2.3. Some Issues in Carbon Taxation

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CARBON TAXATION IN THEORY AND PRACTICE

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I. Introduction

15.01 Among alternative policy measures to reduce greenhouse gas (GHG) emissions that contribute to global climate change, one of the most promising but least employed is the taxation of fossil fuels based on their carbon content.[1] Although first enacted in the Scandinavian countries in the early 1990s, however, very few jurisdictions have introduced carbon taxes since then and policy-makers have tended to focus on cap-and-trade regimes as the preferred market-based instrument to contain GHG emissions.

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[1] In recent years, CO_2 has accounted for three-quarters of greenhouse gas emissions. Most CO_2 emissions result from the combustion of fossil fuels and correspond in mathematical proportion to the carbon content of these fuels. Nicholas Stern, *Stern Review on the Economics of Climate Change* (2006), 170–1, available at <http://www.hm-treasury.gov.uk/ stern_review_report.htm> (accessed 1 March 2010) (hereinafter the 'Stern Review').

15.02 This paper advocates a renewed emphasis on carbon taxation as a key element of any policy mix to address climate change. Section II presents the theoretical case for carbon taxation, arguing that it has several advantages over cap-and-trade regimes. Section III surveys experience with carbon taxes in the Scandinavian countries and the Canadian province of British Columbia, which enacted a carbon tax in 2008, in order to derive lessons for the implementation of future carbon taxes. Section IV provides general conclusions.

II. The Case for Carbon Taxation

1. Economic Efficiency

15.03 Some economists propose a carbon tax as a 'Pigouvian tax', a unitary tax to equate the tax level with the marginal damages of carbon emissions. Because there is so much controversy over estimates of the marginal damages of carbon emissions, an alternative rationale is necessary. Rather than fulfilling Pigou's ambition of optimizing social welfare through unitary taxation, we propose a carbon tax on the grounds that as a price instrument, it is better suited to the problem of accumulating greenhouse gases than a quantity instrument such as a cap-and-trade programme.

15.04 In terms of economic efficiency, the case for a market instrument (a tax or cap-and-trade programme) over command-and-control programmes is well-rehearsed: given heterogeneity in marginal abatement costs, a price on a polluting externality has the effect of concentrating abatement among those emitters for which abatement is the least expensive. Whether the price is effected by a tax or a cap-and-trade programme, a price harnesses market forces to draw out the best abatement opportunities, and spur research and development into new abatement technologies. Similarly, the case for market mechanisms over government subsidies is on solid theoretical and administrative ground: if the intent is to price a pollution externality, it is much easier to impose a price on emission of that pollutant than it is to lower the price (through subsidization) for everything else. Among other problems, there is a lower bound to how cheap alternatives can be made, whereas a tax has no upper limit.

15.05 The more interesting exercise arises in comparing a carbon tax with a cap-and-trade programme, which requires a comparison of the potential economic efficiencies to be gained or lost under uncertainty. Uncertainty in the climate change context is a given, as are the marginal abatement costs (although much more is known about the latter). With this in mind, which is more likely to be more efficient?

15.06 While there is much uncertainty on both the marginal damage side and the marginal cost side, two things are known. First, the marginal damages of CO_2 emissions is, in the short term, relatively fixed. This is most true of CO_2 since it is more than other greenhouse gases since it is so long-lived; a CO_2 molecule will last about 100 years. Given this long life, it is much more important to look at the total amount of CO_2 in the Earth's atmosphere than it is to look at variations in any given year. Second, the marginal abatement cost of CO_2 emissions is much more elastic over the long term than the short term, due to the central role that technology and innovation will play in reducing emissions. Of course, long-term marginal abatement cost will always be more elastic than short-term marginal abatement costs, but in the case of CO_2 emissions, this is especially true with the huge pipeline of abatement and conservation projects currently in development, and anticipated to reduce future abatement costs.

15.07 Given these two economic realities, does a price instrument (a carbon tax) or a quantity instrument (a cap-and-trade) programme fare better under uncertainty? The answer is that a price instrument does, because the short-term inelasticity of marginal costs and short-term elasticity of marginal damages means that we can less afford to tolerate price volatility than we can tolerate volatility of emission quantity. Put more simply, it is not so important to strictly regulate the *quantity* of year-to-year emissions, since each year makes such a small contribution to the overall stock of CO_2. It is important, however, to regulate the *price* of emissions over a long period of time so as to maintain a consistent long-term price signal to induce the technological innovation and induce the right marginal abatement efforts.

15.08 Economist Martin Weitzman's seminal analysis, 'Prices vs Quantities',[2] makes this point in the general pollution context, without abstracting it to longer time horizons. Economist William Nordhaus, in his book *A Question of Balance*,[3] restates the Weitzman argument in terms of the nonlinearity of marginal damages and costs. It is sufficient simply to observe that when it comes to controlling the *stock* of CO_2 in the Earth's atmosphere, a persistent price is needed rather than a year-on-year quantity control. And, moreover, to minimize the abatement costs over time, a consistent price would be much more effective than a quantity control.

2. Minimizing Interference with Other Jurisdictions and Policy Instruments

15.09 An advantage that appears to be increasing in importance is the ability for carbon taxes to be levied at various governmental levels without interfering

[2] ML Weitzman, 'Prices vs Quantities' (1974) 41 *Review of Economic Studies* 477.
[3] WD Nordhaus, *A Question of Balance* (New Haven: Yale University Press, 2008).

with each other. Nor does it interfere with other regulatory instruments, as a carbon tax can be implemented simultaneously with a cap-and-trade programme, command-and-control regulation, and even government subsidies. As such, it is particularly worth attempting, as it does not require the abandonment of attempts to reduce greenhouse gas emissions using other instruments.

15.10 The reason that this feature of carbon taxation is of increasing importance is the variety of jurisdictions that are attempting to reduce greenhouse gas emissions, and the implementation and federalism issues raised by these attempts.[4] The Regional Greenhouse Gas Initiative[5] among 10 north-eastern US states is an important attempt to reduce greenhouse gas initiatives. In addition, the Western Climate Initiative, which now includes seven US states and four Canadian provinces, will also undertake a cap-and-trade programme that aims to reduce emissions by 15 per cent below 2005 levels by the year 2020.[6] While both of these initiatives are incomplete, both should remain free from interference from parallel federal attempts in Canada and the US to regulate greenhouse gas emissions. In addition, a network of US cities that have agreed to attempt to at least meet Kyoto Protocol targets that apply to the US of reducing emissions by 7 per cent below 1990 levels by the year 2012. The US Conference of Mayors Climate Protection Agreement now includes 911 cities with a total population of over 80 million Americans.[7] Finally, the Canadian province of British Columbia has implemented the first significant carbon tax in North American, levying a carbon tax of approximately $10 per short ton of CO_2, increasing over five years to about $30 per ton.[8] A federal carbon tax by Canada or the US would easily mesh with these sub-national initiatives. A federal cap-and-trade programme may, but would likely create some implementation issues, as emitters wrestle with complying with cap-and-trade programmes at two levels.

15.11 These sub-national efforts are important to the overall emissions reduction effort because it is increasingly clear that reducing greenhouse gas emissions will require *many* governmental efforts. It is clear that state and local governments, and perhaps some private networks, will have to supply some of the efforts to

[4] See, eg, DA Farber, 'Climate Change, Federalism and the Constitution', Conference paper, Federalism and Climate Change: the Role of the States in a Future Federal Regime (11 February 2008), The William H Rehnquist Center on the Constitutional Structures of Government, University of Arizona, online at <http://www.rehnquistcenter.org/Climate%20Change%20and%20Federalism%20REV.pdf> (accessed 1 March 2010).

[5] Regional Greenhouse Gas Initiative, available at <http://www.rggi.org/home> (accessed 1 March 2010).

[6] Western Climate Initiative, available at <http://www.westernclimateinitiative.org/ewebeditpro/items/O104F19871.PDF> (accessed 1 March 2010).

[7] See <http://www.usmayors.org/climateprotection/about.htm> (accessed 1 March 2010).

[8] Carbon Tax Act 2008 SBC, ch 40.

find an effective battery of regulatory instruments to reduce greenhouse gases. While we argue that a carbon tax should be a centerpiece of greenhouse gas reduction efforts, other compatible regulatory instruments will no doubt be needed as well.

3. Ease of Administration

15.12 A carbon tax has a number of administrability and programme-design advantages over alternatives. A cap-and-trade programme requires a determination of the level of the cap, the sources covered by the cap, and a method for allocating emissions allowances, a vexing problem. When 'offsets'[9] are allowed, rules and criteria must be developed for when an offset project creates new emissions allowances. There are also some tricky taxation questions that must be grappled with. At each stage, rent-seeking is a real danger. Even the often-praised sulphur dioxide emissions trading programme of the US Clean Air Act contained provisions of unnerving audacity: s 404(a)(3) provides that utilities in Indiana, Ohio, and Illinois would receive a special clump of 200,000 allowances for the years 1995–1999, to be split in proportion to their baseline emissions.[10] One would be hard-pressed to find a more naked example of raw political power.

15.13 By contrast, a carbon tax requires the setting of tax levels, and a phase-in schedule. A carbon tax may be vulnerable to rent-seeking, but less so than a cap-and-trade programme. While a cap-and-trade programme can always be defined for a discrete set of industries, a carbon tax is less easily justified if it is less than universal. Differential treatment of fossil fuels is necessary, but only to adjust for carbon content. British Columbia's (BC's) carbon tax, for example, lists all 19 fossil fuels sold in the province. For each fossil fuel, Sch 1 of the BC Carbon Tax Act specifies the tax rate for each fossil fuel, for each of five phase-in years, from 2008 to 2012. Each rate translates into roughly $10 per short ton of CO_2. Could it be done any other way? Again, it would be naïve to discount rent-seeking, but as compared with alternatives, rent-seekers would have to be more audacious to succeed in tampering with carbon taxes than they would need to be to manipulate the many design elements of a cap-and-trade programme.

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[9] Offsets are grants of emissions allowances for activities that are deemed to reduce emissions from some baseline. For example, if a project proponent can convince an authority administering a cap-and-trade program that construction of a dam will eliminate the need for construction of a coal-fired power plant, it may receive emissions allowances that it may use or sell. For a critique of offsets, see MW Wara, 'Measuring the Clean Development Mechanism's Performance and Potential' (2008) 55 *UCLA Law Review* 1759; MW Wara and DG Victor, *A Realistic Policy on International Carbon Offsets*, Working paper, available online at <http://iis-db.stanford.edu/pubs/22157/WP74_final_final.pdf> (accessed 1 March 2010).

[10] Clean Air Act, s 404(a)(3), s 7651c(a)(3).

15.14 Tax collection is much less problematic than most would suspect. The BC carbon tax essentially deputizes every fossil fuel retailer as a tax collector, requiring the collection of the tax at the retail sales level. For the carbon tax as applied to the sale of gasoline, the combustion of which accounts for 40 per cent of BC's CO_2 emissions,[11] the tax collection is trivial: it is tacked onto existing federal and provincial taxes already collected at the gasoline pump. Other retailers also are expected to collect, and in many cases simply add onto, existing taxes. The dominant natural gas supplier in BC, Terasen, simply adds the carbon tax onto customers' bills. Key to the administrability of a carbon tax is the fact that every fossil fuel produced in Canada or imported into Canada generates a paper trail that terminates only upon ultimate disposition—that point before which it is expected to be combusted. Enforcement thus draws from existing tax-collection procedures and institutional arrangements.

4. Revenue Raising

15.15 A carbon tax raises revenues. For many countries, there is a concern with tax receipts. Especially as concerns about the cost of stabilizing economies start to cast doubt on the wisdom of reducing greenhouse gases, it may be wise to favour options that increase revenues.

15.16 This advantage of carbon taxation should not be overstated. First, revenues raised by carbon taxes may need to be refunded to help build political support. Because carbon taxes remain unpopular, recent carbon tax programmes have been put forth as being 'revenue neutral'. British Columbia's carbon tax goes so far as to require the Minister of Finance to forfeit 15 per cent of her salary if the carbon tax proceeds exceed the amount distributed through the various revenue-recycling mechanisms.[12]

15.17 Second, while the concept of revenue recycling appears intuitive and helpful in dividing and conquering opposition to carbon taxes, closer inspection reveals some limitations. It is not necessarily clear that voters believe that carbon tax proceeds would truly be recycled. Countering these kinds of anti-government suspicions is clearly the goal of the BC penalty on the provincial finance minister that fails to recycle carbon tax revenues, but even still, provincial voters remain suspicious.

[11] Environment Canada, National Inventory Report: Greenhouse Gas Sources and Sinks in Canada, 1990–2006,Table A11–21: 2006 GHG Emission Summary for British Columbia, online at <http://www.ec.gc.ca/pdb/ghg/inventory_report/2006_report/ta11_21_eng.cfm> (accessed 1 March 2010) which shows total transportation emissions of 24 Kt and total emissions of 62.3 kt.

[12] Carbon Tax Act, 2008 SBC, ch 40, s 5.

15.18 Third, it is not clear that voters even *want* the money back. Awash in cash from oil revenues after the conclusion of fiscal year 2006, the government of Alberta issued every Alberta resident a check for $400. This was met with surprising hostility, as Albertans, unhappy with public school infrastructure and health care delivery, mocked the premier's 'prosperity cheques'.[13] Similarly, in a survey in Vancouver of willingness to pay increased gasoline taxes, one study found that respondents were moderately more enthusiastic about higher gasoline taxes if the revenues were recycled back in the form of lower income taxes. However, respondents were only slightly more interested in receiving the money back in tax refunds than they were in having the proceeds fund technological research projects that would reduce vehicular greenhouse gas emissions.[14] The literature generated prior to this study found statistically significant, but tepid support for revenue-recycling schemes.[15]

15.19 Finally, the purpose of a carbon tax is to reduce greenhouse gases by changing behaviour. If it does change behaviour, then the revenue stream becomes smaller. A carbon tax will either be effective and only raise large revenues for a short period of time, or raise revenues for a long period of time but be ineffectual. Assuming that the more important goal is to achieve the former, the prospect of a sustained revenue stream is misleading.

15.20 Despite these limitations, given the massive changes in behaviour and infrastructure required to reduce greenhouse gases, a little temporary revenue will be very useful. In the short run it can fund the kinds of structural changes that might be needed to help people and communities cope with change.

5. Better Justification for a Border Tax

15.21 A crippling concern with greenhouse gas regulation is the negative competitive effects on domestic industries. If no import or export adjustments were made, domestic industries having to pay a carbon tax or subjected to other costly greenhouse gas regulation may lose out to international competition, notably from

[13] See eg, G Morton, 'No money available for new schools' *Calgary Herald*, 23 Mar 2006 at A5; D Olive, 'Dubious Dividend: Despite a laundry list of items demanding fiscal attention, Alberta Premier Klein plans to send a $400 'resource rebate to all 3.2 million Albertans' *Toronto Star*, 23 October 2005, at A18.

[14] S-L Hsu, J Walters & A Purgas, 'Pollution Tax Heuristics: an Empirical Study of Willingness to Pay Higher Gasoline Taxes' (2008) 36 *Energy Policy* 3612.

[15] I Parry, 'Revenue Recycling and the Costs of Reducing Carbon Emissions', Resources for the Future, Climate Issues Brief No 2 (1997), available online at <http://www.rff.org/rff/documents/rff-ccib-02.pdf> (accessed 1 March 2010); GR Timilsina, *The Role of Revenue Recycling in Environmental Tax Schemes,* World Bank Policy Research Working Paper 4438 (2007), available online at <http://papers.ssrn.com/sol3/ papers.cfm?abstract_id=1069478> (accessed 1 March 2010); W Harrington, A Krupnick and A Alberni, 'Overcoming Public Aversion to Congestion Pricing' (2001) 35 *Transportation Research* A 87.

China, which is not required to reduce emissions under the Kyoto Protocol, and signalled an unwillingness to do so.

15.22 There are two answers to this concern. First, if this logic is allowed to determine greenhouse gas policy, then there is no hope at all of reducing greenhouse gas emissions unless a nearly universal international agreement is secured that mandates the reduction of greenhouse gases.

15.23 That said, there may be a way to avoid such leakage, and a carbon tax offers the best chance for doing so. The General Agreement on Tariffs and Trade (GATT) art II:2(a) provides that GATT's prohibitions on tariffs do not prevent a country 'from imposing at any time on the importation of any product … a charge equivalent to an internal tax … in respect of the like domestic product or in respect of an article from which the imported product has been manufactured or produced in whole or in part'. A long-standing and unresolved debate is whether this provision permits a country that regulates greenhouse gas emissions to impose a border tax on imports from countries that do not regulate greenhouse gas emissions, to equalize tax burdens in competitive industries.

15.24 It *is* certain, however, that a country that imposes a carbon tax stands the *best* chance of being able to impose a border tax without running afoul of GATT. Apart from the live question of whether a carbon tax falls within the art II:2(a) definition,[16] for a country adopting a cap-and-trade programme to reduce greenhouse gas emissions, it must address the additional question of whether the price of an emissions allowance can be considered an 'internal tax' that can be used as the basis of a border tax. The answer to this question is far from clear, and as cap-and-trade programmes have thus far not been embroiled in international trade litigation, there is no guidance. But intuitively, a border tax must be easier to justify if there exists a clear price—the carbon tax—than if the price is one derived from trading, especially, as has been the case in the EUETS, the market price has fluctuated greatly. Also, as cap-and-trade programmes often distribute free allowances to some industries a strong argument could be made against a cap-and-trade programme; that a border tax adjustment would not survive a trade challenge because there is no tax burden from a cap-and-trade programme.

15.25 The availability of a border tax would embolden other importing countries in considering the imposition of a carbon tax, and the importance of alleviating this international coordination problem is extremely important. Minimizing

[16] For an analysis, see J Pauwelyn, 'US Federal Climate Policy and Competitiveness Concerns: The Limits and Options of International Trade Law', Working Paper, Nicholas Institute for Environmental Policy Solutions (April 2007), available online at <http://www.nicholas.duke.edu/institute/internationaltradelaw.pdf> (accessed 1 March 2010).

opposition from domestic industries fearful of competition from imports will at least make feasible unilateral action in pricing carbon.

III. Carbon Taxes in Practice

1. Finland

15.26 Finland was the first country to introduce a carbon tax, which came into effect in 1990.[17] Imposed in the form of a surtax on fossil fuels other than motor fuels that were already subject to tax,[18] the tax was based on the carbon content of the fuels subject to the tax at a rate equivalent to €1.2 per ton of CO_2 or €4.4 per ton of carbon.[19] Although originally imposed solely on the carbon content of the fuel, the tax was altered from 1994 to 1996 so that rates were based on the fuel's carbon and energy contents with a ratio of 60 to 40 per cent.[20] Since 1997, however, the tax has again been based solely on the carbon content of the fuel, except for fuels that are used to generate electricity—which is subject to a separate tax at the consumer level.

15.27 The reason for exempting fuel used to generate electricity relates to Finland's entrance into the European Union in 1997. As the EU prohibits differential taxation of imports, Finland was unable to impose a tax on imported electricity to compensate for the impact of the carbon tax on domestic electricity generators, and opted to exempt domestic generation from the carbon tax so as not to put this sector at a competitive disadvantage.[21] As a result, like other European countries, Finland now levies a tax on electricity consumption instead, thereby foregoing the valuable incentive that the carbon tax might otherwise create to discourage the use of high-carbon fuels like coal for the generation of electricity.[22] As well, electricity tax rates for industry are lower than household rates,[23] thereby further weakening their incentive to reduce carbon-related energy consumption.

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17 JA Hoerner and B Bosquet, *Environmental Tax Reform: The European Experience* (Washington DC: Center for a Sustainable Economy, 2001), available online at <http://www.rprogress.org/publications/2001/eurosurvey_2001.pdf> (accessed 1 March 2010) (hereinafter 'Hoerner & Bosquet').

18 S Tikkanen, 'Remarks on Few Signs of Environmental Tax Reform in Finland' in A Cavaliere, H Ashiabor, K Deketelaere, L Kreiser & J Milne, *Critical Issues in Environmental Taxation* (Richmond: Richmond Law and Tax, 2006), Vol III, 325 at 330 (hereinafter 'Tikkanen').

19 M Hiltunen, *Economic Environmental Policy Instruments in Finland* (Helsinki: Finish Environmental Institute, 2004) at 9, available at <http://www.environment.fi/download.asp?contentid=20725&lan=EN> (accessed 1 March 2010) (hereinafter 'Hiltunen').

20 Horener & Bosquet (n 17 above) at 15.

21 Tikkanen (n 18 above) at 331.

22 Hoerner & Bosquet (n 17 above) at 15.

23 Tikkanen (n 18 above) at 332.

15.28 Following its introduction at a very low level, the rate of carbon tax in Finland was increased substantially in the 1990s, rising to €17.16 per ton of CO_2 or €63 per ton of carbon by 1998.[24] In order to lessen the impact on household heating costs, however, natural gas and peat were subject to tax at reduced rates.[25] As well, in response to concerns regarding the competitiveness of energy-intensive domestic industries, a refund system was also introduced in 1998 under which enterprises with electricity and carbon tax bills exceeding €50,000 in a year may claim a refund equal to 85 per cent of the amount by which these taxes exceed 3.7 per cent of their value added.[26] As a result, carbon tax burdens are distributed unevenly among different economic sectors,[27] adversely affecting the efficiency and environmental impact of the tax.

15.29 Since 1998, carbon tax rates in Finland have been increased less frequently and more gradually—reaching €18.05 per ton of CO_2 in 2003 (€66 per ton of carbon),[28] and €20 per ton of CO_2 in 2008 (€73 per ton of carbon).[29] Notwithstanding these rate increases, though, the basic structure of the carbon tax remains unchanged, with lower rates on natural gas and peat, no tax on the combustion of fossil fuels used to generate electricity, and a refund for energy-intensive enterprises. Not surprisingly, therefore, studies have generally concluded that the environmental impact of the carbon tax has been limited, reducing CO_2 emissions by no more than a few per cent.[30] In 1998, however, before structural changes limited the scope of the tax, the Finnish Economic Council estimated that CO_2 emissions would have been 7 per cent higher had the carbon tax not been introduced.[31]

2. Sweden

15.30 Following Finland's lead, Sweden introduced a carbon tax in 1991.[32] Originally imposed at a rate of approximately €43 per ton of carbon, rates were increased

[24] Ibid at 331.

[25] Hiltunen (n 19 above) at 9.

[26] Tikkanen (n 18 above) at 332.

[27] Eurostat, *Energy Taxes in the Nordic Countries – Does the Polluter Pay?* (March 2003), available online at <http://www.scb.se/statistik/MI/MI1202/2004A01/MI1202_2004A01_BR_MIFT0404.pdf> (accessed 1 March 2010).

[28] Ibid.

[29] Finnish Ministry of the Environment, 'Environmentally Related Energy Taxation in Finland' available online at <http://www.environment.fi/default.asp?contentid=299288&lan=EN> (accessed 31 July 2009).

[30] J Vehmas, 'Energy-related Taxation as an Environmental Policy Tool: The Finnish Experience 1990–2003' (2005) 33 *Energy Policy* 2175 at 2180.

[31] Finnish Economic Council, *Environmental and Energy Taxation in Finland – Preparing for the Kyoto Challenge*, Summary of the Working Group Report (2000), cited in OECD, *Environmentally-Related Taxes in OECD Countries: Issues and Strategies* (Paris: OECD, 2001) at 105.

[32] S Speck, 'The Design of Carbon and Broad-Based Energy Taxes in European Countries' (2008) 10 *Vermont Journal of Environmental Law* 31 at 50 (hereinafter 'Speck').

to roughly €100 per ton of carbon by 2007 and €106 per ton of carbon by 2008.[33] Like the carbon tax in Finland, the Swedish carbon tax is based on the carbon content of each fossil fuel, resulting in different tax rates for different fossil fuels.[34] Also like Finland, the tax does not apply to fossil fuels that are used to generate electricity which is subject to a separate tax at the consumer level. Since Sweden obtains most of its electricity from hydroelectric power and nuclear energy, however, the effect of this exemption is not as significant in Sweden as it is in Finland.

15.31 Although the Swedish carbon tax originally applied equally to households and industry, the rate on industrial use was reduced to 25 per cent of the general rate in 1993 to address concerns about the competitiveness of domestic producers.[35] Although this ratio was increased to 50 per cent in 1997,[36] it was subsequently reduced and stood at 21 per cent in 2007.[37] As well, as in Finland, energy-intensive enterprises with energy and carbon tax payments exceeding a stipulated percentage of sales can receive a partial or full refund of carbon taxes: 24 per cent of taxes exceeding 0.8 per cent of sales and a full refund for carbon taxes exceeding 1.2 per cent of sales.[38]

15.32 Notwithstanding these special provisions and exemptions, the Swedish carbon tax appears to have had a measureable impact on CO_2 emissions in at least some sectors. According to several studies, for example, the tax encouraged fuel-shifting for heating purposes from coal to biomass,[39] leading to marked reductions in CO_2 emissions from the district heating, industrial and housing sectors.[40] According to the Swedish Environmental Protection Agency, CO_2 emissions in 1994 would have been 9 per cent higher had the carbon tax not been introduced.[41] More recently, the Swedish Environment Minister had claimed that CO_2 emissions would be 20 per cent higher in Sweden but for the carbon

33 Ibid.

34 See, eg S Speck, MS Andersen, HO Neilsen, A Ryeland and C Smith, *The Use of Economic Instruments in Nordic and Baltic Environmental Policy 2001–2005* (2006) at 194 (Table 9.1), available online at <http://www.norden.org/is/publikationer/2006-525/at_download/ publicationfile> (accessed 1 March 2010) (hereinafter 'Speck et al').

35 B Johansson, 'The Carbon Tax in Sweden' in OECD, *Innovation and The Environment: Sustainable Development* (Paris: OECD, 2000) 85 at 87 (hereinafter 'Johansson').

36 Ibid.

37 Speck (n 32 above) at 51.

38 Speck et al (n 34 above) at 195.

39 Johansson (n 35 above) at 88.

40 Naturvärdsverket, *Utvärdering av koldioxidskatten – har utsläpppen av koldioxid minskat?* (1995) cited in OECD, *Environmentally-Related Taxes in OECD Countries* (Paris: OECD, 2000) at 105.

41 Swedish Environmental Protection Agency, *Environmental Taxes in Sweden* (1997), cited in European Environment Agency, *Environmental Taxes: Recent Developments in Tools for Integration* (Copenhagen: EEA, 2000) at 46.

tax, crediting the tax as one reason why CO_2 emissions in Sweden declined by 9 per cent between 1990 and 2006 despite economic growth of 44 per cent over this period.[42]

3. Norway

15.33 Like Sweden, Norway also introduced a carbon tax in 1991. Imposed on the combustion of fossil fuels, the tax applies to petroleum products, coal and coal and oil production in the North Sea.[43] As in Finland and Sweden, the tax is subject to various rate reductions and exemptions to address competitiveness concerns raised by specific industries, such as pulp and paper, metal manufacturing, and fishing.[44] As well, the use of natural gas in the mainland is not taxable, and rates for other fuels vary.[45] As a result, effective tax rates differ widely, from zero for some fuels and industries to almost €40 per ton of carbon for gasoline.[46] Although the use of petroleum products in the North Sea is also subject to reduced rates, these rates are approximately €30 for oil and €38 for gas, in contrast to the pulp and paper industry that is taxable at roughly one-third these rates, and the metal and fishing sectors that are fully exempt.[47]

15.34 Given these rate reductions and exemptions, it is perhaps not surprising that the Norwegian carbon tax appears to have had little impact on overall CO_2 emissions, reducing emissions by only 2.3 per cent overall according to one study.[48] Considering specific sectors, on the other hand, there is considerable evidence that the impact of the tax has been more significant. According to one study, for example, the tax is estimated to have reduced CO_2 emissions at statutory combustion plants by 21 per cent between 1991 and 1995.[49] As well, by imposing relatively high rates on offshore oil and gas production, the tax encouraged the country's largest producer Statoil to develop technology for the undersea storage of CO_2.[50] While increased oil production has caused Statoil's emissions

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42 G Fouché, 'Sweden's carbon-tax solution to climate change puts it top of the green list,' available online at <http://www.guardian.co.uk> (accessed on 29 April 2008).

43 Hoerner and Bosquet (n 17 above) at 22.

44 A Bruvoli and BM Larsen, 'Greenhouse Gas Emissions in Norway: Do Carbon Taxes Work?' (2004) 32 *Energy Policy* 493 at 498 (hereinafter 'Bruvoli & Larsen').

45 Hoerner and Bosquet (n 17 above) at 22.

46 Norwegian Ministry of the Environment, *Norway's Fourth National Communication Under the Framework Convention on Climate Change*, Status Report as of December 2005, at 32 (Table 4.3). Tax rates converted from Norwegian Kroner to Euro using exchange rate applicable on 31 July 2009.

47 Ibid.

48 Bruvoli and Larsen (n 44 above) at 500.

49 BM Larsen and R Nesbakken, 'Norwegian Emissions of CO_2 1987–1994: A Study of Some Effects of the CO_2 Tax' (1997) *Environmental and Resource Economics*, cited in OECD, *Environmentally-Related Taxes in OECD Countries* (Paris: OCED, 2001) at 105.

50 Leila Abboud, 'An Exhausting War on Emissions', *Wall Street Journal,* 30 September 2008.

to quadruple since 1990, it is generally accepted that this increase would have been much larger but for the carbon tax.[51] Similarly, while CO_2 emissions in Norway increased by 15 per cent between 1991 and 2008, the carbon tax is generally considered to have contributed to a 'relative decoupling' of emissions from economic growth,[52] which amounted to 70 per cent over this period.[53]

4. Denmark

15.35 Shortly after the other Scandinavian countries, the Danish carbon tax came into effect in May 1992.[54] Based on the carbon content of various fuel types, the tax was originally imposed at a rate of approximately €13 per ton of CO_2 or €48 per ton of carbon.[55] As the tax was intended to encourage the consumption of less carbon intensive fuels without affecting the overall price of energy, energy taxes were reduced when the carbon tax was introduced.[56] In 2005, the carbon tax rate was reduced to roughly €12 per ton of CO_2 or €44 per ton of carbon,[57] at which time energy taxes were increased correspondingly.[58]

15.36 As in the other Scandinavian countries, the Danish carbon tax includes various rate reductions and refunds in order to address concerns about the competitiveness of Danish enterprises. When the tax was first enacted, it applied only to households and industries were fully exempt.[59] From 1993 to 1995, non-energy-intensive industries were subject to the carbon tax at half the rates otherwise applicable, while energy-intensive industries were granted a refund for 95 per cent of carbon taxes exceeding 3 per cent of their gross value added.[60] Since 1996, Danish enterprises have been subject to full carbon tax rates on fossil fuels used for space heating, slightly reduced rates for non-energy-intensive industries, and significantly reduced rates for energy-intensive industries.[61] As well, enterprises can reduce their carbon tax burden yet further by entering into voluntary agreements with the Danish energy authority to increase their energy efficiency.[62]

15.37 Considering the impact of these voluntary agreements, one study estimates that they led to a 9 per cent reduction in energy usage that was only partly offset by an

51 Ibid.
52 Bruvoli and Larsen (n 44 above) at 493.
53 Abboud, n 54 above.
54 Speck et al (n 34 above) at 62.
55 Speck (n 32 above) at 44.
56 Speck et al (n 34 above) at 62.
57 Speck (n 32 above) at 44.
58 Speck et al (n 34 above) at 62.
59 Speck (n 32 above) at 45.
60 Speck et al (n 34 above) at 63–4.
61 Ibid at 64.
62 Speck (n 32 above) at 45. See also the description of this scheme in OECD, *The Political Economy of Environmentally-Related Taxes* (Paris: OECD, 2006) at 166–8.

increase in energy usage attributable to the reduction of tax, suggesting that the voluntary agreements were actually more effective in reducing energy consumption than the tax itself.[63] More generally, the carbon tax and the earmarking of 20 per cent of carbon tax revenues to energy-efficiency measures and upgrades in production technology appear to have played a significant role in a 30 per cent improvement in Danish industry's energy efficiency between 1990 and 2000.[64] As a result, together with other policies, the carbon tax appears to have contributed to a reduction of 8.3 per cent in CO_2 emissions in Denmark between 1990 and 2008 despite sustained economic growth during this period.[65]

5. British Columbia

15.38 The most recent jurisdiction to adopt a carbon tax is the Canadian province of British Columbia, which introduced a consumption-based carbon tax effective 1 July 2008.[66] North America's first broad-based carbon tax, the tax applies to emissions from the combustion of fossil fuels and other specified combustibles within the province, with rates based on CO_2 emissions associated with the various fuels and combustibles that are subject to the tax. As a result, as the provincial budget announcing the tax explains:

> The tax base includes fossil fuels used for transportation by individuals and in all industries, including the combustion of natural gas to operate pipelines, as well as road, rail, marine and air transportation. As well, the tax base includes fuel used to create heat for households and industrial processes, such as producing cement and drying coal.[67]

15.39 Since the tax applies only to the combustion of fossil fuels within the province, it also excludes or specifically exempts fuels exported from British Columbia and fuels used for inter-jurisdictional commercial marine and aviation purposes.[68]

15.40 Introduced at an initial rate of $10 per ton of CO_2-equivalent emissions,[69] the tax is scheduled to increase by $5 per ton on 1 July of each year until 1 July 2012

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63 TB Bjorner and HH Jensesn, 'Energy Taxes, Voluntary Agreements and Investment Subsidies – A Micro-panel Analysis of the Effect on Danish Industrial Companies' Energy Demand' (2002) *Resource and Energy Economics*, cited in OECD, *The Political Economy of Environmentally-Related Taxes* (Paris: OECD, 2001) at 168.

64 MS Anderson, 'Environmental and Economic Implications of Taxing and Trading Carbon: Some European Experiences' (2008) 10 *Vermont Journal of Environmental Law* 61 at 69.

65 Danish Energy Agency, 'Large drop in energy consumption and CO2 emissions in 2008' (18 March 2009), available online at <http://www.sparenergi.dk/sw80769.asp> (accessed 1 March 2010).

66 For a detailed account of the tax and the circumstances leading up to its enactment, see DG Duff, 'Carbon Taxation in British Columbia' (2008) 10 *Vermont Journal of Environmental Law* 85.

67 British Columbia Ministry of Finance, Budget And Fiscal Plan 2008/09–2010/11 (10 February 2008) (hereinafter BC Budget 2008) at 13, available online at <http://www.bcbudget.gov.bc.ca/2008/ bfp/2008_Budget_Fiscal_Plan.pdf> (accessed 1 March 2010) (hereinafter 'BC Budget').

68 Ibid at 12.

69 Ibid.

when it will reach $30 per ton.[70] Expressed as taxes on specific fuels, the initial rate of $10 per ton translates into levies of 2.41 cents per litre of gasoline, 2.76 cents per litre of diesel,1.53 cents per litre of propane,2.45 cents per litre of aviation fuel,49.66 cents per gigajoule of natural gas, $17.72 per ton of low-heat-value coal, $20.79 per ton of high-heat-value coal, $24.87 per ton of coke, $10.22 per ton of peat, $23.91 per ton of shredded tires, and $20.80 per ton of whole tyres.[71]

15.41 Although the provincial government itself acknowledges that a price of even $30 per ton of CO_2e emissions may be insufficient to encourage significant changes in behaviour,[72] it also offers two reasons for introducing the tax at a relatively low rate and gradually increasing this rate over five years. First, it explains, this approach 'gives individuals and businesses time to make adjustments and respects decisions made prior to the announcement of the tax'.[73] Secondly, it notes, the phase-in also ensures 'certainty about rates for the first five years'.[74] This is a notable advantage over emissions trading regimes in which the price of GHG emissions is subject to market fluctuation.[75] Low rates may also alleviate competitiveness concerns in the short run, though the concrete and cement industries have already complained that the tax 'will make BC's three cement facilities vulnerable to plant closures' as consumers switch to Asian producers who are not subject to carbon taxation or emissions limits.[76] As a result, unless competitiveness concerns can be addressed in some way, British Columbia may face the same pressures that Scandinavian countries faced to introduce reduced rates and exemptions for specific sectors.

IV. Conclusion

15.42 As this chapter explains, carbon taxation represents one of the most promising policy instruments to contain GHG emissions and has distinct advantages over cap-and-trade regimes in terms of economic efficiency, integration with other jurisdictions and policy instruments, ease of administration, revenue generation,

70 Ibid at 12 (Table 1.1).

71 Carbon Tax Act 2008 SBC, ch 40, Schs 1–2.

72 BC Budget (n 67 above) at 18, 20.

73 Ibid at 11.

74 Ibid.

75 See, eg RS Avi-Yonah & DS Uhlmann, 'Combatting Global Climate Change: Why a Carbon Tax Is a Better Response to Global Warming Than Cap and Trade', University of Michigan Public Law Working Paper No. 117 (2008) available at <http://papers.ssrn.com/sol3/ papers.cfm?abstract_id=1109167>.

76 R Gilbert, 'British Columbia's Ready-Mix Producers See Threat in New Carbon Tax', *Daily Com News & Construction Rec* (Ontario), 17 July 2008, available online at <http://www.dailycommercial-news.com/article/id28999> (accessed 1 March 2010).

and compatibility with border tax adjustments. Experience in the Scandinavian countries and the Canadian province of British Columbia suggests that carbon taxes are feasible and can have a measurable impact on emission reductions. At the same time, practical experience suggests that carbon taxes are politically difficult to establish and, not unlike cap-and-trade regimes, are vulnerable exclusions and exemptions that can lessen their efficiency and environmental effectiveness. Aside from political opposition, the most serious challenge to the implementation of effective carbon taxes is international competition that can disadvantage domestic industries subject to the tax. While international agreement on a harmonized carbon tax would be one way to address this dilemma, a more practical solution would involve border tax adjustments relieving exports from the burden of embedded carbon taxes and taxing imports on embedded carbon emissions.