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THE PROS AND CONS OF CARBON TAXES AND CAP-AND-TRADE SYSTEMS

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SUMMARY

As part of Canada's effort to meet its commitment to the 2015 Paris climate accord, the provinces must establish their own carbon pricing policies or the federal government will impose a policy on them. When choosing among the various policies, provincial governments should first determine how much a particular policy will negatively affect economic competitiveness in their jurisdictions. When the negative impacts are judged to be low, a carbon tax on each tonne of greenhouse gas emissions (GHG) is the preferred choice. A cap-and-trade policy allocating tradable permits under a market price, or a hybrid combination of carbon tax and cap-and-trade, is best when the negative impacts could be high.

These three policies can all satisfactorily achieve emissions reductions. However, other variables must be taken into consideration, including the provision of price certainty, how strongly each policy promotes innovative research into cleaner technologies, the complexity and costs of set-up, the policy's salience, or visibility to consumers, and the amount of revenue it can raise.

A carbon tax has a major advantage over cap-and-trade and a hybrid version because it allows for carbon price certainty, is less costly to administer and is a substantial source of revenue. However, a cap-and-trade policy offers its own advantages in that emissions allowances can be allocated so as to minimize the policy's negative effects on competitiveness and prevent emissions leakage. The latter is the term used when companies leave one jurisdiction to operate in another jurisdiction that has either fewer or no rules around carbon pricing.

A hybrid policy, also known as output-based pricing, allows for some permits to be allocated freely based on a facility's or industrial sector's emissions and output. It also offers more carbon price certainty than a pure cap-and-trade system. Research shows that a hybrid policy almost completely reduces the

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impacts on competitiveness and emissions leakage. And while a carbon tax is more visible to the public, the advantages of higher visibility are debatable. Such a policy may be favourable because a lower price is required to achieve the same GHG reductions, but it might also be unfavourable because politically it is less palatable.

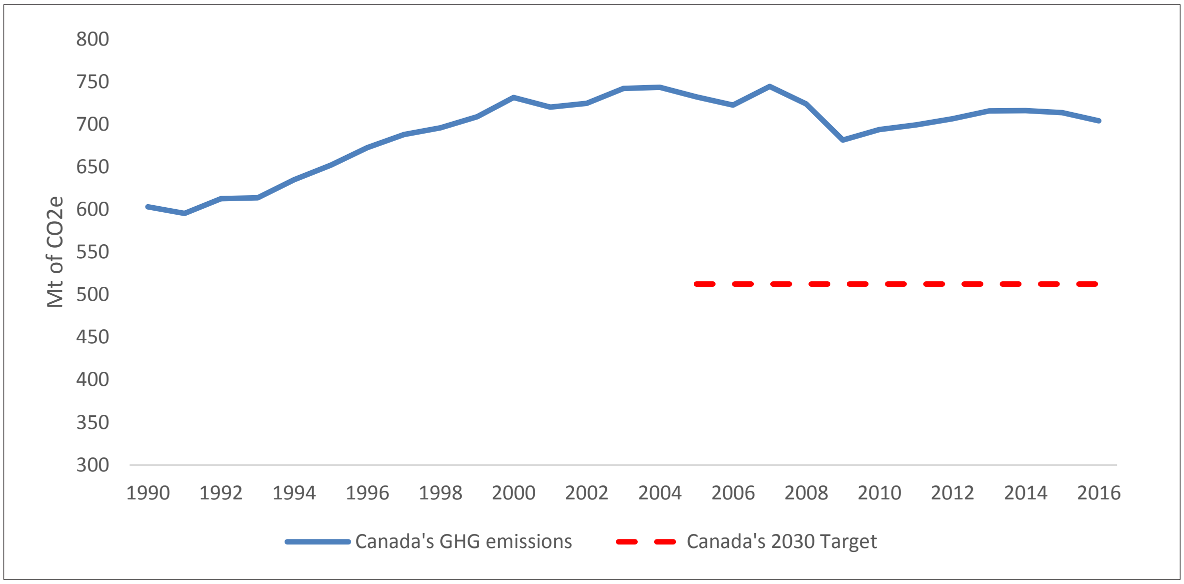
British Columbia has a carbon tax, while Quebec uses a cap-and-trade system. Alberta has a hybrid policy that covers large industrial emitters and a carbon tax for smaller ones. Other provinces remain without a carbon pricing regime, while Ontario's newly elected Progressive Conservative government is set to dismantle the province's cap-and-trade policy. Those provinces that wait for the federal government to impose carbon pricing on them can expect to get a hybrid policy much like Alberta's.

For provincial governments wishing to establish their own policies, choosing one that is the right fit involves weighing the advantages and disadvantages of each. Ultimately, a given jurisdiction should examine its own economic and emissions profile in order to make the best choice for achieving the combined goal of reducing GHGs without negatively impinging on industry's competitiveness.

INTRODUCTION

The accumulation of greenhouse gases (GHGs), such as carbon dioxide (CO2) resulting from human activity, is causing an increase in global temperatures and climate change (IPCC, 2013). In an effort to limit the impacts of climate change, nations from around the world agreed to a goal of limiting the rise in global average temperatures to 2°C above pre-industrial levels. In 2015, as part of the Paris Agreement, Canada pledged to reduce its national GHG emissions to 30 per cent below 2005 levels (this target was first proposed by former prime minister Stephen Harper and then pledged by Prime Minister Justin Trudeau). As part of Canada's strategy to try to achieve this ambitious reduction target, the federal government is requiring provinces to either implement a carbon pricing policy or have a federal carbon pricing policy imposed on them. At the same time, governments around the world are considering implementing carbon pricing policies in their efforts to reduce GHG emissions.

FIGURE 1 CANADA'S GREENHOUSE GAS EMISSIONS



Source: Environment and Climate Change Canada, 2018.

Carbon pricing refers to any policy that imposes a uniform per-tonne cost upon GHG emissions on the margin across all emitters. The general idea is for all emitters to face a cost for each tonne of emissions they release, or at the very least, on any additional tonnes of emissions they release. Carbon pricing policies differ from most of the policies that have been used to control traditional pollution problems. Traditional regulatory policies, in general, either mandate specific technologies and processes to be used (technology-based standards) or implement caps on either total emissions or emissions per unit of output produced (emission standards). In contrast to carbon pricing, traditional regulatory policies impose different costs per tonne of emissions reduced on the margin across emitters.

Generally, three types of policies can achieve a uniform marginal cost on emissions across emitters. A carbon tax can be applied to each tonne of GHG emissions released. This is usually achieved in a similar way as an excise tax on gasoline, but the tax rate differs across different fuels based on the global warming potential of the different GHG emissions released. British Columbia first implemented a broad-based carbon tax in July 2008 (see Box 1) and Alberta has implemented a carbon tax (the carbon levy) on small emitters since January 2017.

Alternatively, a tradable emissions permit policy, colloquially called cap-and-trade, can be implemented on GHG emitters. In this type of policy, the government regulator imposes a cap on the total amount of emissions through allocating permits to emit, but then allows the permits to be traded and a market price for emissions permits develops. Cap-and-trade has been used in Ontario since 2001 to control the emission of sulphur oxides and nitrogen oxides from large emitters (Wood, 2017). Quebec implemented cap-and-trade policies to control GHG emissions beginning in January 2013 and Ontario started in January 2017 (see Box 2). The Quebec and Ontario systems are linked with California's similar cap-and-trade system. However, recently elected Ontario Premier Doug Ford has begun the process of cancelling Ontario's cap-and-trade policy.

A third option is for a hybrid policy (sometimes referred to as output-based pricing) that combines elements of both a carbon tax and a cap-and-trade system. In 2007, Alberta implemented the Specified Gas Emitters Regulation (SGER) which brought in the first carbon price in Canada. Under the policy, large industrial emitters were given individual emission intensity caps, i.e., a facility's emissions could not exceed a certain amount per unit of output produced. If a facility needed to exceed the cap, it could purchase emission reduction credits from another facility; this aspect resembles cap-and-trade. However, the facility could also choose to make a payment of $15/tonne carbon dioxide equivalent (CO2e)[1] into a technology fund; this aspect resembles a carbon tax. Alberta has since replaced the SGER policy with the Carbon Competitiveness Incentive Regulation (CCIR), which is a similar hybrid policy (see Box 3).

Many Canadian provinces have made different choices with respect to which policy to implement. British Columbia chose a carbon tax. Ontario (until recently) and Quebec have selected a cap-and-trade system. Alberta implemented a hybrid policy covering large industrial emitters, but uses a carbon tax for smaller emitters. Meanwhile, some provinces, namely Saskatchewan, have been recalcitrant about implementing a comprehensive pricing policy. The federal government will impose what it has termed the federal backstop carbon pricing policy on provinces that do not implement a carbon price. The federal backstop resembles the Alberta approach – a hybrid policy on large emitters and a carbon tax on small emitters. Manitoba had initially planned to implement a carbon tax, but has recently changed plans and will now be covered by the federal backstop.

The purpose of this briefing paper is to compare and contrast the different types of carbon pricing policies across eight dimensions: cost-effectiveness, price certainty, incentives for innovation, salience or visibility, capacity to generate revenue, impacts on competitiveness and emissions leakage, and administrative requirements. The analysis highlights that each type of carbon pricing policy may be preferred in different situations depending on the jurisdiction's economic and emissions profiles.

[1] Carbon dioxide equivalent (CO2e) is a commonly used way to express the emissions of multiple greenhouse gases in a single metric based on their differing global warming potentials.

Box 1 British Columbia's Carbon Tax

British Columbia's carbon tax came into effect on July 1, 2008 as $10/tonne of carbon dioxide equivalent on fuels sold in the province. The tax increased by $5/t a year until 2012, after which it remained at $30/t until recently. The tax was raised to $35/t in April 2018 with further annual $5/t increases until the tax reaches $50/t in 2021. The tax only covers emissions related to fuel combustion, which amount to 75 per cent of B.C.'s total GHG emissions in 2015 (Dobson et al., 2018a).

The tax was billed as revenue-neutral and was accompanied by cuts to personal and corporate income tax rates, as well as a refundable tax credit to low-income households. Over time, additional tax cuts and tax credits were included as part of the carbon tax revenue-neutral reporting in subsequent provincial budgets; however, some of the tax credits already existed (Lammam and Jackson, 2017). In 2018, the newly formed NDP government repealed the part of the *Carbon Tax Act* that required the tax to be revenue-neutral and increased the corporate income tax rate to the level it was prior to the carbon tax being implemented.

Analysis of the data suggests that the carbon tax has reduced gasoline use (Rivers and Schaufele, 2015a; Antweiler and Gulati, 2016a; Erutku and Hildebrand, 2018a; Lawley and Thivierge, 2018), diesel use (Bernard and Kichian, 2017a), and commercial natural gas use (Gholami, 2014). After reviewing the literature, Murray and Rivers (2015) conclude that the carbon tax has resulted in between a five per cent and 15 per cent decrease in GHG emissions compared to what they otherwise would have been in the tax's absence.

Beck et al., (2015) model the predicted distributional impacts of the tax. They find that even without the tax cuts and low-income transfer, the tax would have had a progressive impact. They conclude that the tax and associated tax cuts and low-income transfer make the tax's impact highly progressive.

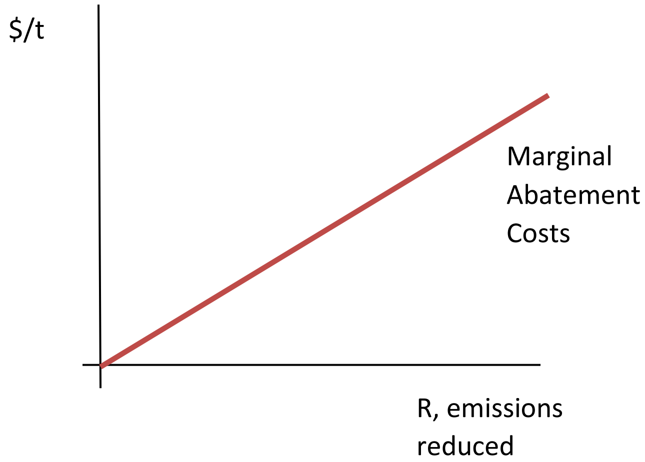
Yamazaki (2017) uses employment data at the sectoral level and finds that the carbon tax and accompanying tax cuts resulted in a small net increase in employment (over what it would have been otherwise) between 2007 and 2013. However, using individual-level data, Yip (2018) recreates Yamazaki's result at the sectoral level, but shows that at the individual level, unemployment increased, especially for low-educated males.

COST-EFFECTIVENESS

The concept of cost-effectiveness refers to achieving a given level of emissions reductions at the lowest cost across all emitters. Carbon taxes and cap-and-trade are both considered to be cost-effective, whereas traditional regulatory policies are not, except under special circumstances.

It is costly for firms and individuals to reduce emissions below the levels they have chosen in the absence of government intervention. Economists generally assume that as a firm or individual is required to reduce emissions, they will act rationally and want to select their cheapest options first. Each additional unit of emissions abated costs more than the last. This leads to a marginal abatement cost schedule as shown in Figure 2, that shows the costs of incremental reductions in emissions from the unregulated level.

FIGURE 2



Note: This figure displays a marginal abatement cost schedule. When faced with the right incentive structure, individuals and firms will reduce emissions by selecting the cheapest options first (whether this is to reduce production or consumption, or adopt lower carbon technologies or a mix of the two). Each additional tonne of emissions reduction is assumed to be more expensive than the previous one.

With traditional regulatory policies, firms and individuals respond by complying with the policy, whether it is to install a prescribed type of cleaner technology or to obtain a certain level of emissions. If the policy is universal across a range of emitters, and the emitters differ in how cheaply they can reduce emissions, compliance with the policy will result in some firms and individuals undertaking more expensive emissions reductions on the margin than others. In other words, some emitters have to pick very expensive fruit high on their tree, while there is still low-hanging fruit available on other trees. When complying with the policy, one firm or individual may have higher or lower marginal abatement costs than another. For example, suppose there are two firms and both are forced to reduce emissions by 50 tonnes through traditional regulation. To achieve the reduction of the final 50^{th} tonne, it might cost one firm $100, but the other firm $30. The goal of a total reduction of 100 tonnes could be achieved at lower cost if the first firm were allowed to do a little less, and the second firm were forced to do a little more.

It is theoretically possible for some types of traditional regulatory policies to be cost-effective. For example, an emissions standard can be cost-effective if the government regulator has sufficient information to assign individual standards to each firm and individual such that none ends up doing more expensive reductions on the margin than anyone else. However, in reality, with most types of emissions, let alone ones as widespread as GHGs, the regulator would never have the required level of information. Flexibility can be added to regulations to make them more cost-effective; however, as more flexibility is added, the more the regulations begin to look like cap-and-trade.

In contrast, carbon pricing policies are generally considered to be cost-effective. With a carbon tax, emitters get to decide how much they reduce emissions. An emitter will reduce emissions until it reaches a point where it is more expensive to additionally reduce emissions than to pay the tax, i.e., where its marginal abatement costs are equal to the tax. If all emitters face the same tax, they will all reduce emissions until their marginal abatement costs are equal; no low-hanging fruit is left unpicked, and no one is picking fruit higher up than anyone else.

With cap-and-trade, an emitter is usually allocated a certain number of permits under the emissions cap. At its capped emissions level, if an emitter can reduce its emissions further at a lower cost per unit than the market price for permits, it will reduce emissions and sell permits. On the other hand, if, at its capped emissions level, it costs more to reduce emissions than to pay the market price, it will buy permits and increase emissions. Ultimately, this flexibility results in all emitters under the policy having marginal abatement costs equal to the market price for permits.

The beauty of carbon pricing is that the government regulator only needs to set and enforce the tax or cap and firms and individuals respond, as to a market price, in a way that uses their own knowledge and preferences to make a decision that is most beneficial to them. Unlike traditional regulatory policies, the cost-effectiveness of carbon pricing does not rely on the implicit assumption that government knows what's best.

Modelling by Canada's Ecofiscal Commission (2015) compares the costs of achieving the provinces' GHG emission reduction targets using regulations versus carbon pricing. They find that using carbon pricing combined with a cut to personal income taxes results in gross domestic product that is 2.5 per cent higher than using traditional inflexible regulations. While this does not mean that carbon pricing is costless, it does indicate that it is the lower cost option.

The emissions coverage of a carbon pricing policy can also affect whether it is cost-effective or how cost-effective it is. If some sources of emissions are exempted, the pricing policy may not be cost-effective. In general, the broader the coverage of a pricing policy, the more cost-effective it is.[2] The broadest carbon tax implemented in Canada, the B.C. carbon tax, only covers emissions from fuel combustion and does not cover emissions from industrial processes, whereas cap-and-trade in Quebec covers both sources of emissions. If the B.C. carbon tax were adopted in Quebec, the policy would only cover 70 per cent of Quebec's emissions compared to 81 per cent under their current policy (Dobson et al., 2018c). Furthermore, the federal backstop policy (a hybrid policy) provides broader coverage than a B.C.-style carbon tax if applied to any of the Canadian provinces (Dobson et al., 2018d).

Box 2 Cap-and-Trade in Quebec

Quebec's cap-and-trade policy for GHG emissions came into force in January 2013 for facilities that had emissions larger than 25kt of carbon dioxide equivalent. The policy expanded to cover distributors of fossil fuels in 2015; the distributors must obtain emissions permits for the emissions resulting from the eventual combustion of the fuels they distribute. Overall, the policy covers 81 per cent of Quebec's 2015 total GHG emissions (Dobson et al., 2018b). The policy was linked to California's in 2014 and Ontario's in 2018.

Permits are allocated for free and by auction. Permits are provided freely to facilities in several industrial sectors based on a formula that sets sectoral benchmark levels of carbon intensity of production specified in the regulatory document. The permit auctions have a minimum bid price to help prevent the market carbon price from dropping too low. There is also a reserve of permits that will be accessed if the carbon price rises higher than planned. Western Climate Initiative Inc., a third party funded by California and Quebec, administers both the auctions and the containment reserve.

The auctions raise revenue, but not nearly as much as B.C.'s carbon tax. Quebec's share of the revenue from the auctions is targeted to the province's Green Fund which then spends the money on public transit, energy efficiency projects, etc. In the most recent auction, current-year emissions permits sold at a price of $18.44/t and the province of Quebec received $196 million. The four auctions in 2017 generated total revenue for the Green Fund of $618 million (MDDELCC, 2018).

There are situations where it may be possible for traditional regulations to be more cost-effective than pricing policies. For example, it is possible for a pricing policy to impose a larger burden on a polluting company, resulting in the company shifting production to facilities in other jurisdictions. This results in emissions being reduced in the jurisdiction with carbon pricing, but increased in another jurisdiction – what is termed emissions leakage. In a situation with high potential

[2] However, it may be cost-effective to exempt small emitters of non-combustion emissions, e.g., agricultural emissions, due to relatively high monitoring, reporting and enforcement costs (De Cara et al., 2018).

for emissions leakage, it is possible for regulations to be more cost-effective than a pure carbon tax (Holland, 2011a). However, as discussed in a later section, this problem can be addressed in the design of the carbon pricing policy. In addition, cap-and-trade can be less cost-effective if a small number of companies can exert substantial power in the market for permits (Hahn, 1984a). However, the potential for market power issues can be minimized when designing how the permits are allocated (Hahn, 1984b). Furthermore, the incorporation of insights from behavioural economics (e.g., cognitive costs of resisting temptation) into models suggests that a combination of energy efficiency standards (a traditional regulation) and a carbon price may be more cost-effective (Tsvetanov and Segerson, 2013).

PRICE CERTAINTY VS. EMISSIONS CERTAINTY

A carbon tax provides certainty to firms and individuals on the cost of their GHG emissions. Cap-and-trade provides governments with certainty over the level of emissions.

Under a carbon tax, the tax per tonne is set and firms and individuals decide how much GHG to emit based on the tax and their abatement costs. The resulting amount of emissions reductions is uncertain and will fluctuate with economic and other conditions. With a pure cap-and-trade system, the overall level of emissions is set, but the carbon price is determined in the market for permits. Therefore, the price can fluctuate substantially if the demand for permits fluctuates. For example, the carbon price in the European Union's Emissions Trading System has experienced large volatility since being introduced.

This fluctuation in the price of permits would add a risk premium when adopting cleaner technologies. However, the literature is mixed on which is best for encouraging the development and adoption of cleaner technologies. Milliman and Prince (1989) and Jung et al., (1996) conclude that the policies are ranked as follows: 1) cap-and-trade with all permits auctioned; 2) a carbon tax; 3) cap-and-trade with free permits; and 4) emissions standards. Fischer and Newell (2008a) examine different policies for the electricity sector in the U.S. and find that a carbon tax is more cost-effective at achieving the target emissions reductions, but results in less research and development in renewable energy than a cap-and-trade policy with free permits.[3] On the other hand, it is possible for innovations in cleaner technologies to diffuse less quickly under cap-and-trade than under a carbon tax. A new technology will reduce the cost of emissions reductions and thus depress the market price for permits, thereby reducing the incentive to adopt the technology. This possibility may lead the developer/owner of the technology to restrict the sale of the technology in order to keep the permit price and price of the technology high (Scotchmer, 2011). Both Aldy et al., (2010) and Popp (2016) conclude that imposing a carbon price, either through cap-and-trade or a carbon tax, is the most important thing a government can do to encourage the development and adoption of lower carbon technologies, suggesting that the difference in incentives between the policies is minimal.

A hybrid policy can provide a balance of price and quantity uncertainty. The Quebec cap-and-trade policy impose a price floor in the permit auctions, which prevents the permit market from being flooded with additional cheap permits if prices are unexpectedly low. They also have a reserve of permits that will be released if the price increases above certain thresholds. Alberta's old SGER policy and the new CCIR policy impose a price ceiling which acts like a carbon tax; the resulting carbon price will never exceed the price ceiling, thus providing some price certainty. However,

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[3] Less R&D is required under the carbon tax because in their simulations the carbon tax reduces electricity production, whereas under cap-and-trade in their simulations electricity production increases. More and cheaper renewables are needed under cap-and-trade to achieve the target reductions while increasing production (Fischer and Newell, 2008b).

any effort to add more price certainty to a cap-and-trade system ultimately leads to a reduction in certainty over the quantity of emissions reduced.

Whether price certainty or quantity certainty is desirable also depends on perspective. From a cost-effectiveness standpoint, both policies apply a single carbon price, ensuring that marginal abatement costs are equal across emitters. However, from an economic efficiency perspective, where we not only take into account the cost of reducing emissions but also the benefits (the forgone climate damages), price certainty is preferred if there is uncertainty over the cost of reducing emissions (McKitrick, 2016a).

Figure 3 shows hypothetical marginal benefits (forgone global damages) and expected marginal costs (MAC_{EXP}) of Canadian emissions reductions. McKitrick (2016b) argues that the marginal benefit function,[4] MB, is horizontal for the following reason:

> The marginal effect of a tonne of emissions depends on the current concentration of CO2. Since Canada is so small, our emissions in any one year cannot change the global concentration …Therefore, the first unit of our emissions in any one year must have the same marginal effect on welfare as the last unit, because the atmospheric concentration will remain the same over the range of emissions. (7)

In Figure 3, to maximize expected net benefits (total benefits minus expected total costs), the government regulator would want to apply a carbon tax of t_0 or an emissions cap reducing emissions by R_0.

The marginal benefit of emissions reduction can be measured using an estimate of the global social cost of carbon (SCC) adjusted for emissions leakage and increased distortions in the tax system that result from carbon pricing (McKitrick, 2016c). The SCC for a particular year is estimated by increasing emissions by one tonne over what they would have been otherwise in a climate-economy integrated assessment model, which then increases net climate damages in all future periods. The SCC is the discounted value of this stream of increased net damages into the future. However, the uncertainty surrounding the values of the social discount rate, equilibrium climate sensitivity and many other parameters leads to a very wide range of values for the SCC. In an analysis conducted by a working group set up by the U.S. government, estimates of the SCC range from being slightly negative to hundreds of dollars per tonne (IWG, 2016a). For a three per cent discount rate, the central estimate from their simulations for 2015 is US$36 per tonne of CO2 and the 95^{th} percentile estimate is US$105 per tonne (IWG, 2016b).

As first demonstrated by Weitzman (1974), and then applied to Canadian carbon pricing by McKitrick (2016e), with a relatively horizontal marginal benefit function, underestimating or overestimating the cost of reducing emissions leads to a net social cost for setting the incorrect emissions cap under cap-and-trade, but to no additional net social cost under a carbon tax. The situation where the government regulator overestimates marginal abatement costs is demonstrated in Figure 3. If the cost of reducing emissions turns out to be lower than expected (MAC_{TRUE}), emitters under an emissions tax will reduce emissions further than expected and reach reductions of R_1 where social net benefits are maximized. However, under cap-and-trade, the emissions cap has been set to achieve R_0 reductions, so that is the level of emissions reductions that occurs. At R_0, the marginal benefit of additional reductions outweighs their marginal cost, indicating that social net benefits could be increased by further reductions. Therefore, if the cost of reductions is uncertain and the marginal benefit of emissions reductions is relatively flat, a carbon tax is preferred to a cap-and-trade policy.

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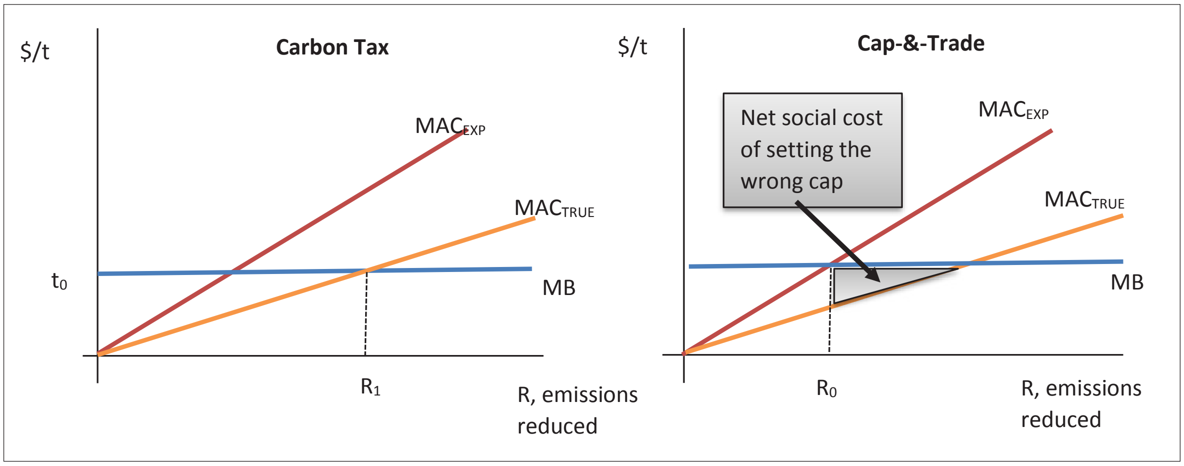
[4] McKitrick (2016d) uses the term marginal damage rather than marginal benefit; these terms are equivalent in this context, i.e., the marginal benefit of reducing emissions is the forgone marginal damage.

FIGURE 3



Note: This figure considers the situation when a tax (left panel) or an emissions cap (right panel) is set when the government regulator overestimates the cost of reducing emissions. The line labelled MB is the marginal benefit of incremental emission reduction and is horizontal to reflect the fact that Canada produces only a small percentage of global greenhouse gas emissions. The line labelled MAC_{EXP} is what the government regulator expected the marginal cost of reducing emissions to be; whereas MAC_{TRUE} is what the costs are realized to be. The grey shaded area is the net social cost of setting the wrong emissions cap. With a horizontal MB line, there is no penalty for setting the tax based on the incorrect abatement costs.

SALIENCE

Salience is the policy's visibility. There is disagreement about whether being more salient or less salient is preferred in a carbon pricing policy.

Carbon taxes are highly visible to users of fossil fuels. The response to the B.C. carbon tax has been a larger decrease in gasoline use than would be expected from a similar increase in the market price of gasoline (Rivers and Schaufele, 2015b; Antweiler and Gulati, 2016b; Erutku and Hildebrand, 2018b), suggesting that the salience and permanence of the carbon tax lead to larger reductions. Bernard and Kichian (2017b) have found a similar result for diesel use.

With cap-and-trade, the carbon price is embedded in the market price of products like natural gas and gasoline. Therefore, cap-and-trade is probably less salient. Under cap-and-trade, we may not get the additional nudge from the higher salience of a carbon tax.

On the other hand, lower salience may reduce the political opposition to the policy. Due to higher salience, politicians may not be able to raise and/or broaden a carbon tax sufficiently to achieve their emission reduction target. Consider that the federal excise tax on gasoline has remained at 10 cents a litre since the mid-1990s. The lower salience of cap-and-trade may be able to avoid some of this opposition. Cap-and-trade in Quebec as well as the hybrid federal backstop policy both provide broader coverage than the B.C. carbon tax. It is not clear whether the higher salience played a role in the B.C. tax not being applied to industrial process emissions, but it is possible.

Traditional regulatory approaches tend to be even less salient. For example, the costs of fuel economy standards are embedded in the price of your vehicle. Jaccard, Hein and Vass (2016) argue in favour of a non-pricing approach in order to meet Canada's reduction target. They argue that an approach using flexible regulations, rather than traditional regulations, can come close to matching the cost-effectiveness of carbon pricing, but be more politically acceptable. Rivers and Jaccard (2006) also make this observation after comparing regulatory policy instruments with market-based policy instruments for clean energy technology adoption.

Box 3 A Hybrid Option: Alberta's Carbon Competitiveness Incentive Regulation

In 2007, Alberta implemented the Specified Gas Emitters Regulation (SGER) on large industrial emitters of GHG emissions (those with annual emissions greater than 100kt of CO2e). This policy represented the first carbon pricing policy implemented in a Canadian jurisdiction. Each facility receives emissions permits based on a cap on its emissions intensity (emissions divided by output) relative to facility-specific benchmark emissions intensity. To comply with the cap, the facility can reduce emissions, increase output, purchase permits from other facilities or make a payment into a technology fund. The payment to the technology fund was set at $15/t and effectively acts as a price ceiling.

The Carbon Competitiveness Incentive Regulation (CCIR) policy replaced the SGER in January 2017. The new policy is very similar in style to the SGER policy with the main difference being how emissions permits are allocated. Instead of allocating permits based on a facility's own emissions intensity, the permits are now allocated based on an emission-intensity benchmark by specific product, rather than by specific facility. A facility that was GHG-intensive relative to peers in its industry would receive relatively fewer free permits under the CCIR than under the SGER. Furthermore, the fixed carbon price payment (the price ceiling) was increased to $20/t in 2017 and to $30/t in 2018. The CCIR policy covers around 50 per cent of Alberta's GHG emissions and the accompanying carbon levy covers 22 per cent (Dobson et al., 2018e).

REVENUE

A carbon tax will clearly become a source of government revenue. In the 2016/2017 fiscal year, B.C.'s revenue from the carbon tax was $1.22 billion (British Columbia, 2017). A cap-and-trade policy will only generate a similar level of revenue as a tax if all permits are auctioned. If all permits are distributed freely, as in Ontario's trading policy for emissions of sulphur oxides and nitrogen oxides, then no revenue is generated. Quebec and Ontario's cap-and-trade policies for GHGs do auction a large percentage of permits, so some revenue is generated, but much less than if replaced with a carbon tax. In 2015, Quebec and Ontario auctioned around 72 and 79 per cent of permits respectively (Dobson et al., 2018f; author's calculations). A hybrid policy can also generate revenue. Alberta's CCIR and the federal backstop policy both generate revenue through a price ceiling. To comply with the policy, emitters can choose to pay a fixed carbon price (the price ceiling) instead of reducing emissions or buying unused permits from another emitter. The coverage of a carbon pricing policy also affects how much revenue it will generate.

Despite generating substantial revenue, a carbon tax does not necessarily mean a larger size of government. The government has choices of what to do with the newfound fiscal capacity, and one possibility is a tax swap. They could, as British Columbia originally did, accompany the tax with cuts to other taxes. By cutting taxes that distort the work, savings and investment decisions of firms and individuals, the negative economic impacts of the tax can be partially offset.

Another use of the revenue is through increased tax expenditure policies. The government can provide rebates based on income. These can help offset the tax's potentially regressive impacts while maintaining the marginal incentive to reduce emissions and not increasing direct government spending. The revenues can also be used to fund public goods such as public transit projects and other public infrastructure projects.

Often the revenues are used to subsidize clean energy, energy efficiency upgrades or other climate policy-related objectives. However, depending on the expenditure, some of these can be very expensive. For example in Ontario, one initiative to which hundreds of millions of dollars of revenue are targeted is improving the energy efficiency in multi-tenant residential buildings at a cost per tonne avoided of over $400/t (Tombe, 2018); this is a much higher cost than the prevailing permit price of close to $15/t. The revenue could also be directed towards general revenue.

IMPACTS ON COMPETITIVENESS AND EMISSIONS LEAKAGE

A major concern in a relatively open economy like Canada's is the impact of climate policies on our industries' competitiveness. This is of particular concern for economic sectors that are both carbon-intensive and trade-exposed (e.g., oil and gas). Beale et al., (2015a) define carbon-intensive as any sector that has a carbon cost greater than five per cent of sector GDP. They define trade-exposed as any sector that has trade exposure greater than 15 per cent of sector GDP. Climate policies, including carbon pricing, can increase costs disproportionately in these sectors, thus making them less competitive and resulting in less production and employment in these sectors. This is not only a concern because of the negative economic impacts, but also because of emissions leakage. If the policy results in economic activity in these carbon-intensive and trade-exposed sectors moving to another jurisdiction, emissions leakage may occur – the emissions of the industry in the climate policy jurisdiction are reduced but are increased in other jurisdictions.

A carbon tax on these industries will have negative impacts on the competitiveness of carbon-intensive and trade-exposed sectors. However, these impacts can be partially offset depending on what the revenues are used for. If the tax is accompanied by cuts to corporate income tax rates, some of the impacts on competitiveness will be offset by making businesses across all sectors more competitive. Although this helps across the whole economy, it may still result in large amounts of emissions leakage since it does not provide targeted relief to the carbon-intensive and trade-exposed sectors. If the potential for emissions leakage is high (i.e., relatively large carbon-intensive and trade-exposed sectors), a carbon tax can potentially be less cost-effective than some forms of regulation (Holland, 2011b). To prevent this possibility, the tax revenue could alternatively be used to provide targeted support to carbon-intensive and trade-exposed industries to reduce the average cost that the tax imposes on them, while leaving the marginal incentive to reduce emissions in place. Alternatively, as argued by Bushnell et al., (2008), if the potential for emissions leakage is high, using subsidies to promote low carbon production and consumption activities rather than using carbon pricing will prevent emissions leakage.

A cap-and-trade policy can potentially impose a smaller impact on competitiveness. How the permits are allocated has implications for the competitiveness impacts. If the permits are freely allocated, the average carbon price that emitters face is much lower than the marginal price. On the other hand, if all permits are auctioned, the costs are similar to a carbon tax. Often, permits are allocated using output-based allocations, where some permits are allocated freely based on the past emissions and output of the facility or industrial sector.

A hybrid policy, like Alberta's old SGER policy or new CCIR policy, uses output-based allocations to mitigate the negative impacts on competitiveness of putting a price on emissions. Using output-based allocations reduces the competitiveness impacts and emissions leakage almost completely (Ecofiscal, 2016).

The relative size with respect to the aggregate economy of the carbon-intensive and trade-exposed economic sectors differs substantially across provinces. Alberta and Saskatchewan have a relatively large share (18 per cent) of their economic activity coming from these sectors, whereas Quebec and British Columbia are relatively less reliant (one to two per cent) on these sectors (Beale et al., 2015b). Due to these different economic and emissions profiles, different policies will be preferable in different provinces. For example, Saskatchewan has a relatively large share of its economy occurring in sectors that are carbon-intensive and trade-exposed, which suggests a large potential for emissions leakage. A policy that collects less revenue (cap-and-trade or a hybrid policy) may be preferable to reduce competitiveness impacts and emissions leakage. Alternatively, if a carbon tax is used, targeted support to these industries can be provided in a way that reduces their average cost but maintains the incentive to reduce emissions. Either way, in a carbon-intensive and trade-exposed jurisdiction, the policy should be designed accordingly.

ADMINISTRATIVE REQUIREMENTS

Carbon taxes and cap-and-trade also differ in their administrative requirements. To a large extent, a carbon tax can piggyback on the administration of existing fuel excise taxes. In this regard, the cost to the government of administering the tax and the tax compliance costs to firms and individuals are minimized. However, if the coverage of the tax is extended to non-fuel emissions, e.g., industrial process emissions, fugitive emissions, slash burning, etc., the costs of administering and complying with the tax will increase. Cap-and-trade in Quebec, as well as the hybrid policy in Alberta, both cover industrial process emissions, whereas the B.C. carbon tax does not.

For cap-and-trade, the government implements complex regulations to impose the cap on emissions and outlines the allocation of emissions permits. Regulations also must outline the rules surrounding the auctioning and trading of emissions permits. The government must then also create the institutional support and processes for the auctioning and trading of permits. Businesses must then use additional resources to navigate this process to comply with the regulations. There are also transaction costs involved in each permit trade; however, financial intermediaries and the auction mechanism would reduce the transaction costs.

A hybrid policy will have many of the same administrative requirements and compliance costs of a cap-and-trade policy. Traditional regulatory policies also have administrative requirements and compliance costs but without the added institutional requirement to support and oversee the auctioning and trading of permits. However, traditional regulatory policies require additional costs in order for regulators to evaluate different abatement technologies and to inspect facilities to assign abatement technologies to be used or to assign individual emissions standards.

CONCLUSIONS AND RECOMMENDATIONS

The aim of this briefing paper was to discuss the advantages and disadvantages of three different approaches to imposing a price on carbon emissions: carbon tax, cap-and-trade or a hybrid approach. The policies were evaluated along several dimensions and the analysis is summarized in Table 1.

All three carbon pricing policies are generally considered to be cost-effective, whereas traditional regulatory policies are not. The major advantages of a carbon tax over the other two policies are that it provides carbon price certainty, has lower administrative costs and raises substantial revenue (that can be used to reduce distortionary taxes). The major advantage of cap-and-trade in contrast to a carbon tax is that permits can be allocated in a way that minimizes negative impacts to competitiveness and reduces potential emissions leakage. A hybrid policy is similar to cap-and-trade, but it provides more carbon price certainty. A carbon tax is more salient than cap-and-trade or a hybrid policy; this can either be considered an advantage because a lower price is required to achieve the same reductions, or a disadvantage because the policy is less politically palatable.

In conclusion, which policy is preferable depends on the jurisdiction's economic and emissions profile. Jurisdictions such as British Columbia, Ontario and Quebec, with very low potential for emissions leakage (i.e., the economic sectors that are both carbon-intensive and trade-exposed make up a small amount of overall economic activity) are best to adopt a carbon tax instead of traditional regulation or other carbon pricing policies. Jurisdictions such as Alberta and Saskatchewan, where a large share of economic activity is carbon-intensive and trade-exposed, should use a hybrid system or cap-and-trade.

TABLE 1

	Carbon Tax	Cap-and-Trade	Hybrid	Traditional Regulation
Cost-effective	**Yes**	**Yes**	**Yes**	**No**
Certainty over the cost of emissions (i.e., the carbon price)	**Yes**	**No**	**Some** degree of price certainty can be achieved using a price ceiling.	n/a
Certainty over emissions reductions	**No**	**Yes**	**Maybe**	**Maybe**. Possible for some regulatory policies but not for most.
Incentives for cleaner technology adoption and innovation	**High**	**High**	**High**	**Moderate**
Revenue	**High**	**High or Low**. Depends on how permits are allocated.	**Low**	**Very Low**
Visibility/Salience	**High**	**Moderate**	**Moderate**	**Low**
Competitiveness Impacts/ Emissions Leakage	**Potentially High**, but depends on the economic and emissions profile of the jurisdiction and on what is done with the revenue.	**High or Low**. Can be mitigated depending how the permits are allocated and/or what is done with any resulting auction revenue.	**High or Low**. Can be mitigated depending how the permits are allocated and what is done with any resulting revenue.	**Depends** on the policy
Administrative and Compliance Requirements	**Low**	**Moderate**	**Moderate**	**Moderate**

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