What Price Carbon?
Theory and Practice of Carbon Taxation in the OECD

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Abstract

To date, seven jurisdictions across the OECD have implemented explicit carbon taxes, approximating what textbook economic theory prescribes with varying degrees of success. The purpose of this paper is to "take stock" of the current state of carbon taxation in the OECD, identify patterns, differences, and best practices. After a brief discussion of carbon pricing, the paper compares carbon taxes where they have been implemented relative to each other, as well as relative to the theoretical ideal. Apart from identifying gaps between carbon tax theory and practice, and highlighting patterns and key differences among jurisdictions with carbon taxes, the ultimate goal of the paper is to develop an alternative measure of the price of carbon for use in quantitative empirical (explanatory) analysis.

I. Introduction

In debates surrounding the appropriate response to climate change, "pricing carbon" has emerged centre stage. To be sure, economic models have long demonstrated that market-based approaches to pollution abatement are more cost-effective than are subsidies, voluntary programs, and regulation (Baumol and Oates, 1985). More recently, countless government and NGO studies from the climate policy community now espouse the relative merits of putting a price on carbon (NRTEE, 2007; Metcalf, 2007; CBO, 2008; Demerse and Bramley, 2008; Mintz and Olewiler, 2008; Rivers and Sawyer, 2008). In addition, there is now a broad-based, cross-cutting consensus among economists (Mankiw, 2007; Nordhaus, 2007), climatologist/environmentalists (Hansen, 2008; Brown, 2008), and even some members of the business community (Hyndman, 2009; Clark, 2009),[1] who otherwise make strange bed-fellows, that a carbon *tax* is the most efficient and in many circumstances the most effective policy instrument to price carbon, and by association, reduce man-made emissions of greenhouse gasses (GHG).

Despite such enthusiasm for carbon taxes among experts, few countries have followed the doctor's orders. Indeed, experience with failed tax proposals has shown that important domestic and international political factors can prevent carbon taxes from being seriously considered. For instance, concerns over their distributional consequences (equity and regressivity) as well as concerns regarding economic competitiveness make the implementation of carbon taxes politically difficult (OECD, 2001; 2006; Zhang and Baranzini, 2004). In contrast to such other policy instruments as emission trading, taxes impose direct and visible costs on society, which further makes for a tough political sell (Barthold, 1994). Nevertheless, a few European countries and sub-national jurisdictions in North America have gone ahead and implemented their own version of a "carbon tax." Upon further analysis, however, important design characteristics, which are adopted to make tax proposals politically palatable, severely undermine the theoretical advantages of carbon taxes, and blur the distinction between a textbook carbon tax and other types of more commonly found energy taxes.

The purpose of this paper is to "take stock" of the current state of carbon taxes in OECD member countries, and propose an approach to measuring the price of carbon. This analysis proceeds in three steps. First, the paper briefly outlines the theoretical reasons for, and advantages of, a pure carbon tax. Next, actual carbon tax schemes in OECD jurisdictions are compared to each other, as well as to the theoretical ideal discussed in the previous section. After highlighting significant gaps between carbon tax theory and practice, the paper proposes a more comprehensive measure for the price of carbon across OECD jurisdictions.

II. Carbon Taxes in Theory

The burning of fossil fuels – a cornerstone of modern industrialized economies – generates significant external costs that are collectively borne by the environment and the

[1] Exxon Mobile in the United States, and the Canadian Association of Petroleum Producers, are among some of the business organizations to make public their preference for a carbon tax.

human societies embedded within it. Though difficult to quantify,[2] the costs of an unstable and changing climate are potentially catastrophic, prompting Sir Nicolas Stern to call global climate change the single largest market failure the world has ever known (Stern, 2006). Current price structures for fossil fuel energy allow firms and individuals to dump thousands of tones of carbon dioxide and other GHG into the atmosphere, free of charge. If polluters were forced to pay for the disposal of their emissions, as is usually the case with other types of human-made waste, then polluters would have an incentive to emit less. For this reason, a growing number of economists (Mankiw, 2007), international organizations (EC, 1991; OECD, 2001) and NGO's (Pembina, Friends of the Earth) advocate putting a price on carbon emissions as a central plank in efforts to reduce GHG emissions from the use of fossil fuels and mitigate the adverse effects of climate change (c.f. Rivers and Sawyer, 2008).

The appeal of market instruments to price carbon lies in their theoretical ability to satisfy three of the most oft-cited objectives of environmental policy (Corfee-Morlot and Jones, 1992: 15). First, market instruments used in climate policy are *cost-effective* in that they the benefits they bring (reductions in GHG) outweigh their cost, and the abatement achieved occurs at minimum cost to society. Second, most studies find market instruments to be *environmentally effective* in that their implementation actually reduces emissions of GHG. Finally, important design features and the use of revenues can help offset any regressive effects of carbon pricing, thereby satisfying the criterion of *equity,* in order to ensure that economic instruments are perceived as being fair.

To be sure, decision-makers in the real world must balance these sometimes-competing objectives, and there are many obstacles to the proper implementation of market-based instruments. In particular, valuing the benefits of reduced GHG emissions is especially contentious. As Corfee-Morlot and Jones (1992: 16) point out, even if we could somehow agree on the future value of a stable climate, at what level should we discount these values in order to compare them with present day costs? In addition, GHG emissions can be difficult to measure, and the cost of a changing climate is difficult to quantify, making straightforward calculations of the cost-and-benefit of climate policy especially difficult. Economic instruments also affect the distribution of production and consumption in an economy, raising thorny questions regarding social equity. Finally, given the global public good nature of the earth's climate, an optimal policy response would be undertaken at the international level. However, given the distribution of costs and benefits and incentives to free ride, international climate policy coordination is notoriously difficult to implement, and governments are apparently unwilling to surrender control of even a small percentage of their domestic tax base to an international body (Corfee-Morlot and Jones, 1992).

Notwithstanding these issues, market-based policies are currently seen as the most promising instruments available for addressing the climate change problem. Indeed, the history of climate policy has evolved from an emphasis on voluntary mechanisms, to the

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[2] Assigning a monetary value to environmental goods and human health is highly controversial (Ekins and Barker, 2001: 329). From a practical standpoint, however, the notion of internalizing the costs of climate change is less to set an accurate price on the externalities associated with fossil fuel so that any benefits, however discounted, outweigh costs, than of increasing the relative price of fossil fuels in order to reduce present levels of GHG emissions.

more recent focus on regulation and carbon pricing. To be sure, a carbon price can be set implicitly through regulation (i.e. a law forcing expenditure on mitigation and therefore imposing a price on emissions); however, across the OECD the debate has evolved into one that is narrowly focused on using market instruments (OECD 2001; 2006).

There are two basic ways of using the market price to "internalize" the external costs associated with fossil fuel use (i.e. climate change). Governments can set a price on carbon either directly, through the tax instrument, or indirectly, through an emissions cap and permit trading system. Both approaches use market prices to internalize some of the costs associated with the burning of fossil fuels, and upon further analysis, the two approaches are much less different than is sometimes portrayed. The main features of the tax and trade options are summarized in Table 1.

Table 1: Main Features of Carbon Tax vs. Cap-and-Trade

	Carbon Tax	**Cap-and-Trade**
Price	Fixed (price certainty)	Volatile (price uncertainty)
Emissions	Reduced (quantity uncertain)	Capped (quantity certain)
Coverage	Economy wide (exemptions for sensitive industry)	Heavy emitters (sector specific, initially, high transaction costs prevent economy-wide application)
Revenue	Generates revenue for tax cuts or expenditures (can be used to offset regressive effects if spent progressively	Only if permits are allocated
Administration/ Implementation	Less complex, can be readily implemented in less time and with existing administrative bureaucracy	Highly complex, requires protracted negotiation around design and creation of new institutions
Political feasibility	More visible (politically less popular)	Costs are hidden (politically preferred)
Design Issues	Tax base (coverage) Collection point Price level	Coverage Point of obligation Cap level Initial allocation Price ceiling/floor Enforcement

Note: this table builds on the work of Olewiler (2008)

In theory, the main difference between the two instruments lies in setting the price versus quantity of emissions (Weitzman, 1974). Taxes are "price-based" instruments, meaning that the *price* of carbon is *fixed*, and the quantity of emissions adjusts, according to decisions made by private actors in the market (i.e. whether to change their emission-generating behaviour, or pay the tax).[3] Conversely, emission trading is "quantity-based," meaning that the *quantity* of emissions is *capped* by government (or some central authority) at a certain level, and the price of emissions is allowed to fluctuate with the market, through trading or auctions (where heavy emitters buy permits from the government of from those polluting less). Theoretically, the choice between the two creates a tradeoff between price certainty (important for economic decisions) and emissions certainty (important for environmental considerations). For this reason, taxes are sometimes preferred because they provide emitters with cost certainty, crucial when making long-term investment decisions, while environmentalists sometimes prefer trading, because its outcome is more certain with regards to achieving a given reduction in emissions (Ekins and Barker, 2001: 331).

Despite the differences outlined in Table 1, however, tax and trade options are broadly equivalent (Ekins and Barker, 2001: 329-330). Indeed, Fischer and Hinchy (2004), demonstrate that both approaches can be equally cost-effective, if certain assumptions regarding the design of cap-and-trade are met. For instance, when permits are auctioned and the system is applied economy-wide, the two approaches are functionally equivalent. Consistent with the "polluter pays principle," emitters are forced to decrease emissions, or else pay a fee. But while the fee is fixed under a tax, and set/adjusted by government, it can fluctuate under cap-and-trade according to supply and demand, and in this sense, a cap-and-auction system is essentially a privatized carbon tax (Hyndman, 2007).

Crucially, from a policy perspective, the two options face many of the same issues when considering their design, the decisions on which can erode the distinctiveness of either approach. For instance, policy-makers interested in implementing either a tax or cap-and-trade must first decide on what sectors of the economy will be affected, and what sectors are exempt, and this choice can minimize a commonly cited difference between the two in terms of coverage (economy-wide versus sector-specific).[4] Similarly, if permits are auctioned under cap-and-trade, it too can raise government revenue, which can be used to offset any potential regressive effects, (a carbon tax is inherently revenue raising). To take another example, commonly cited problems with cap-and-trade, such as price volatility and the associated difficulty business has with making investment decisions under price uncertainty, have given rise to discussion of establishing price ceilings and floors.[5] One option, the so-called "safety-valve," allows emitters to purchase permits from the government at a specified trigger price (Jacoby and Ellerman, 2004),

[3] The tax (or carbon price) is set by government (or some other central authority, like an international organization), and emitters chose how much to emit, according to their marginal abatement costs and future investment decisions.

[4] Because they are more straightforward to implement, carbon taxes tend to be applied economy-wide. In practice, cap-and-trade systems are usually sector specific, targeting heavy emitters, since it would be administratively complex and increase transaction costs to a prohibitive level were they to cover all emitters.

[5] Such innovations are referred to as "hybrid models" in the literature.

effectively removing the "cap" from cap-and-trade. If implemented, innovations like the safety-valve generate more certainty regarding price, but at the cost of less certainty regarding whether a particular emissions level can be met. In these lights, when the pure form of either the tax or trading options are implemented in actual policy, important design characteristics can blur the theoretical distinction between "price versus quantity" discussed above (Fischer, Hanson and Pizer, 2008).

By adding a price to emissions of carbon dioxide, a carbon tax and some forms of cap-and-trade (if auctioned and applied economy wide) can reduce GHG emissions at least cost to society (Ekins and Barker, 2001: 339-340). Though not the only way to price carbon, the following sections will focus on the tax approach. Theoretically, carbon taxes raise a number of interesting questions concerning the politics of expert advice. On the one hand, given the overwhelming enthusiasm for carbon taxes among policy experts, why are they so difficult to implement politically and why have some jurisdictions been more successful in implementing their proposals than others? On the other hand, given concerns over their impact on international competitiveness, why would a jurisdiction unilaterally impose a carbon tax in the first place? In practical terms, insight into particular carbon tax design, and the level of explicit and implicit taxes on fossil fuels, is also of crucial importance for assessing the relative costs and benefits of an important tool for climate policy.

In strict terms, a carbon tax is a direct charge levied on all fossil fuels, *proportionate* to the carbon content (or carbon emissions) of each fuel.[6] Since the carbon content of every fuel is precisely known, as is the amount of carbon dioxide (CO_2) released from the burning of each fuel,[7] it is possible to tax energy sources based on their specific climate-change potential, usually in terms of their carbon content or carbon dioxide equivalent (Baranzini et al. 2000).[8] Accordingly, under a pure carbon tax, coal should be taxed at the highest rate, then oil, then natural gas, since coal emits more CO_2 when burned, and natural gas, the least. This feature is what shall be referred to as the principle of *differentiation,* i.e. the tax differentiates across tax bases (fuels) according to their associated emissions of carbon dioxide. For all intents and purposes, this feature is *the* defining characteristic of a pure carbon tax.[9]

Carbon taxes create an incentive to reduce emissions of CO_2 by forcing individuals and firms to pay a fee for every tonne of carbon dioxide they emit into the

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[6] Some authors (Baranzini et al. 2000) distinguish between a tax on the carbon content of fuels (a carbon tax) and a tax on the carbon emissions of different fuels (a CO_2 tax). This distinction is technical and the present research uses carbon tax, CO_2 tax, carbon levy, carbon tariff, and emissions tax interchangeably.
[7] When converting from a carbon tax to a tax on carbon dioxide emissions, a standard carbon to CO_2 ratio is applied; 44:12.
[8] The carbon content of coal is 25.1 grams of carbon per 1,000 British Thermal Units (BTUs); 20.3 for oil; and, 14.5 for natural gas (Pearce, 1991: 939). It should be noted that of the three main fossil fuels, the carbon content of coal is the most variable.
[9] Carbon taxes are thus distinct from other taxes on energy products more commonly found in the OECD, such as ad valorem taxes (VAT), which are based on the value of a good or service, "energy taxes," which apply to energy consumption, and excises levied on particular energy sources, such as coal or motor fuels (Pearce, 1991; Baranzini et al. 2000). Notably, while these latter taxes affect the price of carbon-based energy, their rates are not set proportionate to the carbon content/emissions of each fuel, and are thus not a "carbon tax."

atmosphere. Goods and services that cause very high emissions become relatively more expensive, and polluters are forced to either reduce emissions through beahvioural change or technological innovation, or pay the tax. A carbon tax thus addresses the externality (more CO_2 in the atmosphere) by directly adding a cost proportionate to the carbon content of, or emissions from, a particular fuel. In this way, carbon taxes are a relatively straightforward and direct mechanism for "internalizing" the environmental and social costs of burning fossil fuels.[10]

At the conceptual level, carbon taxes have certain theoretical advantages that make them a preferred policy instrument among many climate policy experts (Nordhaus, 2007; Hansen, 2008; Hyndman, 2009). These advantages can be summarized in terms of meeting three key policy criteria: efficiency, equity, and effectiveness.

Cost-efficiency. A carbon tax is "cost-effective" in the sense of minimizing compliance costs for emitters (Pearce, 1991). By imposing a uniform price on emissions that is applied economy-wide, the marginal cost of abatement is equalized across all sectors of the economy (a condition for cost-effectiveness).[11] The choice of whether to emit and pay the tax, or reduce emissions (through energy conservation, investing in more efficient technology, or substituting for less carbon-intensive fuels), thus falls on individual polluters, each possessing their unique marginal cost function for pollution abatement. Each polluter weighs the cost of emission control against the cost of emitting and paying the tax, and will invest in climate friendly technology when the cost of such actions is less than what it would cost to continue emitting (IPCC, 2007: 755). Assuming actors are rational,[12] low marginal cost polluters will make greater abatement efforts (since the cost of abatement is less than the price to pollute), achieving the intended reduction in pollution at the lowest aggregate cost to society (Pearce, 1991: 941; Baranzinni et al. 2000: 396; Grafton et al. 2004: 64).

Equity. The key feature of a carbon tax that makes it cost-effective – a uniform rate applied economy-wide – also makes a carbon tax inherently *regressive*, in the sense that it imposes a relatively larger cost on low-income families. Since lower income families spend a disproportionate amount of their income on energy, any increase in energy prices will have a relatively greater impact on the disposable income and welfare of the poor. However, unlike other forms of pricing carbon – either through an emission cap and permit trading system,[13] or regulations (standards) which impose a defacto price on carbon – a tax is also inherently revenue raising. With the judicious use of revenues, the regressive effects of carbon taxes can largely be offset if revenues are used progressively, as is done in many Scandinavian countries where regressive taxes are used to finance a progressive welfare state (Kato, 2003). Thus, a key design feature for carbon

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[10] See note 2.

[11] As Hahn (1989: 96) explains, "If all firms are charged the same price for pollution, the marginal costs of abatement are equated across firms, and this result implies that the resulting level of pollution is reached in a cost-minimizing way."

[12] Since the debate over climate policy centres primarily on issues of cost, the "rational actor" assumption seems plausible. Applying a price to emissions, however, may have the unintended effect of legitimating the act of polluting, and of increasing emissions (c.f. Danhof 2008).

[13] Though there are many theoretical advantages to auctioning permits, in practice, all emissions trading schemes allocate permits based on past emissions, free of charge. Such practice makes it difficult to reward early action, creates barriers to entry for new firms, and does not raise revenue for governments.

taxes is that they should be revenue neutral, with some of the revenue dedicated to ensure that the less well off in society are not systematically disadvantaged by the tax (c.f. Sadik, 2008).

Environmental Effectiveness. More so than any other instrument, a carbon tax creates *on-going* incentives to reduce emissions. To be sure, regulations tend to be technology-based (e.g. fuel efficiency standards), and encourage emitters to adopt particular technologies. Under such a framework, there is little incentive for emitters to reduce emissions beyond the prescribed standards, unless governments continually adjust regulations so that they are slightly above the best available technology (Zhang and Baranzini, 2004: 508; OECD, 2006). Similarly, an emission cap and permit trading system also lacks such "dynamic efficiency," since permit prices are likely to fall over time as climate friendly technology is diffused, eliminating the incentive to continue with emission reductions (Baumert, 1998). In contrast, a carbon tax provides a *permanent* incentive to innovate and adopt new technologies, for as long as carbon-based fuels are used (Pearce, 1991: 942).[14] Such permanence helps to ensure on-going reductions in GHG, ostensibly the primary motivation underlying any appropriately labeled "carbon tax."

In sum, if we are to assess carbon taxes currently in place, they should fulfill at least four key criteria. First, carbon taxes should *differentiate* the tax rate imposed on different fuels, according to their carbon content or associated emissions of carbon dioxide. Second, if a carbon tax is to meet the criteria of being *cost-effective,* it should apply a uniform price economy-wide, with no exemptions in terms of coverage, so that those in society with a low marginal cost of abatement (i.e. those for whom the cost of abatement is lower than the price to pollute) have an incentive to reduce emissions (i.e. increase abatement). Both principles of differentiation and broad coverage also have implications for the third key criterion; namely, *environmental effectiveness.* If carbon taxes are to have their intended effect on reducing emissions of CO_2, they should be applied at a relatively high level, gradually increased over time, and apply to all sectors of the economy so that all sources of pollution are regulated. Finally, to ensure that taxes meet the criterion of *equity,* carbon taxes should be revenue neutral (i.e. not dedicated solely to government budgets), so that part of the revenues raised can be used to offset any regressive effects.

III. Carbon Taxes in Practice

Although in principle a simple and straightforward idea, carbon taxes differ substantially across jurisdictions. Given the politics associated with their implementation, political trade-offs must be made, and political factors largely determine the design and substance of particular carbon taxes implemented in OECD jurisdictions (Kasa, 2000; Daugbjerg and Pedersen, 2004; Pearce, 2005). In particular, carbon taxes differ in terms of the rates applied to different tax bases (coal vs. oil vs. natural gas), who pays the tax (sectoral coverage), and how the revenues are used (affecting social incidence). Though

[14] As pointed out by Baumert (1998), emissions trading lacks such dynamic efficiency; since permit prices are likely to fall as climate friendly technology is diffused, there will be less incentive to continue emissions reductions.

important for making carbon taxes politically palatable, certain design features can significantly undermine their cost-efficiency and environmental effectiveness.

To date, several jurisdictions across the OECD have successfully implemented an explicit form of carbon tax, approximating the theoretical ideal with varying degrees of success. Finland (1990), Sweden (1991), Norway (1991), Denmark (1992) and the Netherlands (1996) were among the first countries to do so in the 1990s. Later, a second-wave of incomplete and pseudo carbon taxation emerged in the OECD with Italy (1999), Germany (1999) and the UK (2001) implementing their own brand of energy/carbon tax, in some cases under the broader rubric of ecological or environmental tax reform (ETR).[15] More recently, the City of Boulder, Colorado (2007), and the Canadian provinces of Quebec (2007) and British Columbia (2008) have implemented sub-national forms of a carbon tax in their effort to meet Kyoto targets for the reduction of GHG emissions.

In general, successful carbon tax proposals in the OECD share a few characteristics in common.[16] First, nearly all carbon taxes in existence were implemented incrementally, by increasing the rate over time, or by gradually extending coverage (and removing exemptions and/or rebates for sensitive industry). For instance, tax rates in Finland were introduced at a relatively modest level (approximately $1.4USD/tonne of CO_2) in 1990, and increased (to approximately $22USD/tonne of CO_2) in 1998. Initially limited to heat and electricity production, the Finish tax was also broadened over time to cover transportation and heating fuels (Barde and Braathen, 2007: 54). In other jurisdictions, an increase in carbon tax revenues is generated through the progressive reduction of exemptions, an approach taken by Sweden and Denmark in the early 1990s (Table 2). Finally, increases to the carbon tax can be automatic, as in B.C.'s annual carbon tax increase of $5.00 CDN each year, rising to $30CDN in 2012 (British Columbia, 2008).

Gradual implementation is important for several reasons. First, a low initial tax rate, and allowing both the tax rate and tax base to increase over time, is often required to make carbon taxes politically palatable. Second, an initially low rate (or initially large but gradually decreasing refunds) allows emitters time to adjust. For instance, amidst concern from business, industry in Denmark was granted a 100% rebate on the carbon tax applied to low sulphur fuel oil, when the tax was first implemented in May 1992. The rebate was subsequently decreased over time to 50% (1993), 40% (1997), 30% (1998), 20% (1999) to just 10% (2000) where it stands as of first quarter 2008 (IEA, 2008: 117).[17] In addition, legislated increases in the tax can help alleviate concern that governments adjust the tax for self-interested reasons. Automatic adjustment also sends a

[15] Italy's controversial carbon tax reform in 1999 has since been subject to suspension in light of concern over rising inflation in that country. Its future status is currently unknown. As such, the Italian carbon tax is excluded from the present analysis. In addition, the present analysis excludes the German and UK cases, since both are better interpreted as energy taxes – i.e. taxes on energy consumption – than an attempt to impose a tax on the carbon content/emissions of different fuels.

[16] As the experience of failed proposals suggest, this is not to say that the following characteristics guarantee success.

[17] A similar staggered refund system was implemented for light fuel oil used by industry (IEA, 2008: 118). As of 1 January 1993, the rebate granted to industry using steam coal was cut in half from 100% to 50%, where it remains as of First Quarter 2008.

clear price signal for longer-term investment decisions, and encourages behavioural change even at lower tax rates, as emitters anticipate higher costs in the future. Finally, a legislated, automatic and gradual increase effectively adjusts the tax rate for inflation, ensuring that real tax revenues are not compromised.

A second common trend in carbon taxes in the OECD relates to who is taxed, and by how much. Contrary to the theory of Pigouvian taxation, which stipulates a tax should be uniform across all sectors of the economy (Hoel, 1996), most carbon taxes apply different rates to different uses of the same fuel (e.g. commercial versus household use), and *all* carbon tax countries in the OECD provide special tax rebates, reductions or exemptions for certain sectors of their economy. Due to the difficulty in implementing harmonized carbon taxes on a regional or global scale, and the accompanying concern of losses to international competitiveness, such a practice appears necessary. Indeed, unilateral carbon taxes are often implemented in such a way as to minimize their impact on sensitive industries, by providing a complex mix of tax loopholes, refunds and exemptions. Although necessary for political feasibility, however, specialized exemptions violate the spirit of carbon taxes, undermine their environmental effectiveness, and blur the distinction between "carbon taxes" and other taxes levied on the same energy products. As a result, the majority of the tax burden imposed by carbon taxes, like energy taxes more generally, falls on oil for transport and for household use (Haugland et al., 1992; Barde and Braathen, 2007).

In the absence of an international system of harmonized taxes, and given the perceived negative impact of carbon taxes on international competitiveness, different countries will apply different rates, and will exempt different industries from carbon tax obligations, resulting in very different carbon tax designs. These differences are summarized in Table 2.[18]

[18] In addition, carbon tax schemes can also be distinguished in terms of: the purpose and motivation of the tax; how the proposal was implemented – on its own or as part of a broader tax reform; fuels covered and varying rates applied to each fuel; and, the sectors of the economy to which the tax applies. Where possible, these differences are discussed below.

Table 2. Estimates of Average[19] Carbon Taxes in Selected[20] OECD Countries

Country	Year	Tax rate/tonne of CO_2[21]	Coverage	Revenue use
FIN	1990	*CO_2 Tax* \$22/tonneCO_2[22]	Exempt: Fossil fuels used in industrial processes.	Allocated to general government budget. Reduced income and social contributions.
SWE	1991	*CO_2 Tax* \$41/tonneCO_2[23]	Rebates: Manufacturing initially given 75% rebate, reduced to 50% in July 1997.	Recycled back to industry, reduced income and social contributions.
NOR	1991	*CO_2 Tax* \$21/tonneCO_2[24]	Rebates: Industries like pulp & paper and fishmeal pay only 50% of tax on heavy fuel oil.	Reduction of supplementary wage costs for employers.
DEN	1992	*CO_2 Tax* Range from \$8.48/tonneCO_2, to \$16.96/tonneCO_2[25]	Rebates: Gradual reduction in rebates for industry, from 100% in 1992 to 50% (coal) and lower, depending on type of fuel.	Recycled back to industry.
NET	1996	*CO_2 Tax* \$2.96/tonneCO_2	Exempt: Fuels for petroleum refining.	Earmarked. All revenues used in a special fund for environmental protection.
Boulder, CO	2007	*CO_2 Tax*[26] \$2/tonneCO_2[27]	Rebates: Households using renewable energy receive an off-setting discount.	Earmarked to finance Boulder's climate action plan, (i.e. efforts to increase energy

[19] Carbon tax rates differ across different fuels and across different uses of the same fuel. The numbers quoted in this table are attempts by various sources to summarize the different rates in a single measure. Where necessary, I have converted original figures from a tax on carbon to a tax on CO_2 emissions by using the ratio of 3.67 units of carbon dioxide per unit of carbon.
[20] Italy is excluded from the table since its carbon tax is suspended and data are unavailable.
[21] These figures are approximations only, based on estimates found in the literature. Figures quoted are for the most recent period for which data are available.
[22] Barde and Braathen (2007: 54)
[23] Johansson (2000).
[24] Bruvoll and Larsen (2004).
[25] IEA (2008: 117).
[26] Despite its name, the carbon tax in Boulder, Colorado is **essentially a tax on electricity consumption.** It is levied on the consumption of electricity only, and fails to apply a uniform price across all sectors. As such, it severely violates two of the most fundamental principles of a true carbon tax.
[27] Based on calculations computed by the Carbon Tax Center, then divided by 3.67 (CO_2 to Carbon ratio). See: http://www.carbontax.org/progress/where-carbon-is-taxed/

				efficiency in homes and buildings, switch to renewable energy and reduce vehicle use.[28]
QC	2007	*CO_2 tax*[29] \$2.33/tonneCO_2	Exempt: Given the predominance of hydro in QC's electricity supply, electricity is largely exempt.	Estimated \$200 million CDN/year earmarked for \$1.2 billion "Green Fund," designed to make reductions in GHG called for under Kyoto.
B.C.	2008	*CO_2 tax* \$7.76/tonneCO_2[30]	Exempt: Non-fossil fuels such as biomass and bio-fuels (wood, waste, ethanol, biodiesel, bio-heating oil). Fuels used for inter-jurisdictional commercial marine and aviation purposes, and fuel to be exported. Emissions resulting from industrial processes such as production of oil, gas, aluminum and cement, as well as emissions from landfills.	Refundable tax credit (the Climate Action Tax Credit) as well as reductions in personal and corporate income tax rates.

Source: see footnotes.
Note: For comparison, tax rates converted to USD using 2008 exchange rates.

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[28] Kelley (2008). See: http://www.nytimes.com/2006/11/18/us/18carbon.html?ex=1321506000&en=0394a8cb65f3bd09&ei=5088

[29] The province of Quebec's carbon tax covers "hydrocarbons" (petroleum, natural gas and coal) on 50 energy-producing refiners (including Ultramar, Petro-Can, and Shell) as well as wholesale distributers (including Imperial Oil, Irving Oil, and independent retailers).

[30] The British Columbia carbon tax is a comprehensive tax on fossil fuels – gasoline, diesel, natural gas, home heating fuel, propoane and coal – that are purchased or used in the province. The intention is to effectively tax the emissions from burning fossil fuels within British Columbia. In according with the principles of Pigouvian taxation, the tax is differentiated across fuels, though not in a manner consistent with carbon tax theory. In addition, exemptions decrease the theoretical efficiency and environmental effectiveness of the tax.

As can be seen from Table 2, many differences among carbon taxes implemented in the OECD exist. The first major difference relates to the time of implementation. A first wave of carbon taxes emerged in the 1990s, a time of relatively low energy prices. Low energy prices, however, do not appear to be *the* key determinant of whether and when carbon taxes become politically possible. The Canadian province of British Columbia, for instance, successfully implemented a carbon tax in 2008, at a time when the world price for oil reached record highs, and at a time when a similar proposal at the federal level failed. Rather than determining the timing of a successful proposal, energy prices seem a better determinant of the politically acceptable *level* of the tax, as suggested by the relatively larger carbon taxes implemented in the 1990s, a period of stable commodity prices.

Second, carbon tax jurisdictions in the OECD vary in terms of how revenues are used. In general, all jurisdictions that have implemented a carbon tax adhere to the principle of revenue neutrality, although how this is achieved varies across countries. According to Barde and Braathen (2007: 61), revenues can be used in one of two primary ways. Fiscal orthodoxy suggests that carbon tax revenues should be *allocated to the general government budget*. This approach provides government with maximum flexibility. Once in government coffers, governments can either recycle funds back to industry (making carbon taxes politically palatable), or reduce other distortionary taxes in the economy (e.g. income tax), or do both. For instance, the province of British Columbia's carbon tax recycles revenues through a refundable tax credit, and provides reductions in personal and corporate income tax rates. The impact of such measures on the efficiency and equity of B.C.'s tax system, however, is an empirical question that has yet to be answered in the literature.

Reducing distortionary taxes is sometimes preferred by economists, and may potentially yield a "double-dividend" in the form of realizing economic gains (i.e. a more efficient tax system) that are *additional* to the environmental benefits derived from the tax (c.f. De Mooij, 2000; Goulder, 1995; Bovenberg, 1999). Paying into the general government budget also allows scope for deficit reduction, although such an option would violate the principle of revenue neutrality, and is not used by any carbon tax jurisdictions in the OECD. Alternatively, revenues from a carbon tax can be *earmarked* for specific government expenditures. In the case of the carbon tax, such expenditures usually involve funding for programs designed to further emissions reductions. This approach has been used in such places as Boulder, CO, and Quebec. The most recent carbon tax implemented in the Canadian province of British Columbia has opted to use funds to both reduce distortionary taxes in the economy and to fund actions geared to toward further emission reductions.

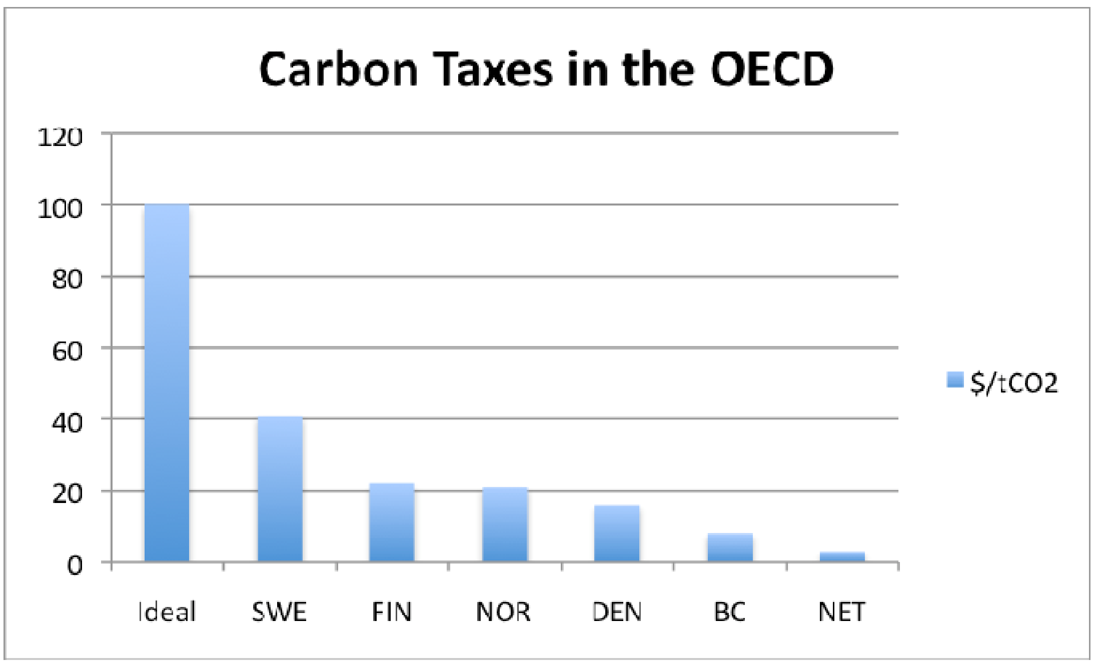
Use of revenues has important implications for the regressive effects of carbon taxes. If used to reduce existing distortions, carbon taxes can make tax systems more efficient, but such a practice might involve reducing taxes on capital as opposed to taxes on labour, thereby making the tax regressive (Zhang and Baranzini, 2004: 510).[31] Thus,

[31] Depending on the existing structure of the tax system, using revenues to make the tax system more efficient may systematically disadvantage the poor. For instance, if taxes on capital are more distortionary

in some instances, there appears to be a tradeoff between using revenues to meet two opposing ends -- using tax revenues to reduce other distortionary taxes (efficiency) and using tax revenues to offset any regressive impacts (equity). In practice, the balance between these two potentially competing objectives is determined by the balance of power among domestic political interests. Indeed, governments use carbon tax revenues in order to make taxes more politically acceptable, by using funds to assuage concerns expressed by the most vocal opponents of the tax. The final impact on social equity is thus an empirical, context-specific question requiring further empirical analysis (c.f. Wier et al. 2004).

A third key difference illustrated in Table 2 relates to carbon tax levels and associated exemptions (coverage). Indeed, tax rates on carbon vary across *jurisdictions,* in *magnitude* relative to other taxes; across different *sectors* for the same fuels; and, across different *fuels* within carbon tax jurisdictions. The first, most obvious difference relates to the average tax rate imposed on fossil fuels across countries (Figure 1).

Figure 1: Carbon Taxes in selected OECD jurisdictions



Cross-national variance. Comparing across jurisdictions, Figure 1 clearly shows that rates vary considerably across carbon tax jurisdictions in the OECD, and *all* carbon taxes currently implemented fall short of a relatively conservative estimate of the ("ideal") level that would be required in order to stabilize GHG emissions (i.e. $100USD/tonne of CO_2).[32] As can be seen from the figure, carbon taxes are highest in Sweden ($41USD/tonne of CO_2). Finland, Norway and Denmark apply a rate of about

than income taxes, as they are in the U.S., seeking a "double dividend" from a carbon tax will lead to a reduction in taxes on capital, which does nothing to offset any regressive effects of a carbon tax.

[32] Estimates of the "optimal" carbon tax rate vary across jurisdictions based on projected levels of GHG emissions with and without the tax. In Canada, estimates range from $75/tonne (NRTEE, 2008), to over $200/tonne (Rivers and Sawyer, 2008).

half of Sweden's, while the carbon taxes in B.C. and the Netherlands are comparatively lower. As should be clear from this pattern, differences in the tax level cannot be explained exclusively in terms of geography or relative price fluctuations over time. For instance, the Netherlands, which implemented a carbon tax in the 1990s at a time of low energy prices, is distinct from its high-tax European counterparts and has one of the lowest carbon taxes among all carbon tax jurisdictions. To take another example, out of three Canadian carbon tax proposals put forth in 2007-2008, one was implemented at a moderate level (B.C.), another at a relatively low rate (Quebec), while a third proposal by the Federal Liberal Party of Canada, completely failed, despite being proposed at the same level as that implemented in the province of British Columbia.[33]

Relative magnitude. The size of carbon taxes, relative to other taxes on energy products, also varies considerably across OECD carbon tax jurisdictions, and the relative size of carbon taxes has tended to change over time. As depicted in Table 2, two of the five carbon taxes in Europe (i.e. Sweden and Finland) have seen the relative magnitude of the carbon tax rise since being implemented. For instance, the CO_2 tax in Sweden accounted for 99% of all taxes levied on light fuel oil used by industry in 2007. Ten years earlier, the same tax accounted for approximately 69% of total taxes on industrial light fuel oil. Although not as pronounced, this trend in the increasing size of Sweden's carbon tax is also seen in tax rates on other energy products, including light fuel oil for household use, gasoline, and diesel fuel.[34] Indeed, between 1997 and 2007, the relative share of the carbon tax applied to light fuel oil for household use grew from 40% to 50%.[35] Such increases are due to the fact that these countries (especially Sweden) implemented a CO_2 tax as part of a comprehensive tax reform. Essentially, the Swedish carbon tax, not unlike the Finish experience,[36] has been accompanied by a simultaneous decrease in and rationalization of existing energy taxes.

In the other European carbon tax jurisdictions, the relative size of the carbon tax has fallen. This is the case in Norway, where the share of the carbon tax in the overall tax burden on light fuel oil for industry fell from 84% in 1995, to 56% in 2007. Similarly, the relative magnitude of Denmark's carbon tax has also fallen over time. More often than not, the reason for these declines has to do with the carbon tax rates in these countries remaining constant, as other taxes are increased. However, in the case of Denmark, the absolute level of the carbon tax for some energy products has actually

[33] Like BC, Federal proposal was also $10CDN/t$CO_2$.

[34] The size of the Swedish carbon tax dwarfs other specialized taxes on fossil fuels. For instance, 1000 litres of low sulphur fuel oil is subject to a levy of 28 Swedish Crown under the *Sulphur Tax,* compared to a levy of 570.63 Swedish Crowns under the tax on CO_2 (IEA, 2008: 263).

[35] The difference in the relative share of the carbon tax in the total tax burden on light fuel oil between industrial and household consumers has to do with the fact that households are subject to a broader range of taxes (e.g. VAT), which decreases the relative proportion of the carbon tax in the total tax burden.

[36] The Finnish carbon tax has been adjusted over time to become relatively larger than standard excise taxes for nearly *all* fossil fuels (with the exception of motor fuels). The carbon tax on light fuel oil (47.80 □/1000 litres), for instance, is more than double the standard excise on this product (19.30□/1000 litres), as of First Quarter 2008 (IEA, 2008: 127). Similarly, the Finnish carbon tax has increased the relative price of natural gas and coal, which prior to the introduction of the reform, were not taxed at all (IEA, 2008: 129).

declined.[37] The extent to which these adjustments are made for political reasons is an interesting question, but one that is beyond the scope of the present analysis.[38]

Incidence. A key debate in the tax policy literature concerns the impact of globalization on taxes, and particularly, the question of whether, and to what extent, under conditions of globalized capital, a jurisdiction's overall tax burden is primarily borne by less mobile factors of production (Garrett, 1998; Genschel, 2002; Kato, 2003; Kemmerling, 2005). In the area of carbon pricing, taxation appears to be unequivocally regressive -- the burden from carbon taxes (both explicit and implicit) falls disproportionately onto households (c.f. Barde and Braathen, 2007).

In terms of coverage, a few carbon tax jurisdictions across the OECD apply different rates to different sectors (or uses) of the same fuel, and all jurisdictions grant significant exemptions and rebates to particular sectors of the economy, effectively violating the principle of comprehensive coverage. Sweden, the country with the highest carbon tax rate in the OECD, is a case in point. For instance, as of 1 January 2006, the carbon tax on light fuel oil in Sweden was nearly 80% higher in the household sector compared to the same tax on the same fuel used by industry (2,663SEK/Kl versus 550.8SEK/Kl). Moreover, if the 50% rebate granted to Swedish industry is applied, this difference increases to 90% (2,663SEK/kl versus 275.4SEK/kl). Similarly, Denmark varies its carbon tax rate according to whether a fuel is used for space heating (80□/tonne of CO_2), "light industrial processes" (12□/tonne of CO_2), or "heavy industrial processes" (3□/tonne of CO_2). Here again, an important feature of carbon tax theory – a uniform price applied economy-wide – is violated in practice.

Other carbon tax jurisdictions apply the same rate to different sectors; however, after rebates and exemptions are accounted for, the result is much the same, if not greater. For instance, in Finland, the carbon tax imposed on households can in some cases be 100% greater than that imposed on industry, given that fossil fuels used in industrial purposes are fully exempt in that country. Similarly, although the tax rate applied to industrial and household use of steam coal in Denmark is identical (242 DKK/tonne), industry is refunded 50% of what is paid in the tax. To take another example, emissions from industrial processes in British Columbia are fully exempt from paying the carbon tax, while emissions from non-commercial activities must pay the tax in full, resulting in only 70% of the provincial economy being regulated by the tax (British Columbia, 2008).[39] Even in Quebec, where a carbon tax is levied on the largest energy producing refiners and wholesale distributers in the province, industry has largely passed the burden onto households in the form of higher energy prices, despite the provincial government insisting that the tax would not be passed onto consumers. Generally, the burden of carbon levies fall much more on households than on other sectors of the economy.

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[37] As of 1 January 2005, the Danish carbon tax was reduced by 10%, for low sulphur fuel oil, light fuel oil, and diesel fuel.

[38] Since carbon taxes are so politically visible, it might be the case that countries such as Denmark, where public support for the tax has fallen, opt to increase other, less visible taxes, and keep the carbon tax rate constant.

[39] According to the government of B.C., the exemptions are for "the time being." The idea is that unregulated industries will eventually fall under plans for some form of inter-jurisdictional cap-and-trade.

In failing to impose a uniform rate across the entire economy, the theoretical cost-effectiveness of carbon taxes is undermined.

Differentiation. It has already been shown that carbon taxes in the OECD fail to impose a uniform price across the entire economy. But how well do existing carbon taxes perform in terms of applying a different price according to the carbon content, and associated emissions, of different fuels? To answer this question, tax data need to be transformed into the equivalent tax on emissions of carbon dioxide, using standard emission coefficients.[40] Table 3 summarizes the transformed data, across different fuels.

Table 3: Explicit Carbon Taxes in Selected OECD Jurisdictions

	Carbon content[41]	**Denmark**	**Finland**	**Norway**	**Sweden**	**British Columbia**
Coal	26	11.5	15.7	21.8	15.9	5.9
Heavy Fuel Oil	21.5	16.9	25.2	35	24	9.07
Light Fuel Oil	19.95	14.8	21.5	29	22.9	8.5
Diesel	19.6	13.5	21.6	*	112.8	8.5
Gasoline	19.3	14	20	47	95	9
Nat. Gas	14.5	16	11	*	*	10.11
Cor (r=)		-.6148	.3361	-.778	-.6364	-.9154

Source: IEA (2008) and British Columbia (2008).
*Data are unavailable at this time.

These data are derived from IEA and official government statistics on carbon taxes in selected OECD countries. Based on the most recent data available, taxes have been transformed from tax rates per base unit of fuel (e.g. tax in $/litre) to the corresponding tax rate per tonne of CO_2. Such a transformation gets to the heart of the issue; namely, what is the corresponding tax rate on emissions of carbon dioxide, and allows for comparision *across* fuels with different carbon contents and measured in different base units (e.g. litres of gasoline vs. tonnes of carbon). These data are also expressed in US dollars, using current exchange rates, in order to allow for cross-national comparison. For illustrative purposes, fuels in the table are arranged from most to least polluting in descending order, accompanied by estimates of their corresponding carbon content (Tg Carbon/QBtu).

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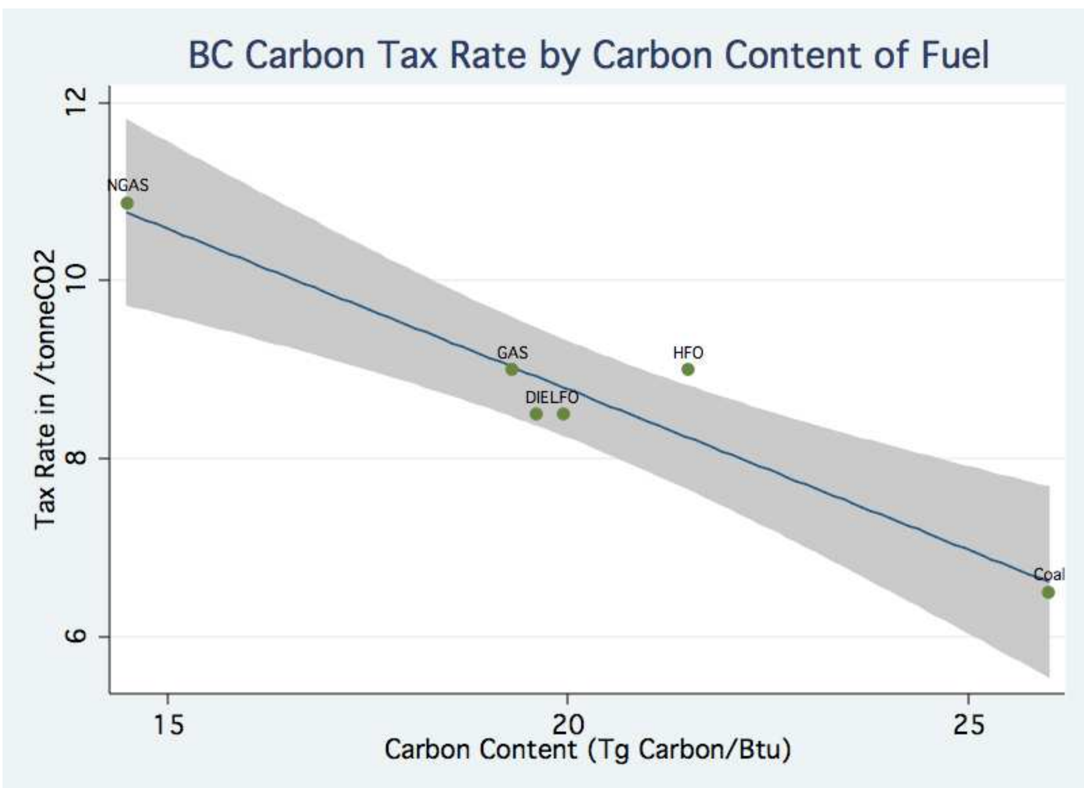
[40] The figures quoted in table 3 are calculated using standard IEA emission coefficients, in tonnes of CO_2 per tonne of oil equivalent: Coal (3.88); HFO (3.15); LFO (3.11); Diesel (3.10); Gasoline (2.95); Natural gas (2.38).

[41] EIA Annex B "Method for Estimating the Carbon Content of Fuels" (B-2 Inventory of U.S. Greenhouse Gas Emissiosn and Sinks: 1990 – 2001);

If the logic of carbon taxes were consistently applied to different fuels based on their environmental effects (i.e. corresponding emissions of carbon dioxide), we should expect to see a decrease in the tax rate as we move down each column from carbon intensive (i.e. coal) to less carbon intensive (i.e. natural gas) fuels. However, it is apparent from Table 3 that carbon taxes are not progressively higher for more carbon intensive fuels. In fact, the opposite is true.[42] In virtually every instance, coal is the *least* taxed fuel, and in such jurisdictions as Denmark and B.C., natural gas is taxed at a higher rate on a per CO_2 basis than coal. If the purpose of a so-called carbon tax really is to decrease atmospheric concentrations of GHG, including carbon dioxide, then these findings indicate that the design of existing carbon taxes are seriously flawed. Indeed, the logic of carbon taxes is inconsistently applied across *all* jurisdictions with a carbon tax.

To take an extreme case, the carbon tax in British Columbia sets rates that are inversely correlated with the carbon content of the corresponding fuel (r = –.9154). This relationship is graphically depicted in Figure 2.

Figure 2: Tax rates applied under BC's carbon tax by Carbon Content of fuels



[42] To be sure, different agencies report slightly different emission factors, which may affect the calculation of tax rate per tonne of CO_2. I used several emission factors and consistently found the same result – inconsistent application of carbon taxes – though there was some minor variation in the precise differences. I am currently working on my own emission coefficients, which take into account different qualities of fuels used in different countries.

As can be seen from the above figure, despite being labeled a "carbon tax," the tax in B.C. is systematically biased in favour of more emissions-intensive fuels, like coal. This curious relationship between carbon content and tax rate, however, is not unique to British Columbia's carbon tax. In fact, B.C. is not the exceptional case, but rather an extreme example of a general pattern – *jurisdictions with carbon taxes inconsistently apply the logic of differentiated rates*. With a Pearson's r correlation coefficient of r = -0.778, Norway is similar in this regard. In fact, 4 out of the 5 carbon tax countries apply rates under the carbon tax that are *inversely* related to the carbon content of fossil fuels (Table 3). Although the correlation coefficient between carbon content and the rates applied to fossil fuels in Finland is positive, it too inconsistently applies the logic of differentiation, with coal bearing the second lowest tax rate under the Finnish carbon tax, despite being the highest polluting fuel. The situation is much the same when comparing the "implicit" tax rate on carbon dioxide (discussed below). Indeed, all energy taxes, whether designated "carbon taxes" or not, tax carbon intensive fuels relatively less. This feature, which so-called carbon taxes share in common with existing energy taxes, effectively blurs the theoretical distinction between taxes designated for carbon, and more commonly found energy taxes across the OECD.

IV. Discussion

To summarize, it appears as though no country has successfully implemented a true carbon tax. The carbon taxes implemented in OECD jurisdictions either fail to differentiate across fuels based on associated emissions of carbon dioxide, or fail to apply a uniform rate economy wide, or in nearly all cases, fail to do both. The tendency for carbon tax jurisdictions in the OECD to violate the principles of differentiation and uniform application severely undermines the theoretical advantages of carbon taxes mentioned earlier, in terms of their economic efficiency and environmental effectiveness. In addition, violation of the key defining features of a true carbon tax blurs the distinction between a "carbon tax" and other more commonly found types of energy taxes (e.g. excise and VAT), that are applied to different energy products with no underlying environmental rationale.

To be sure, the reason for these shortcomings is primarily political. Indeed, the literature on carbon taxes does a good job of exploring differences in carbon tax design in terms of sectoral interests, policy-networks and lobbies. As one might expect, it has been found that sectoral networks influence power relations within governments, and consequently, the design of green tax proposals (Kasa, 2000; Daugbjerg and Pedersen, 2004; Pearce, 2005). Applied to the case of British Columbia, one might explain the odd structure of the carbon tax with reference to the many unionized coal mines across the province, compared to the non-unionized natural gas industry, which is concentrated in just one electoral riding in the North East of the province. To date, relatively less attention has focused on analyzing and explaining the factors behind the actual energy tax structure – including all implicit taxes on CO_2 – and the obstacles to its reform (Baranzini et al. 2000: 397 n8.).

Since existing CO_2 levies fail to differentiate according to the carbon content of different fuels, fiscal taxes levied upon carbon-based energy will have the *same* economic and environmental impact as those carbon taxes already in place (OECD, 2001).[43] Regardless of the label or stated motivation underlying a tax, excise, VAT, carbon and other specialized taxes are functionally equivalent to the so-called "carbon taxes" already in place. As a result, it makes sense to compare countries in terms of "implicit" carbon taxes, defined as the sum total of all taxes (i.e. excise, VAT, carbon, and other specialized taxes per unit) levied on fossil fuels. The implicit carbon tax approach is a more complete measure of tax rates on emissions of carbon dioxide in that it encompasses and captures the carbon tax rate, in addition to other taxes affecting the end-user price of carbon-based fuels. Because of their similar economic and environmental effects, a review of carbon taxes is incomplete if these other taxes are ignored (Haugland et al. 1992). In addition, since only a handful of countries have implemented a carbon tax, looking at the implicit tax rate allows for analysis of a larger number of countries, on a comparable measure.

I am currently working on preparation of a data set that develops an estimate of the implicit or defacto carbon tax for various fossil fuel energy products across 29 OECD countries over the period 1979 – 2006. As already mentioned, this approach carries with it several advantages in terms of broadening the scope of analysis. In addition, knowledge of the existing price of carbon is crucial for assessing the relative costs of climate policy, and for ultimately explaining climate policy outcomes. However, the implicit carbon tax measure is not without its limitations. To be sure, taxes on energy products serve a multitude of purposes. For instance, a tax on gasoline may be levied to reduce traffic congestion, fund road maintenance, or simply to raise government revenue. Depending on the interest of the analyst, therefore, multiple stories might be told; where an urban planner might see gasoline taxes as a tax on traffic congestion, an environmentalist might see the same tax as serving an environmental purpose. The point is that by considering energy taxes to be implicit carbon taxes, findings can only be taken so far. If understood as implicit climate policy, policy makers may or may not understand they were developing climate policy at the time of raising the tax. Therefore, the researcher can't use his or her findings to understand climate policy. But they can use it to understand other things, such as tax policy in general, and can highlight the implications for climate policy, in particular.[44]

With these points in mind, future work should evaluate carbon taxes more systematically, in terms of four criteria: tax rate (high, medium, low); differentiation (consistent/inconsistent), coverage (per cent of GHG emissions covered), and effects on the poor (regressive/progressive). In addition, given the limitations of existing carbon taxes, more work should be done with the implicit carbon tax measure. Early analysis reveals that the same patterns found in this paper – inverse relationship between carbon content and tax rate, majority of tax burden on households and transport – also exist in general tax structures for energy products across the OECD. For instance, one estimate I have developed for the implicit tax rate indicates that Canadians already pay an equivalent of over $120 USD per tonne of carbon dioxide each time they fuel up at the

[43] Of course, carbon taxes retain their theoretical advantages, and properly implemented, are to be preferred over broader "energy taxes" as instruments of climate policy (Zhang and Baranzini, 2004: 508-509). The point is that existing carbon taxes fail to be implemented as theory suggests, and so their theoretical advantages, and distinctiveness, is effectively blurred.

[44] Thanks to Douglas Macdonald for making this point.

gas station. Such findings have implications for our understanding of tax policy, government revenues and their dependency on fossil fuels, and for those politicians who claim a $10 carbon tax would spell "chaos" for the economy.

V. Conclusion

This paper has summarized the current state of existing carbon taxes in the OECD. It has been demonstrated that the carbon taxes implemented so far suffer from significant shortcomings when compared to what textbook economic theory prescribes. In particular, existing carbon taxes fail to apply economy-wide (a condition for cost-efficiency) and fail to differentiate across fuels based on associated emissions of CO_2 (a condition for environmental effectiveness). Robust even when different emission coefficients are used, these findings indicate that current carbon tax designs are seriously flawed, so much so that the theoretical advantages and distinctiveness of carbon taxes is lost when compared to more traditional excise taxes that have no environmental rationale. Short of a broad carbon tax proposal, then, it might be possible to achieve the same policy goals with a relatively straightforward rationalization of the existing tax system. The data I am working on, which will provide estimates for the implicit tax rate on all fossil fuel products across 29 OECD countries for the period 1979 – 2006, will be an important first step in seeing just how skewed existing tax structures are in favour (or not) of carbon intensive fuels.

In addition, with more empirical work conducted in the area of revenue use, it will be possible to rank countries in terms of how closely existing carbon taxes meet the theoretical ideal of what textbook economic theory prescribes. So far, I have only quantified the "differentiation" criterion, but others, like social equity, are equally as fundamental to carbon tax proposals (Zhang and Baranzini, 2004). To be sure, some of the suggested criteria reflect values that compete in the real world of politics. For instance, policy-makers designing a carbon tax might face the trade-off between using revenues to decrease other distortions in the tax system (thereby making the economy more efficient), and redistributing revenues in lump-sum payments (or increased social benefits) for the less-well off in society (thereby making society more equitable). An "ideal" carbon tax is therefore an elusive concept that is no doubt difficult to implement in the real world of politics. Nevertheless, with more empirical research on the design of actual carbon tax proposals, some ranking is possible, and comparing carbon tax proposals against a theoretical ideal can provide insight for analysts of climate policy, and jurisdictions intent on improving or developing their own means of pricing carbon.

While much of this paper has focused on the empirical design of existing carbon taxes as they relate to each other and to the theoretical ideal, it should be noted that the politics of carbon pricing are fascinating. In particular, the politics surrounding the design, implementation and maintenance of a carbon tax are worthy of further study. For instance, why do some carbon tax proposals succeed, while other similar proposals fail, even when proposed at the same time and in the same country (i.e. Dion's failed attempt and Campbell's success)? Though not perfect, the British Columbia carbon tax demonstrates that such instruments are politically possible, even in a North American context and even during a period of record high commodity prices. Moreover, though the recent election in B.C. was not an endorsement of Campbell's carbon tax, his party's winning of a third mandate demonstrates that a carbon tax is not the political suicide some Liberals might have thought it to be following the dismal performance of Dion during the 2008 federal election campaign. This is not to say that a carbon tax is now more likely for Canada, especially given the role of Alberta in Canadian federalism. But the experience of British Columbia, resource-rich Norway, and others across the OECD, provide analysts and policy-makers with a great deal of empirical fodder to test their ideas regarding how climate policy is made, why some instruments are selected over others, and what factors should be included when developing optimal climate policy.

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