Carbon Tax' (n 17).

pressure for member states to eliminate local taxes on fuels.[32] The Commission proposal, however, would not include these sectors in the carbon pricing base, so this reason is moot.

A second reason for midstream imposition is that the Framework Convention, the Kyoto Protocol, and the Burden Sharing Agreement all measure emissions at the place of combustion. For example, if fuel which is extracted in one country and processed or refined in a second is burned to create power for production of a good in a third, and the good is consumed in a fourth, we could allocate the emissions to any of the four countries (or among them). The Framework Convention, the Kyoto Protocol, and the Burden Sharing Agreement allocate the emission to the place where the fuel was burned, which is essentially arbitrary. The EU ETS midstream system follows this allocation. Because each country determines its own ETS targets, only a midstream trading system can allow each country to control its compliance with the Kyoto Protocol. For example, suppose that France imported and used gasoline that was refined in Germany. If the regulatory system is imposed upstream at the refinery level, Germany's regulatory decisions would determine (in part) France's emissions as calculated under the Kyoto Protocol and the Framework Convention.

This reason is also no longer applicable. The third phase of the ETS eliminates the National Allocation Plans so that countries no longer have local control of how the ETS applies to them. Moreover, if mandatory carbon pricing covers all or almost all uses of fossil fuels, discretion over the regulation of non-covered sectors is reduced.

A final reason is that an upstream cap-and-trade system might have been seen as resembling a tax, potentially triggering the unanimity rule for taxes in the EU. A midstream cap-and-trade system would not need unanimity to pass and therefore was seen as the safer option in terms of avoiding potential legal challenges.[33] An EU-wide carbon tax, however, will have to overcome these obstacles.

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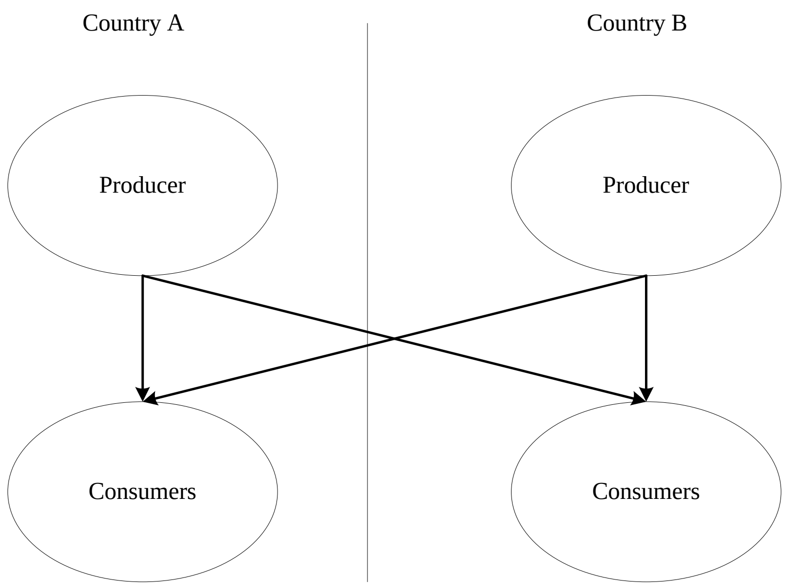
[32] Ellerman, Convery and De Perthuis (n 8) 23, claim that "the predominant view was that the additional fuel price raise that would be engendered by an allowance price in the order of €15-30 would have modest effects on consumption and therefore emissions." It is hard (in fact, impossible) to make sense of this statement, as the change in prices would be identical regardless of where in the production process the system is imposed.

[33] Another important component of the ETS which does not play a role in the discussion here is the Clean Development Mechanism. The CDM allows regulated entities to receive credits for reducing emissions in developing countries. The CDM has been troubled because of the problem of measuring emissions reductions against the hypothetical business-as-usual baseline. Michael Wara, 'Measuring the Clean Development Mechanism's Performance and Potential' (2008) 55 UCLA L Rev 1759. The CDM can be retained under any of the proposals considered here. Modifications to the CDM to address the problems it has encountered also can likely be incorporated into any of the systems considered here.

4.3 Distributional issue, in general

Within a closed economy, an upstream price and a comprehensive mid- or downstream price cover the same emissions, but, as noted, the upstream price is far simpler to administer. If there is more than one jurisdiction, however, substantive differences between upstream and downstream taxation can arise. Consider two jurisdictions, each of which has producers and consumers. Producers in each jurisdiction sell to consumers in both jurisdictions. Figure 2 provides a graphic:

Figure 2: Multiple country production and consumption



Consider an upstream tax on producers. (For simplicity, I will use a tax as an example; the analysis is the same for a trading system.) Each jurisdiction would receive the tax revenue from production in that region. If the tax rates in the countries differ, the tax rates on different types of goods available to the consumers will differ but the rates on consumers in the two countries for a given type of good will be the same.

Compare that to a downstream tax on consumption. In this case, the country where consumption takes place will receive the revenue. In addition, consumers in a given country will face the same tax on all goods but the tax rate may vary from the taxes faced by consumers in the other country.

Note that in the VAT context, we think that production taxes (origin-based taxes) and consumption taxes (destination-based taxes) produce the same result in the long run. This is because in the long run, a country can only consume what it produces. For periods of time, it can run deficits or surpluses, but in present value the two have to be the same. This is not true in a carbon tax because a carbon tax is, broadly speaking, on only a single component of production—the use of fossil fuels. Even though imports will equal exports in present value, imports of embedded carbon need not equal exports of embedded carbon in total or in present value. For example, country A could trade energy-intensive products for services every year indefinitely. Trade, overall, would balance, but the import and export of carbon would not.

Another important difference between upstream and downstream taxes is what is called carbon leakage. If a country imposes taxes upstream on production, producers can move to another jurisdiction with a lower tax and sell the same goods into the original jurisdiction. Carbon leakage is defined as the increase in emissions in non-taxing regions relative to the emissions reductions in the taxing regions. It is entirely inefficient in that there is a distortion in production decisions and no resulting tax revenue. Most estimates of carbon leakage are in the range of 15-25 percent, although some outlying estimates are much higher or lower.[34]

In a downstream (consumption) tax, there is no advantage to shifting production to another country because the tax is based on where the good is consumed. As a result, production decisions are not distorted. A downstream tax effectively eliminates leakage from the shifting of the location of production. Leakage can still occur in a downstream tax, however, because a downstream tax in one jurisdiction can lower the global price of fossil fuels, resulting in an increase in consumption in other jurisdictions. One study estimated that leakage in a consumption (downstream) tax is about half of the leakage in a production (upstream) tax, at least in the medium term. (In the long term, production leakage might be much higher because we may see greater shifts in production location over time.)[35]

If a country taxes production but imposes a tax on imports equal to the carbon footprint of a good and rebates taxes previously on export, it will have converted the production tax into a consumption tax. Production in the home country will be taxed only to the extent the goods are consumed at home. Production in the foreign country will also be taxed to the extent the goods are consumed in the home country. Border tax adjustments, therefore, have the same effect on carbon leakage as a shift from an upstream tax to a downstream tax. If we believe the Elliott, et al estimates, border tax adjustments eliminate about half of carbon leakage.

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[34] Sergey Paltsev, 'The Kyoto Protocol: Regional and Sectoral Contributions to Carbon Leakage' (2001) 22 Energy J 53; Joshua Elliott and others, 'Trade and Carbon Taxes' (2010) 100 American Economic Review: Papers and Proceedings 465; M. H. Babiker, 'Subglobal climate-change actions and carbon leakage: the implication of international capital flows' (2001) 23 Energy Economics 121; Mustafa Babiker, 'Climate change policy, market structure, and carbon leakage' (2005) 65 J of International Economics 421.

[35] Elliott and others (n 34); Joshua Elliott and others, 'A Quantitative Examination of Trade and Carbon Taxes' (2010) <http://www.sbs.ox.ac.uk/centres/tax/symposia/Documents/2010/07%20Weisbach%20Taxes_and_Trade.pdf.> accessed 27 July 2011.

Border tax adjustments of this sort are different from border taxes in the VAT context. In a VAT, border tax adjustments are relatively simple because they can be based on price. On export, we simply need to multiply the price paid by the exporter by the tax rate to determine the rebate. On import, we simply impose a tax on the full price of the good for the first domestic purchase. Border tax adjustments in a VAT also have no present-value revenue effect (assuming constant tax rates) because the present value of imports has to equal the present value of exports. In a carbon tax, border tax adjustments are equal to the tax that would have been imposed in a production tax if the good had been produced locally, which means that we have to know the carbon footprint of imported and exported goods. Knowing the carbon footprint of imported goods will be particularly difficult and in many cases impossible. Moreover, because carbon imports and exports will not, in general, be equal either in total or in present value, border tax adjustments in a carbon tax will have revenue effects. If the nation is a net importer of carbon, it raises money; and if the nation is a net exporter of carbon, it loses money.

There is a substantial literature on estimating carbon footprints using input-output tables.[36] Although details vary across studies, the methodology is relatively straightforward and involves tracing goods through the production process. The carbon produced at any given stage of production essentially moves with the good through the production process, establishing an overall footprint for a given product. One study estimated that for the year 2004, the EU was the largest net importer of carbon for the regions examined.[37] It consumed 5,449 MT of carbon but directly emitted 4,683. The difference is the importation of carbon-intensive goods. The US was also a net importer, while China was a net exporter.

Application of the methodology for computing border tax adjustments within the context of a working tax system, however, would be difficult. To determine a carbon footprint, we have to know the emissions when a good is produced. This requires knowing the production method for each good for each country along with the details of the related energy sources. Even for a good produced in a single country, this is complex and the data will be uncertain. Moreover, many goods are jointly produced in multiple countries: an automobile may have parts produced in a dozen countries and may be assembled in yet another before it is imported. The production methods and locations can change rapidly. Energy sources change; a given production plant may usually draw power from a dedicated power source but occasionally draw power from the grid. Even

[36] Glen P. Peters, 'From production-based to consumption-based national emission inventories' (2008) 65 Ecological Economics 13 provides a recent summary. See also Steven J. Davis and Ken Caldeira, 'Consumption-based accounting of CO2 emissions' (2010) 107 Proceedings of the National Academy of Sciences 5687; Joshua Elliott and others, 'CIM-EARTH: Framework and Case Study' (2010) 10/2 Berkeley Electronic J of Economics Analysis & Policy 11 <http://www.bepress.com/bejeap/vol10/iss2/art11/> accessed 26 July 2011.

[37] Elliott and others (n 36).

the best estimates of carbon footprints tend to use broad product categories and still have substantial margins of error. The burden on a border agent to properly determine carbon footprints and the resulting border tax would be overwhelming.

Moreover, while border tax adjustments are clearly legal in the VAT context, it is far from certain border tax adjustments for a carbon tax are. The central question appears to be whether a country may impose taxes at the border based on the production method for a good.[38] Note that as an economic matter this makes no sense. It is clear that a consumption tax would be legal and a production tax with border tax adjustments is just a method of implementing a consumption tax. Nevertheless, the trade rules appear to make a distinction, and it may be illegal to impose border taxes on embedded carbon.

Within the EU, the issues are similar but somewhat simpler. If the central authority coordinates tax rates within the member state, there will be no leakage with either a production or consumption tax because shifting locations within the federation will not change taxes. Leakage depends on differential taxation, which can be eliminated through central control. (There will still be leakage from the EU to the rest of the world.) The main effect of the choice of an upstream or downstream tax (aside from the administrative advantages of an upstream tax) is that different countries will get the revenue. In an upstream tax, countries that extract or refine fossil fuels will get the revenue while in a downstream tax, the country of consumption gets it (and similarly for midstream taxes, the country where production takes place gets the revenue).

Internal border tax adjustments can convert a production tax to a consumption tax and, therefore, change which country gets the revenue. To illustrate, suppose that all fossil fuel combustion occurs in Country A and Country B production is of services. The two trade so that consumers in both countries consume equal amounts of services and energy-intensive goods. Under a production tax, Country A gets all of the revenue. Under a consumption tax, the two countries split the revenue equally as consumers in the two countries consume equal amounts of the energy-intensive good. In a production tax with border adjustments, when energy-intensive goods are exported from Country A, it would get a rebate of the tax. When border adjustments are imposed to Country B, it must pay

[38] For a discussion of these issues, see Javier de Cendra, 'Can Emissions Trading Schemes be Coupled with Border Tax Adjustments? An Analysis vis-a-vis WTO Law' (2006) 15 RECIEL 131; World Trade Organization and United Nations Environment Programme, 'Trade and Climate Change' (2009) <http://www.wto.org/english/res_e/booksp_e/trade_climate_change_e.pdf> accessed 26 July 2011; Trevor Houser and others, 'Leveling the Carbon Playing Field' (2008) Peterson Institute for International Economics and World Resources Institute <http://pdf.wri.org/leveling_the_carbon_playing_field.pdf> accessed 26 July 2011; Paul Demaret and Raoul Stewardson, 'Border tax adjustments under GATT and EC law and general implications for environmental taxes' (1994) 28 J of World Trade 5; Gavin Goh, 'The World Trade Organization, Kyoto and Energy Tax Adjustment at the Border' (2004) 38 J of World Trade 395; Roland Ismer and Karsten Neuhoff, 'Border tax adjustment: a feasible way to support stringent emission trading' (2007) 24 European J of L & Economics 137.

the tax. If the taxes are at the same rate, the effect is as if Country A simply paid Country B the tax it collected on the production of those goods.

Border taxes within the EU, however, would be very costly and impede the free flow of goods simply because of the administrative costs. It would require constant monitoring of embedded carbon flows and rebates or impositions of taxes. An alternative would be to have countries make transfer payments to one another based on net imports and exports of embedded carbon using economy-wide measures. We would use the same carbon footprint calculations discussed above but internally for member states rather than for the world as a whole. This would tell us the net imports and exports of carbon for each member state. Transfer payments based on these calculations would mimic the effect of actual border adjustments without the need for customs agents imposing taxes as goods move internally in the EU. In fact, transfers can be designed to allocate tax revenue to the countries involved in the chain of production completely as desired. Therefore, it makes sense to choose the administratively simplest system—an upstream tax—and make corresponding transfer payments, if desired, to achieve the effect of a mid- or downstream tax

Note, finally, that if a cap-and-trade system is used and permits are given away, the entity receiving the permit often receives a windfall. Estimates show that free allocation of permits greatly overcompensates industry for their costs of compliance with a cap-and-trade system.[39] The choice of an upstream or downstream cap-and-trade system will determine which industries and countries receive these windfalls. Countries can be expected to want the industries in their jurisdiction to receive windfalls and, hence, will want the imposition of the cap-and-trade system to fall within their borders.

4.4 Distributive issues: Blocking industries and implicit subsidies

A final concern about shifting the system upstream is that it might not be as easy to give implicit subsidies to regulated industries. In particular, the National Allocation Plan allows countries to choose the extent of reductions in the ETS sector. Moreover, free allowance allocation can provide a very substantial subsidy to the industry receiving the allocation. By providing implicit subsidies, industries or member states that might have blocked enactment can be bought out. To some extent this last rationale will be eliminated in the third phase of the ETS because the third phase will have an EU-wide cap rather than the National Allocation Plans and because the third phase will require auctioning of permits. Derogations for some Central and Eastern European member states, however, allow some of these subsidies to be retained.

[39] For example, see Lawrence H. Goulder, Marc A. C. Hafstead and Michael Dworsky, 'Impacts of alternative emissions allowance allocation methods under a federal cap-and-trade program' (2010) 60 J of Environmental Economics and Management 161.

Moving the system upstream would not change these calculations to the extent that it would not shift the regulated entity. For example, if the relevant blocking entity is a power producer, upstream imposition may not change the point of regulation upstream.

If shifting the system upstream does move the point of regulation away from a blocking industry, there are ways within an upstream system to maintain the same subsidies to that industry. Suppose that there is an important industry in a country, that the industry is currently subject to the ETS, and that the industry is given free permits or some other benefit in order to gain its assent. Now suppose that the point of regulation is shifted to the fossil fuel supplier for that industry so that the price of fuels goes up and, moreover, the industry is no longer directly regulated. The industry would face higher costs which would not automatically be offset by the regulatory structure and, therefore, might threaten to block enactment.

There are a number of ways to retain the prior subsidy. Even though it is not itself subject to carbon pricing, the industry could still be given a quota of permits (or tax credits) that it could sell to offset the increased cost of its fuel. Alternatively, if the upstream supplier of fossil fuels is given free permits, it could be required to pass on the benefit for a given quantity of fuels purchased by the industry (but not for marginal purchases). Finally, the industry could simply be compensated explicitly. The EU has a number of explicit transfers to poor regions or industries, such as the European Regional Development Fund, the Cohesion Fund, and the European Social Fund.[40]

5. Taxes or trading

Given that it makes sense to expand the carbon pricing base as part of a single, unified system, the final question is whether the expansion should be part of a revision to the ETD in the form of a carbon tax or whether the new sectors should instead be added to the existing emissions trading system. EU member states appear to view taxes and trading as substantively different. Emissions trading is viewed as a method of reducing emissions cost-effectively while taxes are a source of revenue.[41]

The economic literature on the two instruments, however, establishes that this view is incorrect. Under conditions of certainty, the two are identical; they raise money and reduce emissions equally. If abatement costs are uncertain, the two can differ but not because one is a method for controlling emissions and the other for raising revenue. Instead, they differ in terms of their relative efficiency in reducing emissions. Martin

[40] For a summary of these funds, see Commission, ‘Regional Policy: The Funds’ <http://ec.europa.eu/regional_policy/thefunds/index_en.cfm> accessed 27 July 2011.

[41] See, for example, the discussion of the interaction between energy taxes and emissions trading in Commission, ‘Analyzing the replies to the Green Paper on market-based instruments for environmental and related policy options’ (Staff Working Document) SEC (2009) 53 final 13.

Weitzman argued that their relative efficiency depends on the steepness of the marginal abatement cost and marginal benefit curves.[42] The general conclusion following Weitzman is that taxes are superior in controlling greenhouse gas emissions because the marginal benefit of abatement curve is likely relatively shallow. If we were to follow this literature, we would want to expand the ETD to include a carbon component covering all fossil fuels and eliminate the ETS.

I have argued previously, however, that the differences in pricing instruments in this context are relatively small and are swamped by the importance of a good design for whichever instrument is chosen.[43] Given that the ETS is up and operating, it may make more sense to simply expand the ETS than to try to devise a new carbon tax. Because there is an extensive literature on instrument choice, I only review the arguments briefly here.[44]

Figure 3 is a supply and demand diagram with abatement as the good being supplied. The lower (rightward) upward-sloping curve represents the estimated marginal abatement cost, while the downward-sloping curve is the marginal benefit of abatement. For a traded good, the market would set the price and quantity such that the marginal benefit of an additional unit of the good is equal to the marginal cost. We can achieve this for carbon emissions (or abatement, the opposite of emissions) by either setting a tax equal to t* or a quantity limit equal to q*, where the marginal benefit of abatement is equal to the marginal cost of abatement. Both instruments work equally well.

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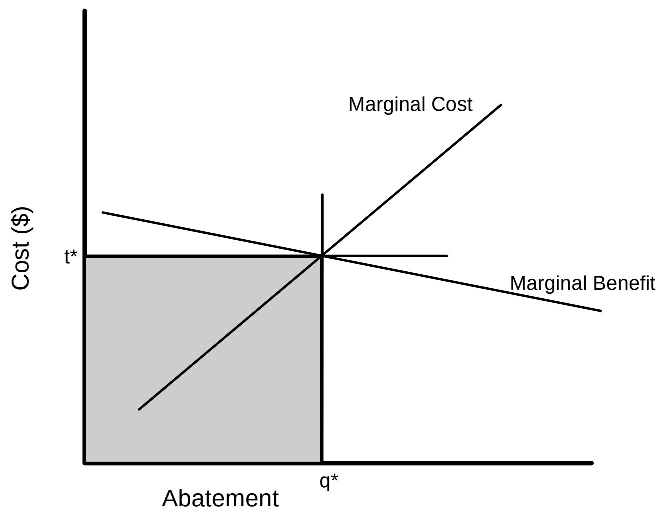
[42] M. L. Weitzman, 'Prices vs Quantities' (1974) 41 Rev of Economic Studies 477.

[43] David Weisbach, 'Instrument Choice is Instrument Design' in Gilbert Metcalf (ed), *US Energy Tax Policy* (CUP 2011). For a similar argument, see Louis Kaplow and Steven Shavell, 'On the Superiority of Corrective Taxes to Quantity Regulation' (2002) 4 American L & Economics Rev 1.

[44] Sources include Weitzman (n 42); Marc J. Roberts and Michael Spence, 'Effluent Charges and Licenses under Uncertainty' (1976) 5 J of Public Economics 193; Richard G. Newell and William A. Pizer, 'Regulating Stock Externalities Under Uncertainty' (2000) 45 J of Environmental Economics & Management 416; Michael Hoel, 'Emission taxes versus other environmental policies' (1998) 100 Scandinavian J of Economics 79; Michael Hoel and Larry Karp, 'Taxes and quotas for a stock pollutant with multiplicative uncertainty' (2001) 82 J of Public Economics 91; Larry Karp and Jiangfeng Zhang, 'Regulation of Stock Externalities with Correlated Abatement Costs' (2005) 32 Environmental & Resource Economics 273; Charles D. Kolstad and Michael Toman, 'The Economics of Climate Policy' in Karl-Göran Mäler and Jeffrey R. Vincent (eds), *Handbook of Enviromental Economics*, vol 3 (Elsevier 2005); A. Lans Bovenberg and Lawrence H. Goulder, 'Environmental Taxation and Regulation' in Alan J. Auerbach and Martin Feldstein (eds), *Handbook of Public Economics*, vol 3 (Elsevier 2002); Gloria Helfand, Peter Berck and Tim Maull, 'The Theory of Pollution Policy' in Karl-Göran Mäler and Jeffrey R. Vincent (eds), *Handbook of Environmental Economics*, vol 1 (Elsevier 2003); William J. Baumol and Wallace E. Oates, *The theory of environmental policy* (CUP 1988); Kaplow and Shavell (n 43).

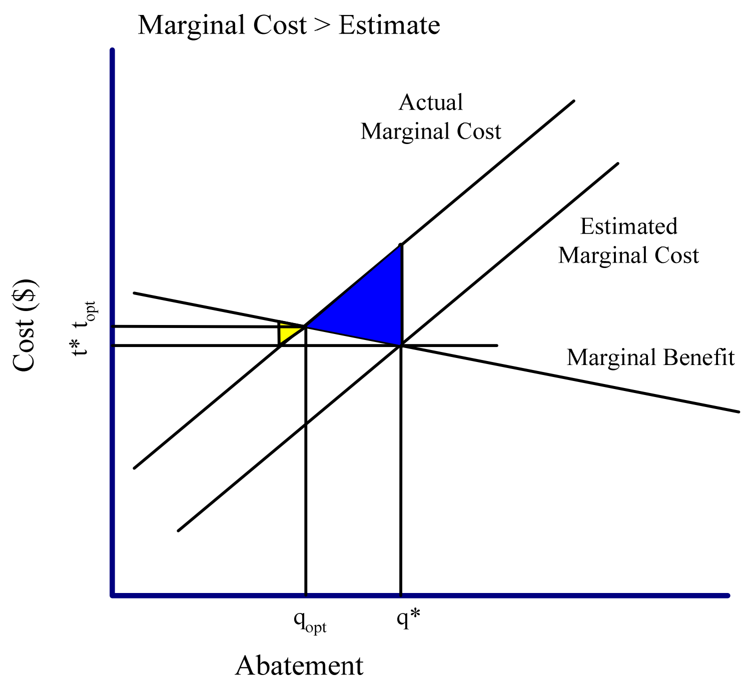
Figure 3: Equivalence of taxes and trading under certainty



Note also that the government receives the same revenues from the tax and the quantity limit if it auctions the permits. In a tax, it receives revenue equal to the tax rate, t*, multiplied by q*. If it auctions q* permits, they will sell for t*, so the auction will produce the same revenue that a tax would. If the government decides not to auction the permits but instead to give them away for free, the permit system is equivalent to a tax system in which the same individuals or firms that receive the free permits instead get refundable tax credits in an amount equal to the permits they would have gotten. Both systems can equally raise revenue or give away those revenues.

Weitzman argued that if the government's estimate of the marginal cost curve is wrong and the government does not update the estimated tax or quantity restriction when it learns that it is wrong, then the two instruments behave differently. Suppose that the government makes an estimate of marginal abatement costs and later learns that the estimate is wrong. Figure 4 is identical to Figure 3 except that it now includes a line representing the actual marginal cost, which I am assuming—merely for purposes of illustration—is above the estimate. Given the new information about the actual marginal cost of abatement, the optimal price and quantity restrictions are labeled t_{opt} and q_{opt}, respectively. If the government does not adjust, there will be a social loss from the incorrect regulation equal to the difference in consumer and producer surplus as compared to the optimal system. The (blue) triangle is the deadweight loss from the quantity restriction while the yellow triangle is the deadweight loss from taxation.

Figure 4: Comparison of taxes and trading with uncertain MAC



Weitzman shows that the relative size of the deadweight loss triangles depends only on the slopes of the marginal cost and marginal benefit curves. In the example, I have drawn the marginal cost curve to be steeper than the marginal benefit curve. As a result, the deadweight loss from an error in the estimated marginal cost is greater for a quantity restriction than for a tax. If the relative slopes of the curves were reversed, the relative size of the triangles would also be reversed.

In climate change, at least for short- or medium-term policies, the marginal cost curve is likely steep because it is difficult to reduce emissions (increase abatement) quickly, given the fossil-fuel-dependent energy supply system currently in place. The marginal benefit curve is shallow because reducing emissions by an increment likely has little effect on global temperatures. Under these conditions, the deadweight loss from quantity restrictions is likely higher, leading to a preference for taxes in the climate context.[45]

These arguments are standard in the literature and are generally repeated without question.[46] Nevertheless, I have claimed that the argument does not apply in the climate

[45] See, for example, William A. Pizer, 'The optimal choice of climate change policy in the presence of uncertainty' (1999) 21 Resource & Energy Economics 255; Nicholas Stern, *The Economics of Climate Change: The Stern Review* (CUP 2007); William D. Nordhaus, 'To Tax or Not to Tax: Alternative Approaches to Slowing Global Warming' (2007) 1 Rev of Environmental Economics and Policy 26.

[46] For example, standard environmental economics texts uniformly repeat this argument without criticism. Baumol and Oates (n 44); Bovenberg and Goulder (n 44); Helfand, Berck and Maull (n 44);

change context and that we should be largely indifferent between the choice of taxes or trading systems. In particular, there are three assumptions in Weitzman's argument which do not carry over to the climate context. The first is that the government has different (and worse) information about the aggregate marginal cost of abatement than does industry. Weitzman's argument relies on asymmetric information. If government and industry estimates are the same, the argument does not go through. The reason is that the government will not systematically set its regulatory policy such that polluters treat it as imposing the wrong price.

In the climate context, the marginal abatement cost curve comes from the aggregation of different technologies that span large portions of the economy. No industry is likely to have a significant (or any) advantage over the government in making these estimates. Climate change is a global problem, involving thousands (or perhaps millions) of firms and billions of individual polluters. Abatement will require massive changes to the economy. Because of the massive, public scale of the problem, firms are not likely to have a significant information advantage over governments, nor will the information about abatement costs change rapidly. Firms, of course, will know their individual costs better than the government will, but the relevant price is the economy-wide marginal cost of abatement, and firms will have no systematic advantage computing this number.

Second, the Weitzman argument depends on the government failing to adjust the tax or quantity restriction when it receives information that it is set incorrectly. In the climate context, given a tax or quantity restriction, the government will know whether the resulting emissions quantity or permit price is consistent with its estimates, so it will know whether the regulatory policy was set in error. To illustrate, suppose that it sets a tax rate t* based on estimates of the marginal abatement and marginal benefit curves. The government will expect that the resulting quantity of emissions will be q*. Because it will have to know emissions to collect the tax, it will know whether actual emissions are greater or less than q*, making it easy to observe if t* was set based on incorrect estimates. The same holds for permits where the government sets the quantity and can observe the price by the minute by simply looking at the current trading price of permits.

Given this information, the government can always adjust the tax rate or quantity of permits to reflect new information. One may object that this is too difficult given bureaucratic and legislative inertia. But in fact, given the likely slow changes to our understandings of the costs and benefits of abatement, tax rates or quantities would not need to be changed frequently. The EU currently uses five-year periods for revisions to the ETS. I estimated in Weisbach (2010) that revisions on this time scale are likely sufficient.

Kolstad and Toman (n 44).

The third assumption in Weitzman's argument is that the tax schedule or quantity restriction is simple. Weitzman only considers flat rate taxes and fixed quantity restrictions.[47] The resulting error leads to deadweight loss. If the regulatory mechanism, whether it is a tax or a permit system, imposes a price equal to the marginal benefit of abatement, incorrect estimates of the marginal cost of abatement will not affect the efficiency of the system. To illustrate, suppose that the government simply announced a price schedule equal to the marginal benefit curve in Figure 3. Then, if the marginal abatement cost curve happened to be equal to the curve labeled "Estimated MAC," the resulting quantity produced would be correct, and if it happened to be equal to curve labeled "Actual MAC" the quantity will again be correct. Quantity restrictions can similarly be designed to keep the resulting price correct.

In particular, the announced tax need only be on a schedule that approximates the marginal benefit curve. It would simply give a tax rate for a given global concentrations of greenhouse gases. This would be far simpler than many income tax schedules currently in use. Quantity restrictions would need to have price ceilings and floors or some other way for the government to manage the price. Many such mechanisms have been proposed.

Arguments based on Weitzman, therefore, should not affect the choice of a cap-and-trade system or a tax. These arguments rely on assumptions that are unlikely to be true in the climate change context.

How, then, should the EU choose between taxes and trading systems? Institutional considerations should be primary. If internal EU structures treat taxes and trading systems differently, these differences will matter more than the claimed economic differences between the two. If, for example, because of its institutional structure, the EU has an easier time imposing a well-designed trading system than a tax (or vice versa), this should determine the answer. Similarly, if the EU is committed to emissions trading, then improving its design, such as by broadening the base, should be the first priority. If the EU is considering expanding carbon taxation, again, designing a good tax system is the central problem, not whether it is superior in principle to a trading system.

6. Conclusion

The conclusions are straightforward. It makes sense to expand the carbon pricing base in the EU. The existing Energy Tax Directive is not well-designed. The Commission's proposal is a good start.

[47] Weitzman was writing before cap-and-trade systems were widely known and was considering a quantity restriction imposed on a single firm. His work, when adapted to cap-and-trade systems, has been interpreted to mean that under a cap-and-trade system, the government fixes a quantity and the permit price is allowed to vary without restriction given the quantity limit.

Nevertheless, it is clear that the EU can do better. The Commission's proposal has the potential to offset the distributive goals of the ETS. It will likely impose different carbon prices on different sectors, and it will be complex to administer. A unified system, such as adding the newly-taxed sectors to the ETS, will be more efficient, be more simple to administer, and better achieve the distributive goals of the ETS. Moreover, a unified system can be moved upstream, achieving administrative and compliance benefits beyond those achieved from merely having a unified midstream system.

Moving to a single system would be a big change, particularly given that substantial changes were made to the ETS for its third phase. Nevertheless, the gains may be large. The fourth phase of the ETS will begin in 2020, and perhaps the best way to think about a shift to a unified system is as part of the fourth phase of the ETS.

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