Smart Prosperity Institute

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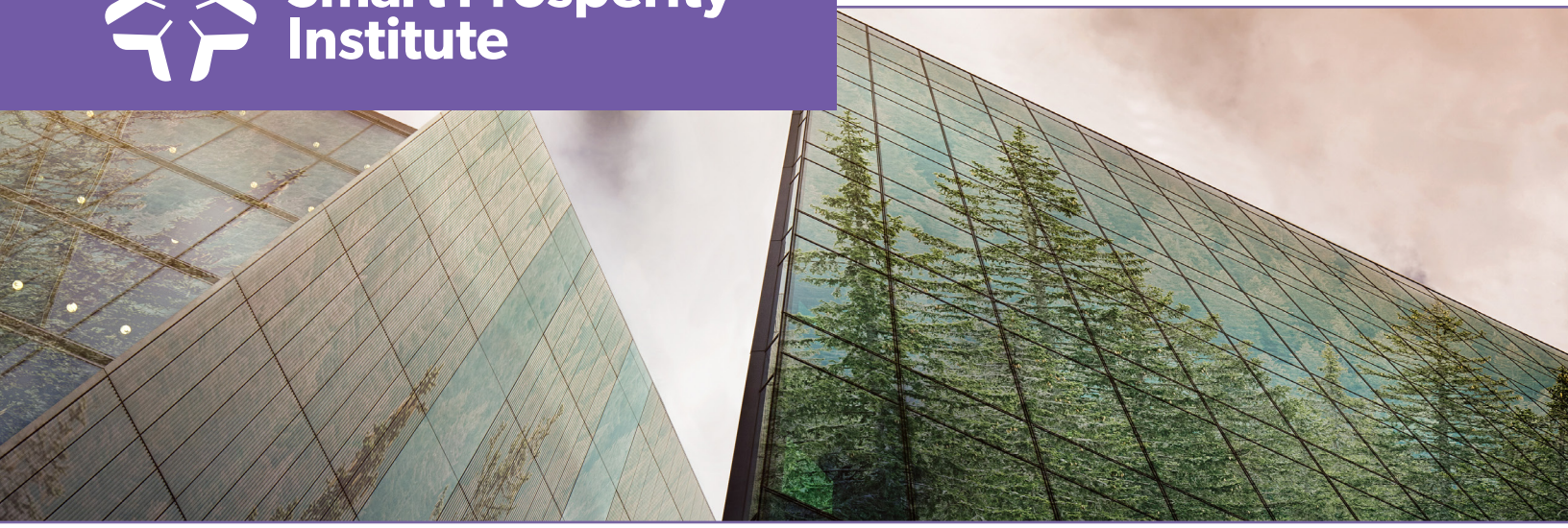

About Smart Prosperity Institute

Smart Prosperity Institute (formerly Sustainable Prosperity) is a national research network and policy think tank based at the University of Ottawa. We deliver world-class research and work with public and private partners – all to advance practical policies and market solutions for a stronger, cleaner economy.

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DO ENVIRONMENTAL REGULATIONS COST AS MUCH AS WE THINK THEY DO?

Introduction

The moment is right to discuss the costs of environmental regulations. Across Canada, fact and opinion swirl about which policies are best for both the economy and the environment. Environmental regulations remain deeply contested and cause concern for some that the costs will simply be too high. At the same time, polling data show that Canadians overwhelmingly want both a protected environment and a vibrant economy.

That is why Smart Prosperity Institute is re-releasing an updated version of our 2016 report on overestimating the cost of compliance with environmental regulations, part of the *Green Tape Measures Up* series. We believe it is critical to look retroactively at positive and negative regulatory impacts, to inform our national conversation as well as smart policy design. We need to test our assumptions and examine past analysis and case studies while asking ourselves, "Does environmental regulation cost as much as we think it does?"

Estimating the cost of regulations is not a perfect science. That said, when we analyze the data and look retroactively at real-world case studies, it becomes clear that **the cost of environmental regulations is not nearly as high as we think**. In fact, costs of environmental regulations are often overestimated by at least double, and sometimes by a factor of 10 or more. We tend to overestimate the costs to companies and households, just as we underestimate the social and environmental benefits. Furthermore, these benefits outweigh the cost.

The outdated traditional view pits the environment against the economy, inferring that regulation is detrimental to economic prosperity. Yet an alternative view exists and persists. One that says that regulation can potentially be good for business. Not

only are we overestimating how much environmental regulation costs, but we are also forgetting that regulations can cause a creative response which results in clean innovations with potential economic benefit.

Rarely before has there been more need for balanced and credible analysis of the cost of environmental regulations. This report helps build a better understanding of the cost and benefits, so that we can design policy that is more efficient, effective and equitable. We can design regulations that spur strong economic performance and a more sustainable relationship to the environment.

"The cost of environmental regulations is not nearly as high as we think."

Key Messages

- There has been a persistent argument against environmental regulations on the basis that the compliance costs to regulated firms and industries are too high; however, evidence shows that the cost of complying with environmental regulations are often overestimated.
- Moreover, a review of the existing literature highlights the large net benefits (benefits significantly outweighing costs) of environmental regulations in most cases. The costs of regulations are more than offset by a broad range of economic, health, greenhouse gas (GHG) and other benefits.
- Estimates of anticipated costs made prior to the regulation's implementation have sometimes been much greater – even double, and sometimes as much as 10 times greater (or more) – than the realised costs.
- There are a number of factors which contribute to the persistence of ex ante overestimates of compliance costs. One of these is the inability to capture the potential to innovate in response to regulations. Another is challenges in identifying baselines or control groups. A third factor is the lack of accounting for flexibility provisions incorporated into regulatory design, which are sometimes added or changed at a later stage of the regulatory process.
- Five case studies provide evidence of how compliance costs of individual regulations have often been overestimated in Canada and the United States: the Light Duty Vehicle Greenhouse Gas Emissions and Standards; Sulphur in Gasoline Regulations; the Acid Rain program; the Montreal Protocol; and the Clean Air Act.
- There is very limited public analysis on realised or ex-post compliance costs of Canadian environmental regulations, and improved efforts in this area would be particularly beneficial for improving evidence-based policy advice.

THE ISSUE

Both our economy and population require a healthy environment in order to prosper. Environmental regulations are often put in place to help ensure the proper management of shared resources such as land, air, water, ecosystems and natural resources, providing a benefit to all. They also ensure our economy can continue to grow through access to natural resources and a healthy workforce. After all, many of Canada's industries rely on accessing healthy ecosystems to provide them with natural resources and ecosystem services like clean water and air.

However, those subject to environmental regulations face private costs of compliance.† The costs that environmental regulations impose on those who are regulated are an important consideration in policy design. However, available evidence points to an interesting outcome: the costs borne by the regulated entity of complying with environmental regulations are often overestimated overestimated. Cost predictions are higher than those that are eventually realized. In short - we think that environmental regulations cost more than they actually do.

Although the net benefits of environmental regulations are almost always positive when including societal benefits such as health impacts or reduced GHG emissions, the tendency to overestimate private costs may be artificially deflating net benefit estimates.

Inaccurate cost and benefit estimates can lead to a number of problems, including a misinformed public, questionable integrity of the regulatory system, inability to secure public and political support for the policy, and increased scepticism about the use of economic modelling in regulatory decision-making. Most importantly, inaccurate cost and benefit estimates can lead to inefficient or ineffective environmental policy design.

This policy brief compares the available evidence of the estimated (ex-ante) and realized (ex-post) net-costs of complying with environmental regulations. Five prominent North American environmental regulations featuring a critical mass of evidence on costs and benefits are profiled – light-duty vehicle greenhouse gas emissions standards, the Sulphur in Gasoline Regulations, the U.S. Acid Rain program, the Montreal Protocol, and the U.S. Clean Air Act. Given the small number of studies that examine these differences in anticipatory and retrospective compliance cost estimates, studies that provide data on overcompliance with environmental regulations are also included.

Estimating costs of compliance before a regulation is imposed, and calculating the actual costs that materialise after the regulation is in effect, is complicated. Few studies are available; few data are publicly available. Likewise, capturing a consistent and comprehensive suite of benefits from an environmental regulation poses significant challenges. This policy brief explores the available evidence of realised compliance costs; cost-benefit analysis; and overcompliance data.

Box 1

What Comprises Compliance Costs?

Regulated parties face costs to invest in new pollution-abatement technologies, change their practices or behaviours, or pay pollution charges in order to comply with environmental regulations. For this policy brief, these costs are referred to as "industry's compliance costs," but in practice the regulated entities can also include governments of all levels, private citizens and non-profit organizations.

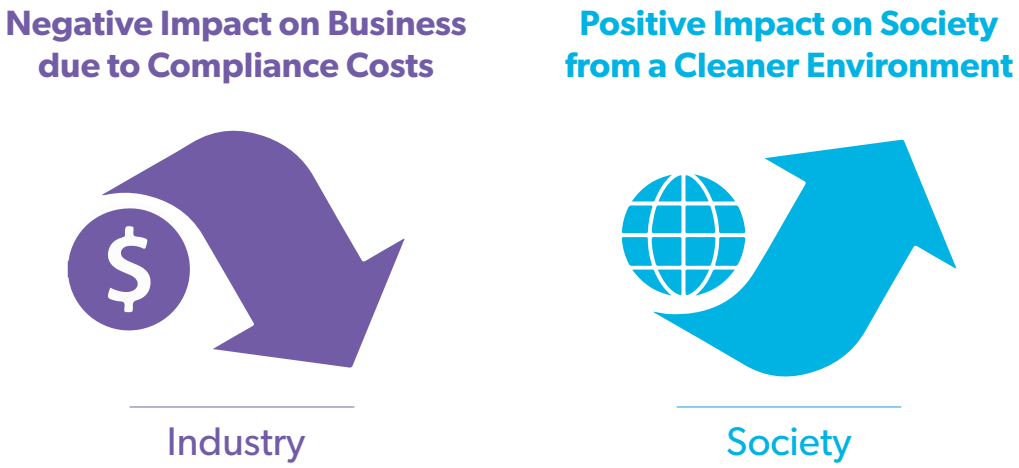
"Inaccurate cost and benefit estimates can lead to inefficient or ineffective environmental policy design."

† While the initial incidence of the regulation falls on the regulated entity, there are costs borne by consumers and individuals as well if cost increases are passed on to them through increases in product/service prices, or if employment or overall economic activity is negatively affected. These may be short-term or more persistent impacts.

THE KNOWLEDGE BASE

An outdated view frames environmental regulation as detrimental as detrimental to economic growth, due to the increased private costs imposed by complying with the regulation. From this perspective, firms are assumed to be using their resources at maximum efficiency, and any regulations could only serve to restrict their options, leading to less resource-efficient outcomes. Those who hold this view have often argued that the compliance costs of environmental regulation have been too high and have been a detriment to Canada's economic performance (Figure 1).

Figure 1: Traditional view of Environmental Regulation



In this view, the main argument is that those parties who fall under the regulation are negatively impacted because environmental regulations require parties to either invest in more inputs for the same level of output, or reduce some of their output altogether. In other words, they have to pay for the use of certain resources that were otherwise once free. These costs either are absorbed by the entity paying them, cut into wages, profits or future growth, and/or are passed on to consumers in the form of higher prices or less product selection.

Meanwhile, research and analysis are increasingly showing a new way of looking at environmental regulation. This more modern perspective considers the potential economic and environmental benefits that occur from innovation, which occurs as a creative response to well-designed regulation. In this view, there is no necessary trade-off between the economy and the environment, or between social and private costs. This is because the rising private costs to meet the regulation are (at least to some extent), offset by the falling private costs due to innovations spurred by the regulation (Figure 2).

Figure 2: Modern view of environmental regulation

In this modern view, private costs increase because of the new compliance costs, just as in Figure 1. However, while the private costs of meeting the regulation generally occur before or at the time of implementation of the regulation, over time this induces innovations - such as greater operational efficiency, reduced waste, new input mixes, or new products - that decrease or potentially even offset these compliance costs.

In addition, the regulation improves environmental indicators leading to broader societal benefits. Depending on the objectives and design of the regulation, the social impacts may be felt immediately (as may be the case with regulations that limit local air pollutants, in turn reducing smog days and sickness due to asthma) or over longer time periods (as with persistent pollutants that take time to clear from the environment). The combination of lower aggregate private costs and strengthening social benefits leads to significant net benefits when environmental regulations are well designed (e.g., they must maintain the incentive to innovate).

The modern view of regulation is increasingly commonplace in economic literature. The development of the modern view can be attributed to a hypothesis proposed by the economist Michael Porter back in 1991. The Porter Hypothesis states that well-designed environmental regulation can benefit regulated firms by spurring innovation, thus leading to improved efficiency and enhanced competitiveness that (at least partially) offsets the cost of regulatory compliance.[1]

Additionally, opponents of environmental regulation have argued that some regulations influence the ability of industries to compete on an international scale and/or reduce productivity relative to a scenario with limited regulation, both of which could cause a loss of industries, firms and jobs. This becomes an environmental concern when production simply shifts to jurisdictions with weaker regulation (for climate change policies, this is known as "carbon leakage"). Well-designed regulations often offer flexibility mechanisms, such as output-based allocations, in recognition of these competitiveness issues, and are often designed to limit cost to industries while maintaining the incentive to invest in cleaner technologies and practices.

Box 2

Who Ultimately Pays the Costs?

In some cases, regulatory compliance costs may be passed on to consumers; in other cases, it may be the producers of the regulated good or service who do themselves absorb the costs. Each regulation will impact firms within the regulated sector differently. In some cases, regions, technologies, plant vintages and/or other defining characteristics may influence how compliance costs impact the individual firms in the industry.

In cases where environmental regulations are expected to have a negative impact on vulnerable sectors - such as emissions-intensive and trade-exposed industries - there are a number of policy tools to address these impacts. These include: output-based allocation systems, free allowance distribution, full or partial rebates in a cap and trade system, border carbon adjustment taxes, and exemptions for certain sectors. These flexibilities, though often effective at sheltering affected industries, should be transparent, targeted, temporary, and justified by data and analysis.[2]

Box 3

Looking Back on B.C.'s Carbon Tax[3]

British Columbia's carbon tax is a proven climate change success story, offering instructive lessons for implementing and designing carbon pricing schemes. It also underscores the importance of rigorous ex-ante and ex-post assessments of costs and benefits.

British Columbia's carbon tax was introduced at $10/tonne in 2008 and reached $30/tonne in 2012.† Until the 2017/2018 provincial budget update, the carbon price was almost entirely revenue neutral, with proceeds recycled through reductions in personal and corporate income taxes, along with tax credits for low-income households and select industries.[4] Early modelling commissioned by the province estimated that B.C.'s carbon tax would reduce emissions by approximately 5% relative to business as usual in 2020.[5]

Sufficient time has passed for analysts to attempt to statistically estimate the effects of the carbon tax. These have largely confirmed the projected benefits of the carbon price, while also highlighting some policy design considerations. The carbon tax is estimated to have substantially reduced the consumption of fossil fuels in the province including: gasoline[6], diesel fuel[7] and residential and commercial natural gas.[8] It has also spurred the purchase of more fuel-efficient vehicles.[9]

On the basis of these impacts, Murray and Rivers (2015) estimate that the carbon tax has reduced GHG emissions by 5% to 15% relative to business-as-usual scenarios – potentially even greater than the province's original projections. Moreover, during the first eight years of the carbon tax (2008-2015), B.C.'s per capita GHG emissions from fossil fuel combustion declined by more than 7% while GDP per capita increased by over 6% – superior to the rest of Canada for both trends.[10] Other studies have failed to identify any statistically significant negative effect of the carbon tax on B.C.'s economic growth rate.[11]

Another analysis shows that through the tax cuts and rebates, over 40% of households (all from the bottom income deciles) were estimated to be financially better off due to the carbon tax in years 2008-2012 (the time period modelled in the study).[12]

Studies of the employment impacts of B.C.'s carbon tax have found mixed results, but overall the evidence suggests no significant effect on overall employment in either direction – although it does lead to a significant shift in the composition of the workforce. One recent study estimated that the tax led to a modest increase in overall employment, with jobs shifting from more emissions-intensive and trade-exposed sectors to 'cleaner' sectors such as services.[13] A follow-up study compared projected employment impacts of the carbon tax with ex-post statistical estimates, and found that the two estimates were in very strong agreement.[14]

By contrast, another recent study estimated that the carbon tax increased B.C.'s unemployment rate. The impacts also raised important equity considerations, since men with moderate or lower levels of education were disproportionately affected (as they are more likely to be employed in emissions-intensive and trade-exposed sectors).[15] One of the most recent studies used a more comprehensive dataset along with a novel methodology; it estimated that the carbon tax had no statistically significant effect on overall employment levels, but it corroborated previous findings that the tax induced a shift in employment from emissions-intensive sectors to 'cleaner' sectors.[16]

There is merit in considering policy measures that improve competitiveness and promote a just transition, given the significant negative employment effect on emissions-intensive, trade-exposed industries identified across studies. This might include additional targeted supports for heavy industry, as well as re-training and new skill development programmes for any negatively impacted workers.

† The carbon price remained at $30/tonne until 2018, but a new price schedule has been announced by the coalition government between the B.C. NDP and the B.C. Green Party. Under this new schedule, the carbon price increased to $35/tonne in April 2018, and will rise by annual $5/tonne increments until it reaches $50/tonne by 2021. See British Columbia Ministry of Finance. (2017). *Budget 2017 September Update*. Retrieved from https://www.bcbudget.gov.bc.ca/2017_Sept_Update/bfp/2017_Sept_Update_Budget_and_Fiscal_Plan.pdf.

Net Benefits of Environmental Regulations

Prior to the imposition of regulation, compliance costs are routinely estimated and are a requirement under federal Regulatory Impact Analysis Statements (RIAS) in Canada and under federal Regulatory Impact Analysis (RIA) in the United States. In many cases, the regulated industry will also prepare costs estimates.

An RIAS is a form of analysis that accompanies new federal regulations. It outlines the context of the regulation, including estimated costs and benefits of its implementation. The cost-benefit component of the RIAS provides an estimate of present and future costs; however, regulators are not always required to conduct ex-post analyses of the environmental and economic outcomes of regulations after they have been implemented, and in some cases public data on the relevant endpoints of regulations (e.g. pollution control expenditures by U.S. firms) are not collected.[17]

Studies conducted both inside and outside government suggest that these costs tend to be overestimated - both by regulators and regulated industries. Industry may have an incentive to overstate costs or may simply not fully account for its own ability to innovate. The regulator may rely on the costs of existing technology and may not have access to data on the operating expenses of private firms, which may lead regulators to err on the side of caution by overestimating the costs of regulation.

An analysis commissioned by the European Commission found that. "There are only few examples for ex-post costs to be higher than ex-ante estimates. Anecdotal evidence indicates that costs of the public projects, such as waste water treatment plants, tend to be underestimated, whereas costs of compliance for private companies might be overestimated."[18]

There is a small but growing literature on overestimating the costs and underestimating the benefits of environmental regulation. The next section explores two Canadian and three American case studies related to cost-benefit analysis of environmental regulations – the Light Duty Vehicle Greenhouse Gas Emissions and Standards, the Sulphur in Gasoline Regulations, the Clean Air Act, the Montreal Protocol, and the Acid Rain Program. The section that follows will provide a broader review of the evidence base for the tendency to overestimate costs and underestimate the benefits of environmental regulations.

Case Study Results

It is helpful to explore, via case study, some specific examples of cost-benefit estimates. Because there is a lack of research on the implications of environmental regulations after their implementation, not every case study is able to offer ex-post cost assessment, in which case other indicators, such as overcompliance, are illustrated.

Box 4

Reporting Estimates of Compliance Costs

A 2016 study[19] looks at the (sometimes) different messages that oil companies send to regulators and investors when faced with regulations or regulatory changes. The study empirically demonstrates, by looking at the EPA's Renewable Fuel Standard, that "oil companies facing costly regulations tailor their messages to each audience—emphasizing the cost and economic danger of regulation to regulators while telling shareholders that regulation is merely a cost-of-doing business with few negative impacts. Meanwhile, corporations anticipating beneficial regulations—such as the ethanol companies planning on mandates for their product—present a more consistent and cautiously optimistic forecast in both fora."

Box 5

Total Costs and Benefits

Looking more broadly at total costs and benefits of environmental regulation, a 2017 draft report to the U.S. Congress from the White House found that the benefits have greatly exceeded the costs for the 39 major rules introduced by the EPA between 2006 and 2016. The estimated 2015 annual costs of these regulations were between $54.1 to $64.8 billion, while benefits were estimated to be between $195.8 to $705.7 billion per year (US$ 2015). [20]

CASE STUDY 1: THE CANADIAN LIGHT-DUTY VEHICLE GREENHOUSE GAS EMISSIONS STANDARDS AND THE UNITED STATES CORPORATE AVERAGE FUEL ECONOMY (CAFE) STANDARDS

Canadian Regulation Name	Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations (2011-2016)
Description	The regulation requires importers and manufacturers of new vehicles to meet fleet average emission standards for GHGs
Coverage	The regulations establish progressively more stringent greenhouse gas emission standards over the 2011 to 2025 model years for both passenger automobiles and light trucks
Costs	$4.2 billion (2011-2016 model years)
Benefits	$13.4 billion (2011-2016 model years)
Result	The present value of net benefits of the regulations (i.e. total benefits of $13.4 billion minus total costs of $4.2 billion) was estimated to be $9.2 billion. Overall, the total benefits exceeded total costs by a ratio of over 3:1.

The United States Regulation Name	Corporate Average Fuel Economy (CAFE) Standards & Greenhouse Gas (GHG) Emission Standards for Light-Duty Vehicles
Description	EPA and the National Highway Traffic Safety Administration (NHTSA) jointly established a National Program consisting of standards for light-duty vehicles that reduce GHG emissions and improve fuel economy.
Coverage	EPA's GHG rules for light-duty vehicles require compliance with progressively more stringent GHG emission standards.
Costs	$52 billion (2012-2016 model years)
Benefits	$182 billion (2012-2016 model years)
Result	The NHTSA estimated 2012-2016 net benefits under the Regulatory Impact Analysis was $131 billion ($182 billion in benefits subtracting $52 billion in costs with rounding). Overall, the total benefits exceeded total costs by a ratio of 3 and a half to 1.

The Passenger Automobile and Light Truck (light duty vehicle) Greenhouse Gas Engine Emission Regulations establish standards for 2011 and later model year vehicles offered for sale in Canada. The standards are aligned with those of the U.S. Environmental Protection Agency (EPA) and are progressively more stringent over the 2012 through 2025 model years.

The regulation requires importers and manufacturers of new vehicles to meet fleet average emission standards for GHGs and also includes an emission credit system that allows companies to generate emission credits if their fleet average performance is better than the standard. The credits can be sold or traded to other companies or can be banked for future use. The regulations also include incentives for advanced technology vehicles such as electric vehicles, fuel cell electric vehicles, and plug-in hybrids.

The Regulatory Impact Analysis Statement (RIAS) for the 2011-2016 model years reported that the regulation was expected to result in total benefits of $13.4 billion, including fuel savings (from more efficient vehicles), reduced refuelling time, additional driving, reductions in criteria air contaminants, and reductions in GHG emissions. In terms of the specific GHG benefits, the regulation was projected to result in an average decrease of 15.3 megatonnes (Mt) of carbon dioxide equivalent (CO2e) per year.[21]

Meanwhile, the total costs of the regulations were estimated to be $4.2 billion. This included technology costs, vehicle testing, compliance promotion, enforcement and administration as well as costs from added noise, increased road congestion and associated accidents (as driving increases through fuel savings). Therefore, the present value of net benefits of the regulations (i.e. total benefits of $13.4 billion minus total costs of $4.2 billion) was estimated to be $9.2 billion. Overall, the total benefits exceeded total costs by a ratio of over 3:1.

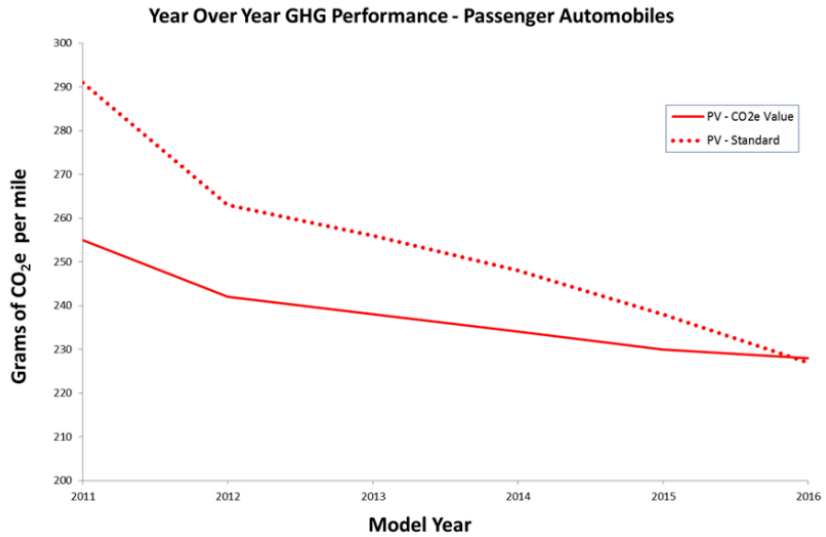
Moreover, although the regulation was anticipated to add an additional $89 to the average purchase price of a 2011 model year vehicle, and an additional $1,195 to the average purchase price of a 2016 model year vehicle, the added costs would be more than offset by fuel savings with a payback period averaging less than 1.5 years.[22]

Finally, the RIAS stated that the costs could be considered to represent a high-cost scenario since the calculations did not include the regulatory flexibilities such as banking and trading credits. However, it is difficult to test if this assumption ended up being accurate, since ex-post data on costs are not readily available. There were no reporting requirements related to average technology costs. Light duty vehicle prices have changed over the years due to a number of factors, making it challenging to prove any causal relationship to stricter standards using price data alone.

The mandatory reporting did however capture the rate of compliance with fleet average emissions standards. The Greenhouse Gas Emissions Performance (2011 to 2016) compliance summary report illustrates that companies significantly over-complied with the standard in each year until 2016 (where they used banked credits that could have otherwise expired)[23] (Figure 3).[24]

"Total benefits of the 2011-2016 Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations exceeded total costs by more than 3:1."

Figure 3: Year over year greenhouse gas emission performance of passenger automobiles



Box 6

What's the Social Cost of Carbon?

Cost-benefit analyses of climate change mitigation policies or regulations often consider the climate change mitigation benefits of regulation, as estimated by the social cost of carbon (SCC). The SCC is a monetary measure of the global damage expected from climate change from the emissions of an additional tonne of carbon dioxide (CO2) in the atmosphere in a given year.[31] The social cost of carbon is calculated as the value of avoided climate change damages at the international level, for current and future generations. This looks at GHG emissions' climate change impacts, such as on agricultural productivity, human health, property damages from increased flood risk, and changes in energy system costs.

Canada's estimates of the SCC mirrored those of the U.S. estimates since 2011, and Canada significantly increased its benefit estimates in 2016 based on revised U.S. figures from the U.S. Interagency Working Group in 2013 (with technical updates in 2015).

Environment and Climate Change Canada updated Canadian SCC figures, resulting in a central SCC value of $41/tonne CO2 in 2016 (C$ 2012). This is an increase of 30% from the previous $31/tonne CO2 (C$ 2012). It also updated an upper bound and an upper bound (95th percentile, used in sensitivity analysis) value of $167/tonne CO2 (C$ 2012) – an increase of 34% from the previous $125/tonne CO2.

These changes have been spurred by developments in the scientific literature, with the weight of evidence continuing to indicate that the social cost of carbon – and hence the benefits of climate action – have been underestimated in most regulatory cost-benefit analyses. Several high-profile external studies suggest that the SCC figures adopted by regulatory agencies continue to remain too low.[32]

U.S. Greenhouse Gas Emission Standards for Light-Duty Vehicles

The parallel light-duty vehicle regulations in the U.S. offer better access to data pertaining to ex-post cost estimates. Canada's light-duty vehicle regulations have been aligned with those of the U.S. since the 2011 model year, which has been particularly important given the integrated nature of the industry within a North American market.

The United States has implemented mandatory fuel economy standards for new vehicles since 1978 through the National Highway Traffic Safety Administration (NHTSA) and later also through the Environmental Protection Agency (EPA). Since the original introduction of NHTSA Corporate Average Fuel Economy (CAFE) standards, the requirements have become more stringent. In January 2017, the former EPA Administrator Gina McCarthy finalized the standards for cars and light trucks through 2025, saying they will save American drivers billions of dollars at the pump while protecting our health and the environment.[25] Two months later, the new EPA Administrator Scott Pruitt reversed that decision stating: "These standards are costly for automakers and the American people."[26]

The NHTSA estimated 2012-2016 net benefits under the Regulatory Impact Analysis to be $131 billion with rounding ($182 billion in benefits subtracting $52 billion in costs). The projected direct costs per passenger car of the final rule varied from a low of US$29 (Toyota in MY 2013) to US$1,884 (Ford in MY 2016), with an average of $695 per vehicle annually.[27] Most associated costs involved technological improvements such as weight reduction and engine efficiency.

The 2016 government's Manufacturers Performance Report found that the auto industry had a solid track record of innovating and pushing towards lowering greenhouse gas emissions. The paper says the technology ended up often being cheaper than was expected in terms of cost, and that automakers adopted new technologies quicker than expected.[28]

In terms of the newer rules, an independent study by the International Council on Clean Transportation observed that automakers are employing innovative technologies more effectively and more cheaply than anticipated in fuel efficiency technologies, including turbocharging and materials that reduce the weight of vehicles and so reduce the amount of fuel required to drive them. ICCT found that new technologies could reduce weight 15 percent by 2025 at costs that are a third of those estimated in the EPA's initial 2022-2025 rule.[29]

Other evidence suggests that the tougher standards are creating jobs in the U.S. A May 2017 report by BlueGreen Alliance found that over 1,200 U.S. factories and engineering companies with 288,000 U.S. workers were building technologies that reduce pollution and improve fuel economy in vehicles - two-and-a-half times as many facilities and almost twice as many jobs in this sector than found in a 2011 report by the same researchers.[30]

Back in Canada, determination of whether the established greenhouse gas emission standards for the 2022 to 2025 model years remain appropriate will be informed by the mid-term evaluation process and careful consideration of environmental and economic impacts to industry and consumers. Public comment for the review closed on September 28th, 2018.

CASE STUDY 2: CANADIAN SULPHUR IN GASOLINE REGULATIONS

Regulation Name	Sulphur in Gasoline Regulations
Description	Canadian federal regulation on sulphur in gasoline, administered by Environment and Climate Change Canada
Coverage	The regulations limit the amount of sulphur in gasoline produced, imported or sold
Initial Cost Estimate	$1.8 billion in capital expenditures and $119 million per year in operating costs
Revised Cost Estimate	Over the 2017 to 2030 period, the present value of total costs resulting from the proposed Amendments is estimated to be about $1.04 billion.
Estimated Benefits	Cumulative health and environmental benefits of $7.3 billion and cumulative net benefits of $4.7 billion by 2030

The Sulphur in Gasoline Regulations protect the environment and the health of Canadians by setting limits on the amount of sulphur in gasoline produced, imported or sold. The first sulphur reducing regulations were announced in 1998 and enforced in 2002. The regulations originally limited sulphur to an average level of 30 mg/kg with a never-to-be-exceeded maximum of 80 mg/kg. Similar regulations exist for diesel fuel, which originally limited sulphur to 15 mg/kg.[33]

During consultations on the design of the regulations, many groups (including the Ontario Medical Association, the Montreal Urban Community, several cities in Ontario, and vehicle manufacturers) were in favour of the 30mg/kg limit due to the health benefits. Initially, some stakeholders (primarily the gasoline industry) were concerned that the costs and potential negative impact on competitiveness would be too onerous for Canada, favouring instead that Canada match the more lenient American regulations at the time.†

The Cost and Competitiveness Assessment Panel Report (part of the Regulatory Impact Analysis Statement) estimated that the compliance costs to achieve 30 mg/kg would be $1.8 billion in capital expenditures and $119 million per year in operating costs.[34]

The Regulations Amending the Sulphur in Gasoline Regulations introduce lower limits on the sulphur content of gasoline, from an annual average of 30 mg/kg to 10 mg/kg, in alignment with the United States Environmental Protection Agency (U.S. EPA) Tier 3 fuel standards and came into force in July 2015.[35],[36]

The Government of Canada estimates that the compliance costs "would initially be experienced over the 2017 to 2020 period, as each refinery makes the necessary production changes and investments to reduce the concentration of sulphur in gasoline". The present value of total costs was estimated at $791 million over the 2017 to 2020 period and $247 million over the 2021 to 2030 period. Over the 2017 to 2030 period, the present value of total costs resulting from the proposed Amendments is estimated to be about $1.04 billion.[37] Benefits from the amendments (which also include matching vehicle emission standards to U.S. Tier 3 standards) include cumulative health and environmental benefits of $7.3 billion and cumulative net benefits for Canadians of $4.7 billion by 2030, representing a benefit to cost ratio of almost 3:1.[38]

"The auto industry had a solid track record of innovating and pushing towards lowering costs and greenhouse gas emissions."

† By the time the regulations were finalized the Canadian Petroleum Products Institute accepted the final goals.

"Even while costs and benefits vary from region to region, due to the state of existing refineries, current fuel quality and emissions standards, and local air quality, the costs of sulphur reduction are affordable and are dwarfed by the benefits."

With regards to the U.S. Tier 3 regulations, the American Petroleum Institute (API) was strongly opposed to these regulations when they were first proposed, claiming the EPA's Tier 3 proposal would increase the cost of gasoline production by up to nine cents per gallon[39] or roughly ten times what the EPA calculated the cost to be in its own assessment.[40] A closer review of the API's study reveals that the costs API cites have been overinflated.[41]

One (now dated) paper summarizes these types of trends. "All of these [U.S.] programs – from unleaded gasoline through RFG [reformulated gasoline] – have met with a similar series of responses from the petroleum industry. Typically, the early stages of the proposals are met with protest and warnings of supply shortages. The programs have generally been modified heavily to accommodate some portion of industry's concerns. Studies are conducted which typically demonstrate extremely high costs of compliance and large price impacts, but implementation continues. As deadlines approach, the refining industry has usually discovered that compliance costs are much less than anticipated."[42]

The United Nations Environment Program also reports evidence of an overestimation of costs of reducing sulphur content. Their analysis finds that even while costs and benefits vary from region to region, due to the state of existing refineries, current fuel quality and emissions standards, and local air quality, the costs of sulphur reduction are affordable and are dwarfed by the benefits.[43]

CASE STUDY 3: SULPHUR DIOXIDE AND NITROGEN OXIDE - ACID RAIN PROGRAM

Regulation Name	United States Acid Rain Program
Description	Emissions trading program primarily targeting coal-burning power plants that produce nitrogen oxide and sulphur dioxide, administered under the Clean Air Act
Coverage	Fossil fuel-fired power plants with generators greater than 25 megawatts and all new utility units
Initial Cost Estimate (SO_2)	Costs of $2.4 to 5 billion per year
Revised Cost Estimate (SO_2)	Costs of $836 million per year
Result	$100 billion per year in health benefits[44]

The Acid Rain Program falls under the 1990 Clean Air Act, and targets the emission of nitrogen oxide (NOx) and sulphur dioxide (SO_2) from the power sector. There are two separate programs to reduce emissions. The SO_2 program is a market-based emissions trading program that sets a cap on SO_2 emissions generated by the electricity generation sector, while the NOx program is a traditional regulatory program that establishes emission limits from coal-fired electric power plants.

The SO_2 regulation of the acid rain program is an important example of how compliance cost estimates can vary. Phase 1 of the regulation required a 10 megaton reduction in SO_2. Initial cost estimates for this reduction were $2.4 billion per year (ICF Consulting, for the National Wildlife Federation), $3.9 billion per year (Peabody Coal), $3-4 billion per year (Office of Technology Assessment) and $4-5 billion per year (Edison Electric Institute).

However, results from the first half of the compliance period showed annual compliance costs under $1 billion. The reason for the lower realized compliance costs were identified as an overestimation of per unit abatement costs and an understatement of how much technological change would be possible.[45] The introduction of the tradeable permits market encouraged innovation, and in particular, innovation that sought to improve environmental outcomes.[46]

"The introduction of the tradeable permits market encouraged innovation, and in particular, innovation that sought to improve environmental outcomes."

The electricity industry argued against the regulation, claiming that the costs of compliance would cost ratepayers. For example, a study commissioned by the Edison Electric Institute claimed the regulation could cost electric utility ratepayers $5.5 billion annually between enactment and the year 2000, increasing to $7.1 billion per year from 2000-2010.[47] However, these claims proved to be an overestimation, as national electricity rates actually declined by an average of 19% between 1990 and 2006.[48]

Because this emissions trading system involves a market, the market price for tradeable permits is an important indicator for estimating total compliance costs.† Before the 1990 Amendments took effect, industry anticipated that the cost of sulphur reduction under the amendments would be $1500 per ton, but in 2000, the actual cost was under $150 per ton.[49] Compliance costs under cap and trade system were estimated to be approximately 55% of the total compliance costs under a command-and-control approach.[50]

However, more recent research suggests that the least-cost options to reduce emissions were not necessarily taken advantage of (largely due to regulatory barriers),[51] and that the savings from cap and trade appear to be less than previously anticipated.[52] For instance, one study estimated that in 2002, the Acid Rain Program saved at least $200 million in compliance costs compared to a uniform emissions standard. While this is a significant amount of money, it is only around 26% of the cost savings estimated by previous studies.‡

Canada and the U.S. also engaged in bilateral agreements to reduce these pollutants. The *Canada-United States Air Quality Agreement* was signed in 1991 to address transboundary pollution. [53] The NOx and SO_2 Electricity Sector Emissions Trading Regulation placed limits on Ontario Power Generation's fossil fuel-fired generating stations starting in 2002. Emissions from electricity generators covered by the program decreased by approximately 80% for NOx and 95% for SO_2 between 2007 and 2016 (although this also includes the result of phasing out coal-fired electricity generation in the province).[54]

† Firms have the option of paying for emissions permits at the market price, making reductions in their own operations through internal investments in technology or process changes, or some combination of the two.

‡See references and discussion in Chan, H.R., Chupp, B.A. Maureen L., C., Muller, N. (2018). The impact of trading on the costs and benefits of the Acid Rain Program. *Journal of Environmental Economics and Management* 88, 180-209. The authors note that this estimate should be interpreted as a lower bound (meaning that the savings may in fact be greater), since the study only analyzed impacts for a single year (2002), before the SO_2 trading system was fully stringent. As a result, the study was unable to account for the cost savings realized through the credit banking provisions of the Program, or the effects of emissions trading on the diffusion of more advanced SO_2 scrubbers.

Smelters in central Ontario are the major sources of SO_2 emissions in Ontario, accounting for approximately 72% of the provincial SO_2 emissions according to 2016 estimates for point, area and transportation sources. The NOx and SO_2 Emissions Trading for Industry Regulation, O.Reg. 194/05, includes large industrial emitters of NOx and SO_2. Thirty facilities from seven industrial sectors are included in the program. Capped sectors include glass, petroleum refining, cement, iron and steel, pulp and paper, carbon black, and base metal smelting. Emissions from industry covered by the program decreased by approximately 30% for NOx and 30% for SO_2 between 2007 and 2016.

The International Nickel Company, while unenthusiastic about these SO_2 limits at first, found innovative ways to reduce emissions and even new uses for waste products at its Sudbury nickel smelter. This led to a 90% reduction in SO_2 emissions and over $70 million dollars a year in savings.[55]

CASE STUDY 4: MONTREAL PROTOCOL (US AND EUROPEAN COST ESTIMATES)

Regulation Name	Montreal Protocol
Description	International treaty designed to phase out the production of ozone-depleting substances
Coverage	Targets 96 chemicals in thousands of applications across more than 240 industrial sectors
Initial Benefit/Cost Estimate	NA
Revised Benefit/Cost Estimate	Administrative costs were overestimated by up to 125 times; technology costs were 2.5 to 40 times overestimated

"In fact, some reports claim that the reduced use of ozone depleting substances has had very little negative impact on industry, and that the regulation even had a positive effect on business."

The Montreal Protocol came into force on January 1, 1989, and was ratified by 197 parties. Similar to the cases described above, initial estimates of the costs of these regulations were overestimated. A study conducted for the European Commission looked at various aspects of compliance cost estimates; it found that pre-regulation estimates of the administrative cost of compliance were 125 times actual administrative compliance costs; technology costs were 2.5 to 40 times overestimated, and estimates of costs to consumers (through increased product prices) were 1.25 times greater than they were later found to be.[56]

Initial analyses of the effort to phase out chlorofluorocarbons (CFCs) – the primary contributors to ozone layer depletion – estimated limited potential for substitution and high costs.[57] While industry initially resisted the regulations, this resistance eventually subsided due to technological innovation that allowed for the development of substitutes and alternative processes to be achieved at a lower cost than anticipated.[58] In fact, some reports claim that the reduced use of ozone depleting substances has had very little negative impact on industry, and that the regulation even had a positive effect on business.[59]

While the costs of the regulation were initially seen as threatening to industry, the Protocol has proven to be an inspiring success story. A 2014 United Nations report finds that the ozone layer is recovering due to the actions under the Protocol, and by mid-century the ozone layer is expected to return to its 1980 levels (before it was significantly depleted).[60] Further, a report published by the US EPA estimates that the protection of the ozone layer under the treaty will avoid 280 million cases of skin cancer, 1.6 million skin cancer deaths, and 45 million cataracts in the United States for Americans born between 1890 and 2100.[61]

While the Montreal Protocol has been successful at phasing out ozone-depleting substances putting the ozone layer on the path to recovery, it led to a shift in demand towards hydrofluorocarbons (HFCs). HFCs are potent GHGs that can be hundreds or even thousands of time more potent that carbon dioxide. The Kigali Amendment to the Montreal Protocol, adopted in 2016, aspires to cut the production and consumption of HFCs. Implementation of the amendment faces similar challenges with regard to high ex-ante cost estimations of cleaner substitutes.

"A 2014 United Nations report finds that the ozone layer is recovering due to the actions under the Protocol, and by mid-century the ozone layer is expected to return to its 1980 levels."

CASE STUDY 5: THE UNITED STATES CLEAN AIR ACT

Regulation Name	Clean Air Act
Description	United States federal law on control of air pollution, administered by the U.S. Environmental Protection Agency in coordination with state, local, and tribal governments†
Coverage	Air pollutants, including: particulate matter, ground-level ozone, carbon monoxide, sulphur oxides, nitrogen oxides and lead
Costs	Annual public and private costs to meet the 1990 Act Amendment: $65 billion in 2020
Benefits	Benefits from reducing air pollution from the 1990 Amendments: $2 trillion annually in 2020
Result	Several cost scenarios are estimated to compare costs and benefits. Benefits exceed costs by a factor of more than 30-to-1 in the main scenario. (The high benefits estimate exceeds costs by 90 times. Even the low benefits estimate exceeds costs by about 3-to-1).[62]

Prior to implementation of the U.S. Clean Air Act, there were claims that the regulations under the Act would be detrimental to economic growth, as industry would be forced to take on extra costs to comply. During a debate on the Clean Air Act amendments, a small town mayor expressed the conventional idea that environmental and economic outcomes were incompatible, and said, "If you want this town to grow, it has got to stink."[63]

However, according to assessments by the EPA, the economic and public health benefits of the Act have far outweighed the costs imposed on businesses. Specific benefits of these regulations have been measured at well over $4,000 added to each affected child's lifetime income from less pollution, fewer sick days, more education and more income as a result of cleaner air.[64] The public and private costs to meet amendments made to the Act in 1990 were estimated to reach an annual value of

† The Act was originally implemented in 1963 and was amended three times, in 1970, 1977 and later in 1990. The amendments in 1970 included the development of federal and state regulations to reduce emissions from industrial and mobile sources, and created the EPA. The 1990 amendments included greater federal controls and introduced programs to address acid rain.

"The total economic benefits of the Clean Air Act are estimated at four to eight times the compliance costs."

$65 billion by 2020.[65] In contrast, reductions in air pollution were estimated to lead to benefits such as reducing premature death and illness, improving the welfare of Americans, and enhancing environmental conditions, all of which were estimated to reach an annual value of almost $2 trillion in 2020.[66]

Similar findings are reiterated in other studies.[67] According to the U.S. Office of Management and Budget, the total economic benefits of the Clean Air Act are estimated at four to eight times the compliance costs.[68]

In terms of overestimating private compliance costs, a study conducted in 2010 looked at various regulations under the Clean Air Act and found that, "Industry and government economists alike have overestimated the (compliance) costs of the Clean Air Act, anywhere from 500% to more than 1,000%."[69]

Despite these studies, some remain sceptical of the EPA's estimates and proclaim that the costs still outweigh the benefits. [70,71]

Box 7

What Does Pollution Cost Canada?

The purpose of environmental regulation is to manage environmental degradation and conserve natural resources, including limiting pollution. The costs of pollution are difficult to quantify, but a recent report by the International Institute for Sustainable Development[75] surveys the literature and finds that in 2015 pollution cost Canadians at least $39 billion in impacts to their health and well-being, and $3.3 billion in out-of-pocket expenses for families, businesses and governments. Although it was not possible to provide a precise estimate, the authors also noted that trillions of dollars' worth of Canadian assets are at risk from pollution and climate impacts. Environmental regulations that reduce pollution in effect avoid or reduce some of these costs.

CALCULATING THE IMPACTS OF ENVIRONMENTAL REGULATIONS ON CANADIAN INDUSTRY

To date, only a handful of empirical studies have estimated the ex-post productivity and competitiveness impacts of environmental regulations on Canadian industries. Some examples include studies of the relationship between the stringency of environmental regulation and total factor productivity growth in the Quebec manufacturing sector,[72] the relationship between the strength of environmental regulation and the business performance of 4,200 facilities in seven OECD countries (including Canada),[73] and the effects of the B.C. carbon tax on total factor productivity in the province's manufacturing sector.[74]

These studies generally identify negative economic impacts of environmental regulations to the regulated industries (although there are exceptions). However, it is not surprising that some short-term economic impacts will result from environmental regulations. Regulations are meant to change behaviour, which in turn changes costs – meaning some firms may exit the industry, others may alter their products or processes, and new firms may be created to fill market needs created by the regulation. Similarly, costs may be front-loaded while benefits accrue later. Change and disruption are part of the process. This is why retrospective analysis is so important – it can help identify the net benefits (or costs) of environmental policies over longer time frames. It can also identify potential shortcomings in the design of existing regulations, which can subsequently be used to strengthen, amend or repeal them, and to improve how new regulations are designed and implemented.

The Canadian Data Gap

Most of the data and analyses comparing ex-ante predictions of environmental and economic impacts of environmental regulations with plausible ex-post attributions of these impacts are from the United States. There is a paucity of literature and analysis of both compliance costs and realised benefits in Canada, especially in terms of ex-post analyses. In a Canadian context, the challenge in accurately assessing the impact of environmental regulations on the economy and on industries and firms is compounded by a lack of publicly accessible data regarding how certain sectors, regions, or the economy as a whole have been impacted when regulations are implemented.

Nevertheless, in recent years, there has been an increasing number of Canadian government publications that discuss compliance to regulations, such as the *GHG Emissions Performance for the 2011-2016 Model year light-duty vehicle fleet*. Although these reports provide measures of compliance and overcompliance with the regulation, they do not include cost estimates, realised benefits, nor do they describe compliance scenarios relative to business and usual baselines for the sector.

In some cases, it is possible to find some information on compliance costs through consultant reports or academic research, but these are not common, and they rarely compare ex-ante and ex-post compliance costs for particular sectors of the Canadian economy. Additional data and analysis in this area would greatly enhance future policy design.

Literature Review: Overestimating Compliance Costs

Evidence from multiple studies consistently point to the tendency of regulators and industry to overestimate the costs of compliance with environmental regulations. For example, a 2018 retrospective analysis[79] compared 34 ex-ante and ex-post estimates of the total costs and/or benefits of federal and subnational environmental regulations. Of the twelve regulations for which both sets of costs could be quantified, ex-ante costs were overestimated in ten cases and underestimated in two cases (Figure 4). There were no cases in which costs were accurately estimated.

Box 8

How Much is Spent on Environmental Protection?

The Survey of Environmental Protection Expenditures, undertaken biennially by Statistics Canada, provides information on the expenditures made by Canadian industries in order to comply with current or impending regulations, and other voluntary agreements or conventions. In 2014, businesses operating in Canada reported spending $11.8 billion on environmental protection, up from $10.9 billion in 2012.[76] The oil and gas extraction industry spent more than any other industry surveyed, spending $6.5 billion; the mining and quarrying industry spent just over $1 billion; and the electric power generation, transmission and distribution industry spent approximately $775 million (2014).[77] The capital expenditures on environmental protection represented approximately 4-5% of total capital expenditures for mining, quarrying, and oil and gas industries, and around 2% of total capital expenditures in the electric power generation, transmission and distribution industry.[78]

Figure 4: Comparison of Ex-ante and Ex-post Cost and Benefit Estimates for U.S. Environment Rules†

Federally Issued Rules	Costs	Benefits or Effectiveness
Acid Rain Program Phase II Trading[80]	⩔ Underestimated	⩓ Overestimated
Renewable Fuel Standard	⩔ Underestimated	-
Critical Habitat Designation Under Endangered Species Act	⩓ Overestimated	-

† The study defined an ex-ante estimate as 'accurate' if its value fell "roughly within +/−25% of the ex-post observation… Outside these bounds, the results are deemed 'underestimates' or 'overestimates.'"

Minimum Efficiency Performance Standards		
• Room air conditioners	Overestimated	Underestimated
• Refrigerators	Overestimated	Underestimated
• Dishwashers	Overestimated	Underestimated
• Clothes washers	Overestimated	Underestimated
• Clothes dryers	Overestimated	Underestimated

Federally Funded, State-Operated Rules

Clean Water State Revolving Fund		
Indiana	Overestimated	Accurate
Iowa	Overestimated	Accurate
Maryland	Overestimated	Accurate
Texas	Overestimated	Accurate

Table reproduced from Morgenstern, R. (2018). Retrospective Analysis of U.S. Federal Environmental Regulations. *Journal of Benefit-Cost Analysis*, 9(2), 285-304.

The weight of evidence suggests that compliance costs tend to be overestimated, although results from individual case studies vary:

- The National Center for Environmental Economics reports that existing studies of regulations issued by the EPA and other U.S. government agencies find that compliance cost overestimates are more common than underestimates.[81]

- Another study by Resources for the Future reviewed the literature comparing the EPA's pre-regulatory estimates of the total costs† of individual regulations to the actual costs after the regulations were implemented.[82] They found that the EPA and other regulatory agencies generally tend to overestimate the total costs of regulations. Earlier work from Resources for the Future also suggested that the *unit costs* of environmental regulation tend to be overestimated.[83]

- Similarly, a study summarizing the European and U.S. literature on environmental regulations reports that the economy-wide costs of environmental protection (in the form of increased consumer costs, or lost jobs) are much more often overestimated, rather than underestimated, in advance.[84] That study's author notes, "reports of the economic burden imposed by regulatory costs have been greatly exaggerated. The widely imagined trade-off between economic prosperity and environmental protection rests on multiple mistaken premises."

- Simpson (2014) ran a regression analysis on 18 case studies comparing regulator' estimates of ex-ante and ex-post total costs of environmental regulations, to determine if he could statistically detect whether regulators' ex-ante costs were biased (relative to ex-post costs). Although there was a

† Here, total costs are defined as the cost to reduce pollution plus "estimates of the basic adjustment process and costs of change itself."

slight tendency among the case studies to overestimate costs ex-ante, the author was unable to reject the null hypothesis that the ex-ante estimates are unbiased. Given the small sample size in the dataset, Simpson concluded that more rigorous statistical tests are needed, using larger and better datasets, before any conclusions can be drawn as to whether regulators' ex-ante estimates of compliance costs are biased or unbiased.[85]

While these studies look at different jurisdictions, different time periods, different metrics for costs/compliance costs, and differing sets of regulations, they generally point to a consistent tendency for regulators and industry to overestimate ex-ante compliance costs.

DISCUSSION

Determining what would have happened in the absence of the regulation can be challenging, since it is not always possible to identify a control group, or to account for all of the relevant variables affecting policy outcomes (such as the business cycle or unexpected events). Costs and benefits are also defined, measured and interpreted inconsistently across different studies.

However, it is increasingly clear that while estimation is an imperfect exercise, the tendency to overestimate is more prevalent than to underestimate, and that overestimations may be significantly larger than retrospective calculations of compliance costs. Likewise, there is extensive literature showing that the costs of environmental regulations are more than offset by a broad range of benefits.

Several **reasons have been identified for why such overestimations exist**. Some of these are technical in nature, whereas others pertain to difficulties in predicting impacts ex-ante. They include:

- Regulatory analyses by regulators and by industry are typically conservative, often failing to consider the cost-cutting innovative measures that firms can take to comply with regulations[86] (See SPI's companion Policy Brief *"Environmental Regulation and Innovation: Select Case Study Evidence of the Porter Hypothesis"* for more on this point.)

- The regulation that is ultimately adopted is not necessarily the same as the one for which the costs were estimated. For example, regulatory design and choice of policy instruments (e.g. market-based instruments or flexible regulations versus prescriptive regulations) can strongly affect the ex-post costs and may not always be captured in the ex-ante estimates.[87]

- Cost data is difficult for regulators to retrieve, meaning that they are often forced to rely on data that is often voluntarily supplied by industry. The regulated industry has an incentive to discourage strict regulation by inflating their cost estimates.[88]

- Oftentimes, cost analyses for a proposed regulation are compared to a baseline without the regulation. These baselines may be hard to predict, and some regulators set the baseline at zero, assuming no action would have been taken without the regulation. Ignoring the baseline and any costs

"Flexible regulations such as market-based instruments are more likely to lower overall compliance costs, and regulators should incorporate these flexibility provisions from the outset."

from voluntary or evolutionary action without the regulation would lead to an overestimate of the compliance costs (as well as the benefits).[89]

- Due to the time required to draft, amend and implement regulations, the initial cost estimates may no longer be relevant at the time of implementation.[90]

- The ex-ante estimated costs of a technology (to be applied as a result of the new policy) often do not take into account economies of scale. Similarly, often costs are calculated for new, prototype technologies.[91]

- If ex-ante cost estimates are highly skewed (e.g. by high-cost outliers), then ex-post cost estimates will tend to be lower than the ex-ante estimates.[92]

These drivers of compliance cost overestimates (and the tendency to underestimate environmental benefits) provide clear **lessons for the design of future Regulatory Impact Analysis Statements**, and retrospective analyses thereof. They include:[93]

- **Account for innovation** – while explicit quantification may not be possible, regulators should better attempt to account for industry's capacity to innovate in response to environmental regulations, and realize that in many cases ex-ante cost estimates are likely to be upper bounds. Conversely, regulators should also attempt to identify potential regulatory or institutional barriers to innovation, to avoid overly optimistic ex-ante estimates.

- **Build flexibility into policy design** – flexible regulations (e.g. market-based instruments) are more likely to lower overall compliance costs,[94] and regulators should incorporate these flexibility provisions from the outset (as long as they don't undermine the goals of the regulation). They should also keep an eye out for potential regulatory roadblocks to exercising these flexibility provisions.

- **Collect more consistent data on compliance costs** – by clearly collecting (and disaggregating) capital and operating compliance costs of regulated industries, for instance.

- **Identify appropriate baselines and/or control groups** – ideally, a regulation should identify a control group to better attribute economic and environmental impacts to the proposed regulations. Depending on the context, potential control groups might include firms within the same industry that are not covered under the regulations or unregulated industries from other jurisdictions, or firms that are regulated only during a certain time of year. In some cases, it may be possible to identify a control group by implementing regulations in a step-wise process (randomly assigning regulatory obligations to some firms but not others in the same industry, phasing in additional groups at a later stage).

- **Collect policy-relevant data and facilitate data linkages** – collecting additional data on policy relevant endpoints (e.g. health and environmental outcomes and expenditures) and facilitating linkages among relevant economic and environmental datasets could go a long way in improving analysis and outcomes.

- **Mainstream retrospective analysis in regulatory agencies** – develop a culture of impact evaluation and continuous learning, including through enabling legislation or cabinet directives where necessary.

IMPLICATIONS FOR POLICY MAKERS

- This discussion regarding the costs of environmental regulation is timely. The federal government is designing and implementing a suite of environmental regulations, including as part of the Pan-Canadian Framework on Clean Growth and Climate Change, and the Canada-wide zero-plastic-waste strategy.

- This paper has provided evidence that the costs of environmental regulations are often initially overestimated. The frequency of these ex-ante overestimates can be attributed to several factors, including underestimating industry's capacity to innovate in response to regulations, challenges in identifying baselines or control groups to isolate the impacts of environmental regulations, and not accounting for flexibility provisions incorporated into regulatory design (sometimes at a later stage of the regulatory design process).

- There is also growing evidence that the resulting benefits of the regulations on the environment, human health, and the economy are underestimated and/or far outweigh both prospective and retrospective cost estimates.

- However, there is a lack of specific or comprehensive ex-post research on the costs and benefits of regulations in a Canadian context, due in large part to data limitations. Such analysis would contribute to the design and implementation of future regulations, and would offer insight on how existing regulations could be improved to ensure efficient, effective, and equitable outcomes.

- The most important takeaway from this report is that policy-makers should read compliance cost estimates with a dose of healthy scepticism. Policy makers can anticipate that initial cost estimates of the impacts of environmental regulations will be high, given the uncertainties involved in scenario analysis and the tendency of firms and industries to overestimate costs.

Box 9

Are Pricing-Based Policies an Opportunity to Better Understand Compliance Costs?

As more pricing-based policies such as the clean fuel standard, output based allocations, or cap and trade regimes are introduced, they will provide an opportunity to understand one key aspect of compliance costs – the cost of tradeable permits. Compliance costs include not just permit costs – but also lost opportunity that could have been earned from selling permits to another regulated firm (shadow costs). In larger markets with allocation of permits/credits and clearing price data available publicly, it will be possible to estimate the total permit costs, and will be easily compared to prospective permit price estimates and marginal abatement cost curves.

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