Sustainable Prosperity

Policy Brief | November 2015

Overestimating the Costs of Compliance with Environmental Regulation

About Sustainable Prosperity

Made up of business, environment, policy and academic leaders, Sustainable Prosperity (SP) is a national green economy think tank/do tank. We harness leading-edge thinking to advance innovation in policy and markets, in the pursuit of a greener, more competitive Canadian economy. At the same time, SP actively helps broker real-world solutions by bringing public and private sector decision-makers to the table with expert researchers to both design and apply innovative policies and programs. We believe that achieving the necessary innovation in policy and markets for a stronger, greener Canadian economy requires a new knowledge base and new conversations. SP's approach is to promote both by generating policy-relevant, expert knowledge to inform smart policy solutions and foster innovative conversations and connections.

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Acknowledgements

Primary research was conducted by Pomme Arros, with writing by Pomme Arros and Michelle Brownlee. Research direction and review by Stewart Elgie. Many thanks to the following reviewers for their helpful and insightful comments: Rachel Samson (Carist Consulting) and Nouri Najjar (Vancouver School of Economics, University of British Columbia). Sustainable Prosperity would like to thank the Ivey Foundation for supporting this project. Special thanks to Lorne Johnson & Andrea Moffat for their valuable guidance.

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This Policy Brief belongs to a set of three papers on environmental regulation. Environmental Regulation and Innovation: Select Case Study Evidence of the Porter Hypothesis introduces the Porter Hypothesis and explores recent case study analysis of how environmental regulation can induce innovation; Overestimating the Costs of Compliance with Environmental Regulations investigates the extent to which industry and regulators overestimate the costs of environmental regulation prior to the implementation of the regulation. Green Tape Measures Up: Environmental Regulation Comes with Lower Compliance Costs and Greater Innovation than Previously Thought presents the findings of both Policy Briefs in a shorter, high-level summary.

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, mounting evidence shows that the cost of complying with environmental regulations are often overestimated. Estimates of anticipated costs made prior to the regulation's implementation are more often than not much greater – at least double, often as much as 10 times greater (or more).
- Economic activity requires a healthy environment and well-managed natural resources. Environmental regulations are one tool that can help limit the detrimental impacts of our activities on our environment and the ecosystems it contains, ensuring our future health, wellbeing and prosperity.
- Four case studies provide evidence of how compliance costs of individual regulations have been overestimated: Three American examples (The Clean Air Act, the Acid Rain program and The Montreal Protocol) and one Canadian example (the Sulphur in Gasoline Regulations.) In all cases, there is evidence that the costs of complying with environmental regulations were overestimated.
- This analysis underscores the importance of making best efforts to estimate compliance costs in advance of regulation and argues for better *ex-post* analysis of actual compliance costs. There is very limited analysis of the compliance costs of Canadian environmental regulations available, meaning such efforts would be particularly important for Canadian policy makers and regulators.

The Issue

Both our economy and population require a healthy environment in order to prosper. Environmental regulations are 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. However, those subject to the regulations face private costs of compliance associated with changing their behaviour.[1]

The costs that environmental regulations impose on those who are regulated are an important consideration in policy design. However, *ex-post* evidence points to a consistent trend: the costs borne by the regulated entity of complying with environmental regulations are often overestimated. At the same time, the public benefits are often underestimated.

What comprises compliance costs? *Regulated parties face costs to invest in new pollution-abatement technologies, change their practices, 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 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

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

policy, and increased scepticism about the use of economics in regulatory decision-making.[2] Most importantly, inaccurate cost estimates can lead to sub-optimal design of environmental policy.

This Policy Brief compares the available evidence of the estimated (ex-ante) and realized (ex-post) costs of complying with environmental regulations. Four prominent North American environmental regulations for which there is evidence of costs are profiled – the Clean Air Act, the Acid Rain program, the Montreal Protocol, and the Sulphur in Gasoline Regulations.

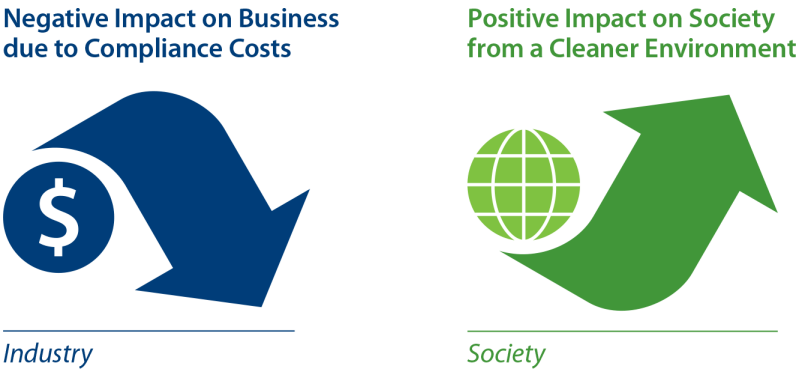
Estimating costs of compliance before a regulation is imposed, and calculating the actual costs that materialise after the regulation is in effect, is complicated. Few studies are available; few data are publicly available. This policy brief explores the available evidence of compliance costs; however, in some cases where compliance costs were not identified separately, cost-benefit calculations are presented.

The Knowledge Base

A Changing View of Environmental Regulation

A traditional view of environmental regulation frames regulation as detrimental to economic growth, due to the increased private costs imposed by complying with the regulation. This traditional view leads to a trade-off between the economy and the environment; that is, a clean environment will only be possible at the expense of economic growth (Figure 1).

Figure 1: Traditional View of Environmental Regulation



In this traditional view, those who are regulated face an extra cost of investing in new pollution-abatement technology or equipment to meet the regulation. These costs either are absorbed by the entity paying them, cutting into profits and future growth, and/or are passed on to consumers in the form of higher prices or less product selection. However, society benefits from a cleaner environment as the costs associated with pollution are decreased (for example, measured as a decreased negative impact from pollution on health.)

Those who hold this view have argued that the compliance costs of environmental regulation have been too high and have been a detriment to the economic performance of firms or sectors. Additionally, opponents of environmental regulation have argued that some environmental 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.

[2] Morgenstern, R.D. (2013). *Retrospective Analysis of Regulation.* PowerPoint, Resources for the Future. Retrieved from http://www.rff.org/Documents/Events/Workshops%20and%20Conferences/Morgenstern-presentation.pdf

However, an alternative view exists. This modern perspective of environmental regulations considers the potential economic benefits that occur from innovation, which occurs as a creative response to regulation. In this view, there are not necessarily trade-offs between the economy and the environment, or between social and private costs, 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). This view reflects the growing recognition that the economy is not a subset of the environment, nor is it separate from the environment – instead, a strong and sustainable economy is ultimately dependent on healthy ecosystems.

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. While the private costs of meeting the regulation generally occur before or at the time of implementation of the regulation, the potential decrease in costs may occur over longer time periods – for instance, as new innovations are found over time, greater efficiency in operations may result, which lowers waste, therefore lowering costs. Depending on the objective 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 a long time (as with persistent pollutants that take time to clear from the environment).

The modern view of regulation is becoming more common in economic literature. The development of the modern view can be attributed to a hypothesis proposed by the economist Michael Porter. 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 offsets the cost of regulatory compliance. (For more on the Porter Hypothesis, see the accompanying Policy Brief "Environmental Regulation and Innovation: Select Case Study Evidence of the Porter Hypothesis."

The intent of this Policy Brief is to explore how accurate estimates of compliance costs (as captured by the arrows above) made in advance of regulation have been when compared to actual costs, calculated after regulation has in fact been imposed. Given the small number of studies that examine these differences in anticipatory and retrospective compliance cost estimates, some studies that explore total costs and benefits (both social and private) are also included.

Calculating the Impacts of Environmental Regulations on Canadian Industry

Generally, there has been little study of the cost impacts of environmental regulations on the Canadian economy. No doubt this is at least partly due to the inherent difficulty of such analysis – determining, after the fact, which impacts were due to the environmental regulation and separating those impacts from other changes is hard to do, particularly when little data are collected and made publicly available. Correlation is easy to find, but causation is difficult to assess because it requires attribution of impact to various changes. However, this is true of any policy and not unique to environmental regulation.

To date, only a few empirical studies have measured the impacts of environmental regulations on Canadian industries. Some examples include studies of: the impacts of pollution charges on the Canadian brewing industry;[3] the relationship between pollution investment expenditures and productivity growth in the manufacturing sector;[4] the impact of occupational safety and health and environmental regulation on the rate of growth of total factor productivity in the Quebec manufacturing sector;[5] and the relationship between the stringency of environmental regulation and total factor productivity growth in the Quebec manufacturing sector.[6]

In general, these studies show a negative economic impact of environmental regulation to the regulated industries. 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. When regulations impose a cap on emissions, surviving firms may cut back on production, at least initially. Similarly, costs may be front-loaded while benefits accrue later. Change and disruption are part of the process. While it is difficult to determine which of these changes would have occurred in the absence of the policy, or would have occurred due to other factors, it is important to look retrospectively at both positive and negative regulatory impacts with a sufficiently long time frame and contextual information in order to best inform future policy design.

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 research paper by Smith commissioned by Sustainable Prosperity[7] surveys the literature and finds that in 2014 pollution costs Canadians: $10.5 billion in lost asset values, $1.5 billion in lost income, and $18.8 billion in out-of-pocket expenses for business and governments. Environmental regulations that reduce pollution in effect avoid or reduce some of these costs.*

[3]Smith, J.B. & Sims, W.A. (1985). The Impact of Pollution Charges on Productivity Growth in Canadian Brewing. *Rand Journal of Economics, 16 (3)*, pp. 411-423.
[4]Conrad, K. & Morrisson, C. (1989). The Impact of Pollution Abatement Investment on Productivity Change: An Empirical Comparison of the U.S., Germany and Canada. *Southern Economic Journal, 55*, pp. 684-698
[5]Dufour, C., Lanoie, P. & Patry, M. (1998). Regulation and productivity. *Journal of Productivity Analysis, 9(3),* pp. 233-247.
[6]Lanoie, P., Patry, M. & Lajeunesse, R. (2008). Environmental regulation and productivity: Testing the porter hypothesis. *Journal of Productivity Analysis, 30,* pp. 121-128.
[7]Smith, R. (2014). *Pollution in Canada: A Review of the Literature and Initial Estimate of Costs.* Sustainable Prosperity Working Paper. Retrieved from http://www.sustainableprosperity.ca/sites/default/files/publications/files/Smith%20-%20Costs%20of%20Pollution%20in%20Canada%20Feb%202014%20DRAFT.pdf

The Canadian Data Gap

Where data and analysis are available, most of it relates to American policies. There is a lack of literature and analysis of compliance costs in Canada, particularly ex-post analysis of the impacts of environmental regulations. 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.

The most easily accessible and publicly available data on the compliance costs of environmental regulation can be found through the Government of Canada's regulatory process. A Regulatory Impact Analysis Statement (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, ex-post data that measure the economic outcome of regulations after they have been implemented is not collected or estimated by the regulator(s).

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 rarely compare ex-ante and ex-post compliance costs for particular sectors of the Canadian economy. Greater data and analysis in this area would greatly enhance future policy design.

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 2012, businesses operating in Canada reported spending $10.9 billion on environmental protection, up from $8.7 billion in 2006.[8] The oil and gas extraction industry spent more than any other industry surveyed, spending $4.7 billion; the mining and quarrying industry spent $1.4 billion; and the electric power generation, transmission and distribution industry spent just over $1.3 billion (2012).[9] As a percentage of total capital expenditures, these expenses represent 4-5% for each of these three sectors.*

Overestimating the Costs of Compliance with Environmental Regulations

Prior to imposition of regulation, compliance costs are routinely estimated. In many cases, the regulated industry will prepare costs estimates; in other cases, the regulator will prepare estimates; often, both parties undertake cost estimates.

However, evidence suggests that these costs tend to be overestimated. Importantly, overestimation is found in both the estimates prepared by regulated industry and in the estimates prepared by regulators. 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.

A 2005 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

[8]Statistics Canada. (2015). Cansim table 153-0052. Retrieved from http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=1530052&pattern=153-0052..153-0056&tabMode=dataTable&srchLan=-1&p1=-1&p2=31

[9]Statistics Canada. (2015). *Environmental protection expenditures by businesses, 2012*. Retrieved from http://www.statcan.gc.ca/daily-quotidien/150429/dq150429d-eng.htm

public projects, such as waste water treatment plants, tend to be underestimated, whereas costs of compliance for private companies might be overestimated."[10]

Reporting Estimates of Compliance Costs

A recent study[11] 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. On the other hand, corporations anticipating beneficial regulations—the ethanol companies planning on mandates for their product—present a more consistent and cautiously optimistic forecast in both fora."

In the next section we share the findings of some studies that review cost estimates (and generally find overestimation). Following that, we profile the four case studies mentioned earlier.

Summary Analyses

A number of studies provide evidence on the practice of overestimates. For example, a study of emission reduction regulations from the Economic Policy Institute, an American economic think tank, found a significant difference between the perceived and actual compliance costs of regulation, noting "a clear pattern of overestimation."[12] This study reviewed 12 regulations and found that in all but one case, the initial compliance cost estimate was at least double the realized costs, and often significantly larger, as shown in Figure 3.

Figure 3: The Estimated and Actual Costs of Emissions Reduction Regulations in the U.S.

Pollutant	Ex-Ante Estimate	Ex-Post or Revised Ex-Ante Estimate	Overestimation as a Percent of Actual Cost
Asbestos	$150 million (total for manufacturing and insulation sectors)	$75 million	-
Benzene	$350,000 per plant	approx. $0 per plant	-
Chlorofluorocarbons (CFCs)	1988 estimate to reduce emissions by 50% within 10 years; $2.7 billion	1992 estimate to phase out CFCs within 8 years: $ 3.8 billion	41%
CFCs-Auto Air Conditioners	$650-$1,200 per new car	$40-$400 per new car	63%-2,900%
Coke Oven Emissions OSHA 1970s	$200 million - $1 billion	$160 million	29%-525%
Coke Oven	$4 billion	$250-400 million	900%-1,500%

[10][Cite European 2005 study here]
[11]Coleman, James (forthcoming) "How Cheap is Corporate Talk?" Harvard Environmental Law Review.
[12]Hodges, H. (1997). *Falling prices: Cost of complying with environmental regulations almost always less than advertised.* Briefing Paper, Economic Policy Institute. Retrieved from http://s1.epi.org/files/page/-/old/briefingpapers/bp69.pdf

Emissions EPA 1980s			
Cotton Dust	$700 million per year	$205 million per year	241%
Halons	1989: phase out not considered possible	1993: phase out considered technologically and economically feasible	-
Landfill Leachate	mid-1980s: $14.8 billion	1990: $5.7 billion	159%
Sulphur Dioxide	$4 billion-$5 billion	-	100%-300%
Surface Mining	$6-$12 per ton of coal	$0.50-$1 per ton	500%-2,300%
Vinyl Chloride	$109 million per year	$20 million per year	445%

Table reproduced from Hodges, H. (1997). *Falling prices: Cost of complying with environmental regulations almost always less than advertised*. Briefing Paper, Economic Policy Institute. Retrieved from http://s1.epi.org/files/page/-/old/briefingpapers/bp69.pdf Empty cells in the table are from the original author.

The evidence of this tendency to overestimate is mounting.

- The National Center for Environmental Economics reports that existing studies of EPA (Environmental Protection Agency) regulations find that compliance cost overestimates are more common than underestimates.[13]
- Another study by Resources for the Future compared the EPA's pre-regulatory estimates of the total costs[14] of individual regulations to the actual costs after the regulations were implemented.[15] Overall, they found that EPA and other regulatory agencies tend to overestimate the total costs of regulations. "Of the rules initially examined, 14 projected inflated total costs, while pre-regulation estimates were too low for only 3 rules. These exaggerated adjustment costs are often attributable to underestimates of the potential that technological change could minimize pollution abatement costs."
- Similarly, a study summarizing the European and US 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.[16] 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."
- Another study of 25 environmental regulations (mainly US federal regulations) finds that initial estimates of total direct costs[17] have tended to exceed the actual costs when calculated ex-

[13]National Center for Environmental Economics. (2012). *Retrospective Study of the Costs of EPA Regulations: An Interim Report of Five Case Studies.* Retrieved from http://yosemite.epa.gov/EE%5Cepa%5Ceed.nsf/webpages/RetroCost.html/$file/retro-cost-3-30-12.pdf

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

[15]Harrington, W., Morgenstern, R., & Nelson, P. (2010). *How Accurate Are Regulatory Cost Estimates?* Policy Brief, Resources for the Future. Retrieved from https://grist.files.wordpress.com/2010/10/harringtonmorgensternnelson_regulatory_estimates.pdf

[16]Ackerman. F. (2005). The Unbearable Lightness of Regulatory Costs. *Fordham Urban Law Journal,* 33 (4). Retrieved from http://ir.lawnet.fordham.edu/cgi/viewcontent.cgi?article=2201&context=ulj

[17]Direct costs here are defined as defined as public and private compliance costs.

post.[18] The authors looked at cost of compliance per unit of pollution reduced and found that in the 25 regulations, initial estimates were too high in 12 cases, accurate in seven cases, and too low in just six cases. The authors note "much of the overestimation can be attributed to technical innovations unanticipated at the time the rule is issued" (in addition to methodological errors and inaccurate estimates of how much emissions would decline).

- As noted earlier, Canadian analysis is harder to find; however, a study for Environment Canada and the Ontario Ministry of Energy, Science and Technology, focusing specifically on the costs of controlling chlorinated substances, confirmed that overestimation of regulatory costs is more common than underestimation.[19]

Total Costs and Benefits

Looking more broadly at total costs and benefits of environmental regulation, a 2014 report to the U.S. Congress from the White House found that the benefits have greatly exceeded the costs for 34 major rules introduced by the EPA between 2003 and 2013.[20] The estimated 2010 annual costs of these regulations were between $38.2 and $46.1 billion, while benefits were estimated to be between $164.8 billion and $849.5 billion per year (US$ 2010.)

While these studies look at different jurisdictions, different time periods, different metrics for costs/compliance costs, and differing sets of regulations, they all point to a consistent trend of initial estimates overestimating costs.

What about climate change regulations? *Cost-benefit analyses of climate change mitigation policies/regulations often consider the social benefits of regulation, as measured in avoided social cost of carbon. The social cost of carbon is calculated as the value of climate change damages for current and future generations resulting from greenhouse gas (GHG) emissions' climate change impact on agricultural productivity, human health, property damages from increased flood risk, and changes in energy system costs.*

In June 2015, the U.S. EPA updated its central social cost of carbon estimate for 2015 to $36/tonne (2007 USD).[21] In Canada's most recent GHG-related regulations, policy makers used a value of $29.38/tonne of carbon dioxide in 2013.[22] Recent research efforts report that the social costs of carbon are likely higher than originally assumed, and are estimated at $220 per tonne.[23]

While carbon dioxide is the most prevalent greenhouse gas, other gases, such as methane and nitrous oxide, have larger climate impacts and thus have higher social costs -- For the year 2020 they are estimated to be $1,200 (2007$USD/tonne) for methane and $15,000 (2007$USD/tonne) for nitrous oxide.[24]

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[18]Harrington, W., Morgenstern, R.D., & Nelson, P. (1999). *On the Accuracy of Regulatory Cost Estimates*. Discussion Paper, Resources for the Future. Retrieved from http://www.rff.org/files/sharepoint/WorkImages/Download/RFF-DP-99-18.pdf

[19]Cheminfo Services. (2000). *A retrospective evaluation of control measures for chlorinated substances*. Cited in Ackerman. F. (2005).The Unbearable Lightness of Regulatory Costs. *Fordham Urban Law Journal,* 33 (4). Retrieved from http://ir.lawnet.fordham.edu/cgi/viewcontent.cgi?article=2201&context=ulj (Unfortunately, the Cheminfo report is not publicly available so we are unable to present more detail on the study's findings.)

[20]Office of Management and Budget. (2014). *Draft Report to Congress on the Benefits and Costs of Federal Regulations and Unfunded Mandates on State, Local, and Tribal Entities*. Retrieved from http://www.whitehouse.gov/sites/default/files/omb/inforeg/2014_cb/draft_2014_cost_benefit_report-updated.pdf

[21]Interagency Working Group on Social Cost of Carbon, United States Government. (2015). *Technical Support Document: -Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis -Under Executive Order 12866.* Retrieved from https://www.whitehouse.gov/sites/default/files/omb/inforeg/scc-tsd-final-july-2015.pdf

[22] Canada Gazette. (2014). *Regulations Amending the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations*. Retrieved from http://www.gazette.gc.ca/rp-pr/p2/2014/2014-10-08/html/sor-dors207-eng.php

[23] Moore, F. C. & Diaz, D.B. (2015). Temperature impacts on economic growth warrant stringent mitigation policy. *Nature Climate Change*, 5, pp. 127–131.

[24]Marten, A., Kopits, E., Griffiths, C., Newbold, S., & Wolverton, A. (2015). Incremental CH4 and N2O mitigation benefits consistent with the US Government's SC-CO2 estimates. *Climate Policy*, 15 (2), pp. 272-298, DOI: 10.1080/14693062.2014.912981.

Case Study Results

In addition to the summary studies presented above, it is helpful to explore, via case study, some specific examples of compliance cost estimates. Because there is a lack of research on the implications of environmental regulations after their implementation, the four case studies explored in this section were chosen largely because they are the rare exceptions where information regarding the costs of implementation is publicly available.

Case 1: 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[25]
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.)[26]

Prior to implementation of the US 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."[27]

Overestimating Costs

30:1

The ratio of benefits to costs for the 1990 amendments to the US Clean Air Act.

$4000

Dollar value of the cleaner air benefits of these regulations to each affected child's life-time income from less pollution, fewer sick days, more education and more income.

[25]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.
[26]U.S. Environmental Protection Agency, Office of Air and Radiation. (2011). *The Benefits and Costs of the Clean Air Act from 1990 to 2020.* Retrieved from http://www.epa.gov/air/sect812/feb11/fullreport_rev_a.pdf
[27]Rogers, P. G. (1990). *EPA History: The Clean Air Act of 1970.* Retrieved from http://www2.epa.gov/aboutepa/epa-history-clean-air-act-1970

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.[28] The public and private costs to meet amendments made to the Act in 1990 are estimated to reach an annual value of $65 billion by 2020.[29] In contrast, reductions in air pollution will lead to benefits such as reducing premature death and illness, improving the welfare of Americans, and enhancing environmental conditions, all of which are estimated to reach an annual value of almost $2 trillion in 2020 (Figure 5).[30,31]

These findings are confirmed in similar studies.[32] 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.[33] Another earlier peer-reviewed EPA study` examined the benefits and costs of the Act's programs from 1970 to 1990, and found that the public health protection and environmental benefits exceeded the costs by a large margin.[34] 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%."[35]

Despite these studies, some remain sceptical of the EPA's estimates and proclaim that the costs still outweigh the benefits.[36,37]

Case 2: United States 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

[28] Isen, A., Rossin-Slater, M., & Walker, W. R. (2014). *Every Breath You Take - Every Dollar You'll Make: The Long-Term Consequences of the Clean Air Act of 1970*. National Bureau of Economic Research Working Paper No. 19858. Retrieved from http://www.nber.org/papers/w19858
[29] U.S. Environmental Protection Agency. (2011). *The Benefits and Costs of the Clean Air Act from 1990 to 2020.* Retrieved from http://www.epa.gov/cleanairactbenefits/feb11/summaryreport.pdf
[30] ibid
[31] In fact, the regulations have coincided with a time when the US economy has grown; between 1970 and 2013, aggregate emissions of common air pollutants dropped 68%, while US GDP grew 234%.[31] See U.S. Environmental Protection Agency. (2014). *Air Quality Trends.* Retrieved from http://www.epa.gov/airtrends/images/y70_13.png
[32] Early research on the new Clean Power Plan, announced under the Clean Air Act in August 2015, shows similar estimates of a positive benefit-cost ratio. The plan establishes state-level targets that collectively would cut national electricity sector CO_2 emissions 30 percent below 2005 levels by 2030. An EPA analysis of the draft standards found that the combined climate and health benefits will far outweigh the costs and that it will deliver tens of billions of dollars in net benefits each year – from $27 billion to $50 billion in 2020, to $46 to $84 billion in 2030. However, many continue to challenge these estimates.
[33] Small Business Majority and Main Street Alliance. (2010). *The Clean Air Act's Economic Benefits Past, Present and Future.* Retrieved from http://www.smallbusinessmajority.org/pdf/Benefits_of_CAA_100410.pdf
[34] U.S. Environmental Protection Agency. (1997*). The Benefits and Costs of the CAA, 1970 to 1990*. Retrieved from http://www.epa.gov/air/sect812/retro.html
[35] Small Business Majority and Main Street Alliance. (2010). *The Clean Air Act's Economic Benefits Past, Present and Future.* Retrieved from http://www.smallbusinessmajority.org/pdf/Benefits_of_CAA_100410.pdf
[36] Katz, D. (2011). *Coming Clean on Regulatory Costs and Benefits.* Retrieved from http://www.heritage.org/research/reports/2011/03/coming-clean-on-regulatory-costs-and-benefits
[37] Thorning, M. (2011, Oct. 24). The high price of EPA regulations. [Blog]. Retrieved from http://thehill.com/blogs/congress-blog/energy-a-environment/189321-the-high-price-of-epa-regulations

Initial Compliance Cost (SO_2)	Costs of $2.4 to 5 billion per year
Revised Compliance Cost Estimate (SO_2)	Costs of $836 million per year
Estimated Benefits	$100 billion per year in health benefits[38]

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 interesting example of how compliance cost estimates can vary. Phase 1 of the regulation required a 10Mt 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). The US Energy Information Administration (EIA) calculated the annualized costs of achieving compliance with Phase 1 at just $836 million.[39]

Another study shows similar results – early estimates of annual costs were predicted to be several billion but 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.[40] As noted in the companion Policy Brief to this one, Popp found that the introduction of the tradable permits market encouraged innovation, and in particular, innovation that sought to improve environmental outcomes.[41]

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.[42] However, these claims proved to be an over-estimation, as national electricity rates actually declined by an average of 19% between 1990 and 2006.[43]

Because this emissions trading system involves a market, the market price is a telling factor in total compliance costs.[44] 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

[38]In 2005, the health benefits of reductions in fine particle air pollution were estimated to reach over $100 billion annually by 2010. Chestnut, L.G. & Mills, D.M. (2005). A fresh look at the benefits and costs of the US acid rain program. *Journal of Environmental Management, 77*, pp. 252–266.

[39]Small Business Majority and Main Street Alliance. (2010). *The Clean Air Act's Economic Benefits Past, Present and Future.* Retrieved from http://www.smallbusinessmajority.org/pdf/Benefits_of_CAA_100410.pdf

[40]Ellerman, D.A. (2003). *Ex-post Evaluation of Tradable Permits: The U.S. SO^2 Cap-and-Trade Program*. Center for Energy and Environmental Policy Research. Retrieved from http://web.mit.edu/ceepr/www/publications/workingpapers/2003-003.pdf

[41]See "Environmental Regulation and Innovation: Select Case Study Evidence of the Porter Hypothesis" by Sustainable Prosperity, available at http://www.sustainableprosperity.ca/content/environmental-regulation-and-innovation-select-case-study-evidence-porter-hypothesis.

[42]As cited in Weiss. D. J. & Kong, N. (2008). *Fool Me Twice, Shame on Me Learning from History on Electricity Rate Data.* Centre for American Progress. Retrieved from https://www.americanprogress.org/issues/green/news/2008/04/15/4263/fool-me-twice-shame-on-me/#_edn1

[43]ibid

[44]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.

under $150 per ton.[45] The cost savings from the cap and trade approach are estimated to be about 55% of the total compliance costs under a command-and-control approach.[46] Technology-prescriptive regulations, such as a mandatory requirement to install "scrubbers" to remove pollution from industrial processes, were considered, but could have cost substantially more than the cap and trade system.[47] However, more recent research finds that the least-cost options to reduce emissions were not necessarily taken advantage of (largely due to regulatory barriers),[48] and that the savings from cap and trade appear to be less than previously anticipated.[49]

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 trans-boundary pollution. [50] The latest progress report states that both sides have reached significant reductions of SO_2, with the U.S. and Canada reducing emissions by 67% and 57% respectively in 2010 over 1990 levels.[51] Despite this agreement, information regarding the costs and benefits of SO_2 reductions in Canada is harder to find.

Case 3: 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

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.[52]

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[45] Ackerman, F. & Massey, R. (2002). *Prospering with precaution: Employment, Economics, and the Precautionary Principle.* Retrieved from http://www.ase.tufts.edu/gdae/policy_research/PrecautionAHTAug02.pdf

[46] Ellerman, A.D., Joskow, P. L., Schmalensee, R., Montero, J-P., & Bailey, E. (2000). *Markets for Clean Air: The U.S. Acid Rain Program*. Cambridge: Cambridge University Press.

[47] Burtraw, D. & Palmer, K. (2003). *The Paparazzi Take a Look at a Living Legend: The SO^2 Cap-and-Trade Program for Power Plants in the United States.* Resources for the Future Discussion paper. Retrieved from http://www.rff.org/Documents/RFF-DP-03-15.pdf

[48] Chan et al cite these reasons: (1) utilities subject to regulation by public utilities commissions could pass compliance costs on to ratepayers and had little incentive to minimize costs; (2) the fact that utilities commissions allowed scrubbers to enter the rate base and thus earn a normal rate of return provided incentives to scrub rather than substitute low- for high-sulfur coal, (3) uncertainty about the treatment of allowances in the rate base provided incentives to fuel switch rather than purchase allowances, and (4) the least-cost options for fuel switching were also prevented by regulators who encouraged the purchase of in-state coal or by long-term coal contracts that might be difficult to break.

[49] Chan, R., Chupp, A.B., Cropper, M.L., & Muller, N.Z. (2015). *The market for sulfur dioxide allowances: What have we learned from the grand policy experiment.* National Bureau of Economic Research. Retrieved from http://www.nber.org/papers/w21383.pdf

[50] Environment Canada. (2015). *Canada-United States Air Quality Agreement.* Retrieved from https://www.ec.gc.ca/air/default.asp?lang=En&n=83930AC3-1

[51] Environment Canada. (2013). *Canada-United States Air Quality Agreement Progress Report 2012.* Retrieved from https://ec.gc.ca/air/default.asp?lang=En&n=8ABC14B4-1&offset=2&toc=show

[52] Oosterhuis, F. (Ed.). (2006). *Ex-post estimates of costs to business of EU environmental policies: A case study looking at Ozone Depleting Substances.* Policy Studies Institute final report. Retrieved from http://ec.europa.eu/environment/enveco/ex_post/pdf/costs.pdf

In initial analyses of the effort to phase out chlorofluorocarbons (CFCs), the primary contributors to ozone layer depletion, research found limited potential for substitution and high costs.[53] While industry initially resisted the regulations, this resistance subsided through technological innovation that allowed for the development of substitutes and alternative processes to be achieved at a lower cost than anticipated.[54] 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.[55]

While the costs of the regulation were initially seen as a challenge to industry, the Protocol is proving successful. A recently released 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).[56] Further, a report published this year 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.[57]

Case 4: Canadian Sulphur in Gasoline Regulations

Regulation Name	Sulphur in Gasoline Regulations
Description	Canadian federal regulation on sulphur in gasoline, administered by Environment Canada
Coverage	The regulations limit the amount of sulphur in gasoline produced, imported or sold
Initial Compliance Cost Estimate	$1.8 billion in capital expenditures and $119 million per year in operating costs
Revised Cost Estimate	Not available
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. Today, the regulations limit 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 limit sulphur to 15mg/kg.[58]

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

[53] See Palmer et al., 1980; Mooz et al., 1982; Wolf, 1980 in Rand Corporation studies from http://onlinelibrary.wiley.com/doi/10.1002/eet.257/epdf
[54] ibid
[55] International Chemical Secretariat. (2015). *Cry Wolf: Predicted costs by industry in the face of new environmental regulations*. Retrieved from http://www.chemsec.org/images/stories/publications/2015_Cry_Wolf.pdf
[56] World Meteorological Organization. (2014). *Assessment for Decision-Makers: Scientific Assessment of Ozone Depletion.* Global Ozone Research and Monitoring Project—Report No. 56. Retrieved from https://www.wmo.int/pages/prog/arep/gaw/ozone_2014/documents/ADM_2014OzoneAssessment_Final.pdf
[57] U.S. Environmental Protection Agency. (2015). *Updating ozone calculations and emissions profiles for use in the atmospheric and health effects framework model.* Retrieved from http://www.epa.gov/ozone/science/effects/AHEF_2015_Update_Report-FINAL_508.pdf
[58] Environment Canada. (2015). *Current Regulation.* Retrieved from http://www.ec.gc.ca/lcpe-cepa/eng/regulations/detailreg.cfm?intReg=63

competitiveness would be too onerous for Canada, favouring instead that Canada match existing American regulations.[59]

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.[60] An analysis undertaken in 2004 found similar estimates -- total capital costs would be just under $2 billion and total operating costs would be $164 million per year.[61]

Amendments to the regulations came into force in July 2015; these amendments included lower limits on the sulphur content of gasoline to align with the U.S. EPA Tier 3 fuel standards, which were approved in 2014, reducing the average sulphur content of gasoline 10 parts per million, starting in 2017.[62] 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 SiGR Amendments is estimated to be about $1.04 billion"[63] 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.[64]

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[65] or roughly ten times what the EPA calculated the cost to be in its own assessment.[66] A closer review of the API's study reveals that the costs API cites have been overinflated.[67] One paper summarizes this trend as " 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."[68]

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[59] By the time the regulations were finalized the Canadian Petroleum Products Institute accepted the final goals.

[60] Sulphur in Gasoline Regulations. (1999). *Canada Gazette Part II, 133(13).* Retrieved from http://publications.gc.ca/gazette/archives/p2/1999/1999-06-23/pdf/g2-13313.pdf

[61] Purvin & Gertz. (2004). *Economic and environmental impacts of removing sulphur from Canadian gasoline and distillate production*. Retrieved from http://canadianfuels.ca/userfiles/file/desulphurization.pdf

[62] Government of Canada. (2014). Government *of Canada Takes Further Action to Reduce Greenhouse Gases (GHGs) and Air Pollution from Cars and Trucks*. Retrieved from http://news.gc.ca/web/article-en.do?nid=886509

[63] [write out source] http://www.gazette.gc.ca/rp-pr/p1/2014/2014-09-27/pdf/g1-14839.pdf

[64] Government of Canada. (2014). Government *of Canada Takes Further Action to Reduce Greenhouse Gases (GHGs) and Air Pollution from Cars and Trucks*. Retrieved from http://news.gc.ca/web/article-en.do?nid=886509

[65] American Petroleum Institute. (2013). *EPA's Tier 3 proposal latest in tsunami of regulations that could raise gasoline manufacturing costs.* Retrieved from http://www.api.org/news-and-media/news/newsitems/2013/march-2013/api-epas-tier3-proposal-latest-in-tsunami-of-regulations-that-could-raise-gasoline-costs

[66] U.S. Environmental Protection Agency. (2013).*Draft Regulatory Impact Analysis: Tier 3 Motor Vehicle Emission and Fuel Standards*. Retrieved from http://www.epa.gov/otaq/documents/tier3/420d13002.pdf

[67] Stevenson, A. (2013). *Oil Industry Inflates Cleaner Gasoline Cost Claims with Windfall Profits*. [Natural Resources Defense Council Blog]. Retrieved from http://switchboard.nrdc.org/blogs/astevenson/oil_industry_inflates_cleaner.html

[68] Purvin & Gertz. (1997). *Review of the U.S. experience with fuel reformulation*, Phase II report, p. VI-1. As cited in Environment Canada. (2001). *Reducing the level of sulphur in Canadian on-road diesel fuel: A Discussion Paper on Designing Canadian Regulations to Align with the New U.S. Standard*. Appendix B. Retrieved from http://www.ec.gc.ca/lcpe-cepa/documents/consultations/diesel/sulphur_reduction-eng.pdf?file=.pdf

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.[69]

Discussion

Comparing prospective and retrospective costs of regulation is challenging; it is difficult to determine what would have happened in the absence of the regulation, through the normal course of business or due to unexpected factors. Costs are defined, measured and interpreted differently across different studies as well. 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 orders of magnitude larger than retrospective calculations of compliance costs.

Researchers have proposed **reasons for why overestimations exist**, including:

- Regulatory analyses often do not consider the cost-cutting innovative measures that firms take to comply with regulations.[70] (See the companion Policy Brief "Environmental Regulation and Innovation: Select Case Study Evidence of the Porter Hypothesis" for more on this point.)
- Cost data is difficult for regulators to retrieve, and regulators rely on data that is often voluntarily supplied by industry. The regulated industry has an incentive to discourage strict regulation by either inflating cost estimates or keeping costs secret.[71]
- Often cost analyses for a proposed regulation are compared to a baseline without the regulation. These baselines may be hard to measure, and some regulators set the baseline at zero, assuming no action would have been taken without the regulation. Ignoring the baseline and any costs from voluntary action without the regulation would lead to an overestimate of the compliance costs.[72]
- It may be difficult for regulators to separate reported compliance costs from other capital, operating, and maintenance expenses of firms.[73]
- 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.[74]

[69] Blumberg, K. O., Walsh, M. P., & Pera, C. (2003). *Low Sulphur gasoline and Diesel: The key to lower vehicle emissions.* Retrieved from http://www.unep.org/transport/pcfv/PDF/PubLowSulfurPaper.pdf

[70] ibid

[71] McGarity, T. O. & Ruttenberg, R. (2002). Counting the Cost of Health, Safety and Environmental Regulation. *Texas Law Review*, 80 (7), pp. 1997-2058. It has also been suggested by other sources that regulatory capture may exist, in which regulatory agencies lose some degree of impartiality and may advance the interests of the sector they are regulating.

[72] ibid

[73] ibid

[74] National Center for Environmental Economics. (2012). *Retrospective Study of the Costs of EPA Regulations: An Interim Report of Five Case Studies.* Retrieved from http://yosemite.epa.gov/EE%5Cepa%5Ceed.nsf/webpages/RetroCost.html/$file/retro-cost-3-30-12.pdf

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 mass production. Similarly, often costs are calculated for new, prototype technologies.[75]

- The policy ultimately adopted is not necessarily the same as the one for which the costs were estimated. Also, the implementation of the policy might be incomplete. Moreover, the way in which the policy or legislation is implemented and the instruments chosen (e.g. market-based instruments versus direct regulation) strongly affect the ex post costs.[76]

One aspect of compliance costs that this paper has not addressed relates to the incidence of the compliance costs – i.e., who ultimately pays the costs. In some cases, these costs may be passed on to consumers; in other cases, it may be the producers of the regulated good/service who do indeed absorb the costs. Similarly, 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. However, where it is expected that environmental regulations may have a negative impact – particularly on specific firms, sectors or regions -- research has been conducted to determine the ways policy can address these uneven impacts. For example, a 2015 report from Canada's Ecofiscal Commission[77] examines measures that could be taken to address competitiveness concerns in Canada with regards to carbon pricing regulations. These measures include policy design features such as border adjustments, full or partial rebates in a cap and trade system, and exemptions for certain sectors that may be hardest hit.

Are pricing-based policies an opportunity to better understand compliance costs?
As more pricing-based policies such as cap and trade regimes and other forms of environmental markets[78] are introduced, they will provide an opportunity to understand one key aspect of compliance costs – the permit cost. Compliance costs include not just permit costs -- but also lost opportunity to earn revenue if output decreases, costs of technology adoption or changes in processes, or administrative costs – but the cost of obtaining permits is an important component of total compliance costs. In larger markets with allocation of permits by auction 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.

The most important take away from this analysis is that policy-makers should read compliance cost estimates with a dose of healthy scepticism. Any analysis requires the use of assumptions and base case estimates; compliance cost estimates are no different, but these limitations are compounded by the factors listed above (key among them being our inability to anticipate firms' creativity and innovation to meet regulatory standards coupled with our tendency to err on the side of caution in creating cost estimates.)

Are we underestimating our productivity growth in times of increasing environmental regulation?
A small but growing number of studies have explored the ways in which productivity metrics may be failing to tell a complete story of a nation or sector's performance in times of new or more stringent environmental regulations. Adjusting metrics of productivity to incorporate changes in pollution or natural capital use can provide another layer of understanding to environmental and economic perspectives. For instance, Conrad and Morrison[79] look at a period when environmental regulations were minimal (1960-67), and find that conventional productivity growth measures were approximately the same as an estimate of productivity inclusive of environmental inputs. However, for a period

[75] Institute for Environmental Studies. (2005). *Literature Review on ex-post assessment of costs to business of environmental policies and legislation*. Retrieved from http://ec.europa.eu/environment/enveco/ex_post/pdf/literature.pdf
[76] ibid
[77] Canada's Ecofiscal Commission. (2015). *The Way Forward: A Practical Approach to Reducing Canada's Greenhouse Gas Emissions*. Retrieved from https://www.documentcloud.org/documents/1717118-ecofiscal-commission-report-the-way-forward.html
[78] See "Environmental Markets 2014" by Sustainable Prosperity for more on different types of environmental markets and how they work.
[79] Conrad, K. and C.J. Morrison, (1989), "The Impact of Pollution Abatement Investment on Productivity Change: An Empirical Comparison of the U.S., Germany, and Canada," Southern Economic Journal, 55(3): 684-698.

during which many environmental regulations were introduced (1972-80, which coincides with many of the regulations under the Clean Air Act, among others), the conventional measure understated the environment-adjusted measure (annual average rates of 2.2 and 2.4 percent, respectively). This is because traditional productivity metrics capture the costs of compliance (via increased input costs) but fail to capture the benefits from improved environmental outcomes.[80]

Implications for Policy Makers

- There is growing evidence that the costs of environmental regulations are overestimated – most often by at least double, and often by a factor of 10. There is also evidence that the resulting benefits of the regulations on the environment, human health, and the economy are underestimated and far outweigh both prospective and retrospective cost estimates. The case studies examined in this Policy Brief, including the Clean Air Act, the Acid Rain program, the Montreal Protocol and the Sulphur in Gasoline Regulations provide evidence of these trends.
- There is a lack of research regarding the costs of regulations (both prospective and retrospective analysis) 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.
- Policy makers can anticipate that initial cost estimates of the impacts of environmental regulations will be high, given the tendency of firms and industries to overestimate costs. However, further ex-post analysis would help to identify how great the overestimates are, and to determine how any potential cost savings resulting from innovations induced by the regulation could offset the cost estimates.
- This discussion regarding the costs of environmental regulation is timely. Climate policy is gaining attention both in Canada and around the world in the lead-up to international climate negotiations later this year. The reoccurring examples of incorrect cost estimates are unfortunate for policy makers tasked with designing regulations to address climate change. The international nature of the climate change challenge will inherently require all nations to contribute their share of emissions reductions strategies. These national policies will likely require increased regulations on industries that emit a high proportion of greenhouse gas emissions, and national policy makers will benefit from accurate cost estimates to design their own national policies to support international targets.

[80] For more on the ways in which the environment is and is not captured in productivity metrics, and on how new complementary metrics can be created, please see www.sustainableprosperity.ca/nkp.