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Canadian Cost-Benefit Analysis Guide

Regulatory Proposals

Canada

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I. Introduction

The *Canadian Cost-Benefit Analysis Guide* is provided for the use of federal departments and agencies as they perform cost-benefit analysis to support regulatory decisions. The guide incorporates the evolution of regulatory policy and developments in the analysis of the impacts of regulations in Canada and elsewhere over the past decade. In November 1999, the Government of Canada instituted the policy that a cost-benefit analysis must be carried out for all significant regulatory proposals to assess their potential impacts on the environment, workers, businesses, consumers, and other sectors of society.[1] Regulatory authorities must make a convincing case that the regulatory approach recommended is superior to non-regulatory alternatives. They must demonstrate not only that the benefits to Canadians outweigh the costs, but also that they have structured the regulatory program so that the excess of benefits over costs is maximized.

In April 2007, the *Cabinet Directive on Streamlining Regulation* replaced the 1999 *Government of Canada Regulatory Policy*.[2] One of the key requirements of this new directive is that departments and agencies assess regulatory and non-regulatory options to maximize net benefits to society as a whole. Hence, all regulatory departments and agencies are expected to show that the recommended option maximizes the net economic, environmental, and social benefits to Canadians, business, and government over time more than any other type of regulatory or non-regulatory action. Instrument choice is thus essential to the regulatory process. Departments and agencies are also expected to show how the costs and benefits are distributed across the various affected parties, sectors of the economy, and regions of Canada. As a best practice, departments and agencies are expected to prepare an accounting statement. The purpose of this guide is to provide guidance to departments and agencies on how to conduct a sound cost-benefit analysis.

Other countries and international communities such as the United States, Australia, the European Commission, etc. have also come to recommend that a cost-benefit analysis be the centre of regulatory analysis. A cost-benefit analysis has become one of the key analytical tools employed to assist in making this determination before approval is given for any significant new regulation.

Such an analysis highlights the importance of identifying and measuring the economic benefits and costs as an essential input into the design process of such regulatory actions. Increased government interest in the consequences of regulating has led to the development of various cost-benefit analysis guides in countries such as the United States and Australia; some international organizations have also developed guides on the subject.[3]

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1. Government of Canada, Privy Council Office, *Government of Canada Regulatory Policy*, November 1999.
2. Government of Canada, *Cabinet Directive on Streamlining Regulation*, April 2007. There are generally around 350 federal regulations developed in Canada each year. Only proposals with impacts judged to be of medium and high significance will require a rigorous cost-benefit analysis. See Canada, Privy Council Office, *Framework for the Triage of Regulatory Submissions*, May 2006.
3. In the United States, guides were published by the Environmental Protection Agency (*Guidelines for Preparing Economic Analyses*, September 2000) and the Office of Management and Budget (Circular A-4, September 2003). In Australia, the Office of Regulation Review released *A Guide to Regulation*, second edition, December 1998. International organizations have released the following documents: the Organisation for Economic Co-operation and Development (OECD), *Regulatory Impact Analysis (RIA) Inventory*, April 2004; OECD, *Cost-Benefit Analysis and Environment: Recent Developments*, 2005; and the European Commission, *Impact Assessment Guidelines*, June 15, 2005.

The cost-benefit analysis should be guided by the principle of proportionality. In other words, the effort to do the cost-benefit analysis should be commensurate with the level of expected impacts on Canadians. For further details, see the *Framework for the Triage of Regulatory Submissions*.[4]

In Canada, a guide was first published in 1995.[5] The 1995 guide required updating to reflect the changes in the economy, new regulatory policies, and advances in analytical methods. This guide is designed to outline in brief the analytical methodologies, empirical techniques, and practical approaches to performing analyses of regulatory policies. Efficiency is not the sole criterion for decision making of a regulatory policy. The stakeholder analysis of who gains or loses as a result of a regulation can be critical to decision making; it is therefore included as part of the overall impact analysis in this guide. This guide will assist regulatory officials in employing techniques developed elsewhere to produce consistent high-quality cost-benefit analyses of proposed and existing regulations.

II. The Need for Government Intervention

The *Cabinet Directive on Streamlining Regulation* notes that, "Regulation is an important tool for protecting the health and safety of Canadians, preserving the environment, and securing the conditions for an innovative and prosperous economy." In a perfectly competitive market, the outputs of the goods and services of the economy and the set of prices for these outputs are determined in the marketplace in accordance with consumers' preferences and incomes, as well as producers' minimization of cost for a given output. In this market, the outcome is efficient and social welfare is maximized. However, in some situations, markets fail to achieve such efficient outcomes. *Market failure* refers to situations in which the conditions required to achieve the market-efficient outcome are not present. Market failure is an important reason for the need for government intervention. Common examples of market failure are the existence of significant externalities, the exercise of market power by a small number of producers or buyers, natural monopolies, and informational asymmetry between producers and their customers.[6]

For example, many motorists are not aware of the environmental consequences of the pollutants emitted by their automobiles, nor do they bear a significant amount of the externalities of the environmental costs that they create by using a motor vehicle. Similarly, many consumers may not be aware of the longer-term effects of the improper use of pesticides on their health, or the health of others, nor do they personally bear a significant share of the medical expenditures that may be imposed on provincial governments by the illness created. When negative externalities exist, part of the cost to society is not recognized by private decision makers. In such situations, it is important for the government to put in place regulatory policies or market-based instruments to restrict the behaviour that leads to such negative externalities or social welfare losses so that Canadians as a whole will be better off.

4. Government of Canada, Privy Council Office, *Framework for the Triage of Regulatory Submissions*, May 2006.
5. Government of Canada, Treasury Board of Canada Secretariat, *Benefit-Cost Analysis Guide for Regulatory Programs*, August 1995.
6. See e.g. the Office of Management and Budget, Circular A-4, September 2003; OECD, *Cost-Benefit Analysis and Environment: Recent Developments*, 2005.

Regulatory actions are instruments of command and control that address particular problems in society. An advantage to this approach is the relative ease with which governments can be seen to undertake actions to address the problem. At the same time, command and control actions may not be as cost-effective as other policy tools such as market-oriented approaches. Many of the costs of regulations are hidden from public scrutiny because the compliance costs are often imposed on the private sector and are buried in the normal costs of doing business.

Regulations may also deaden innovation by not providing market-based incentives to encourage technological advances to reduce pollution, safety, or security beyond what is required by the regulations. Thus, market-oriented approaches or performance-based standards are alternatives that have the potential to achieve the same goals in perhaps a more efficient and cost-effective manner. Both regulatory and non-regulatory approaches, however, create compliance costs that the private sector must bear and will impose additional administrative costs on governments, as they will need to monitor and/or enforce these policies.

Any new regulations or review of existing regulations requires a proper assessment to ensure they will not impose excessive burdens on Canadian businesses that would reduce their international competitiveness. While it is important to protect the environment and safeguard the health and safety of Canadians, regulatory actions need to be carried out in a way that allows for private-sector innovation to take place.

In order to minimize the negative impacts of regulations, and enhance their effectiveness, it is important that all relevant information about how they will affect Canadians is obtained before they are implemented. This will require extensive consultation with all Canadian stakeholders that will be impacted by the proposed regulation. It is primarily through these consultations that the impacts will be best understood.

III. Impact Analysis

This guide presents an analytical framework and steps to facilitate a disciplined approach to assessing the regulatory policy and its alternative options so that informed recommendations can be made to decision makers. The following steps outline the process of selecting the best option and conducting an impact analysis of a regulatory policy.

Step 1: Identify the public policy issues, assess the nature of the issues and related risk, and define the baseline situation.

Step 2: Set out the objectives the policy intends to achieve.

Step 3: Develop alternative regulatory and non-regulatory policy options and how they affect the baseline scenario.

Step 4: Conduct an impact analysis—including cost-benefit analysis and stakeholder/distributional analysis—of alternative options and make recommendations for actions to be taken.

Step 5: Prepare an accounting statement.

During the process of identifying the issues, and developing and assessing alternative policy options, consultations should be carried out with Canadians and affected parties so that inputs and feedback can be properly taken into consideration.

STEP 1: Identifying Issues, Risks, and the Baseline Scenario

1.1 Issue

The first step in any policy analysis is to identify and define precisely the key features and sources of the issues. The issues may decline in importance or become increasingly serious in the future without government intervention. Certain public policy issues such as health and the environment are often characterized by risks associated with the baseline scenario, i.e. the scenario without a policy. Understanding and assessing the nature of the risks in this case becomes one of the key decision factors for government intervention.

1.2 Incremental impacts

One of the important concepts for defining the impact of a policy is to assess the incremental impact of the policy on the issue. This is to measure the impact—benefits and costs—that occur over and above what would have occurred in the absence of the policy. This means that one should identify only the benefits and costs that are associated with the policy in question and not include any other effects that would exist whether or not the policy is undertaken. With this concept in mind, one can then properly determine the true contribution of the policy. In other words, when conducting a policy's impact, one should conceptualize two scenarios: one that does not include the policy (i.e. the baseline scenario) and one that does include the policy (i.e. the "with regulation" scenario).

To the degree that this is feasible, one should evaluate the economy-wide impact of the policy. Although one is likely to be more focussed on the direct impacts of the policy on the affected sectors and individuals that must comply with it, indirect impacts can also be significant and therefore should also be measured. One should then attempt to establish which other sectors of the economy the policy might affect.[7]

7. This task is made considerably easier by the fundamental principle of welfare economics that, if the demand or supply of a good or service is changed because the price of another good is changed, but no distortion exists in its market, then no change in economic welfare will occur. (See e.g. Harberger, Arnold C., "Three Basic Postulates for Applied Welfare Economics." In: *Journal of Economic Literature*, Vol. IX, No. 3, September, 1971; Mishan, E. J., *Cost-benefit Analysis*, London: George Allen & Unwin Ltd., 1971; and Townley, Peter G. C., *Principles of Cost-Benefit Analysis in a Canadian Context*, Scarborough: Prentice Hall Canada Inc., 1998. As a consequence, the secondary impacts of a regulation that occur in these undistorted markets can be disregarded in the cost-benefit analysis. This is because, in the competitive undistorted market, the gross economic benefits accrued to the secondary impacts will be equal to the gross financial receipts received by the producers. Likewise, the gross economic costs are the same as the financial costs. No extra benefits to society are generated.

1.3 Establishing the baseline scenario

An important element of the assessment is ensuring that the baseline scenario is properly defined. The baseline situation does not necessarily mean that nothing will happen to the current situation over time if the policy is not implemented. Business will go on as usual and the resources of the economy will be allocated according to the forces of the market within the existing legal and regulatory environment. Over time, there will almost certainly be innovation and technological progress. Some of these changes may improve in the baseline scenario, while others may exacerbate the problem. To the degree possible, the impact of the technological changes that are in the pipeline, but not necessarily in the market, should be incorporated into the baseline scenario.

For example, the development of wide-bodied jet aircraft was known for a decade or more before they were introduced. Airport planners were aware at that time that the noise pollution and runway congestion associated with large volumes of travellers would be greatly reduced through the use of these jet aircraft and the new engine technologies. As a consequence, the relocation of airports away from major cities such as Toronto and Montréal was made unnecessary. In the case of Toronto, this element was an important factor in the decision not to relocate the Toronto airport to the Pickering area.

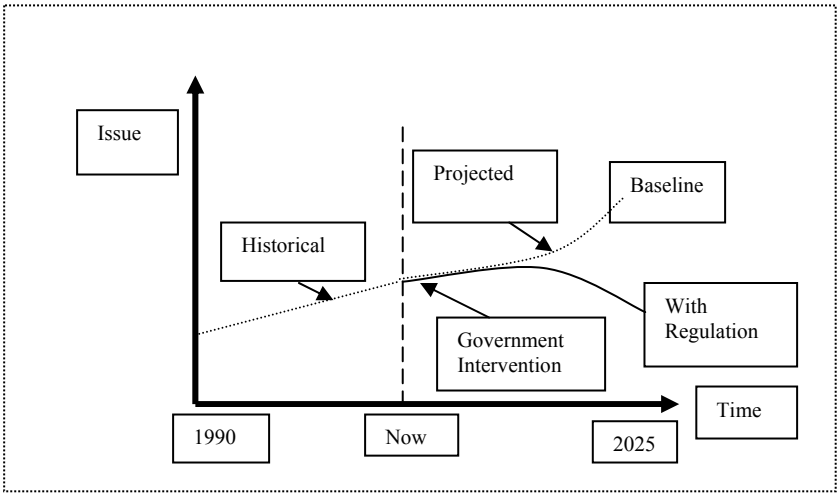
It is this optimized baseline scenario that should be compared to the "with policy" scenario in order to calculate the incremental benefits and costs over the life of the regulation. It is not correct to compare a non-optimized baseline scenario to an optimized "with policy" scenario, as this will overstate the incremental net benefits attributable to the regulation.

1.4 Risk assessment

In the case of health or environmental issues, there is often associated risk. Consequently, a dynamic risk assessment is often required. A dynamic risk assessment can be illustrated as in Figure 1 (taken from the Environment Canada study referenced in note 10). The historical projected line represents the baseline development of an issue in the absence of any government interventions with which some risk is inherently associated.[8] The "with regulation" line stands for the desired outcome the regulatory authority would like to achieve. The gap between "without regulation" and "with regulation" indicates the stream of benefits over time as a result of government actions.

8. See Canada, Privy Council Office, *Assessing, Selecting and Implementing Instruments for Government Action*, 2005.

Figure 1
Comparison Between the Baseline and "With Regulation" Scenarios



The following example taken from a recent study by Environment Canada will illustrate the establishment of the baseline scenario for a regulation to limit the concentration of 2-butoxyethanol.[9]

Regulation of 2-butoxyethanol (2-BE)

Issues and Objectives

- A regulation was proposed by Environment Canada on the use of 2-BE beginning in 2007 that would limit the concentration of 2-BE used in a wide range of consumer products for household cleaners, automobile cleaners, and paints. It is considered toxic based on its health hazard potential and it may endanger human life and health.

Baseline Scenario

- In conducting the cost-benefit analysis for the proposed regulation over a period of 20 years, the first step is to establish a baseline scenario of what the outcomes would be over time with no regulation in place.
- By observing the historical data, it was discovered that the quantity of 2-BE used in Canada was growing in the 1990s and peaked in the year 2000 at approximately 8 kilotonnes (kt). Since 2001, the quantities of 2-BE used have been declining, reaching about 4.6 kt in 2004. This represents an average annual decline rate of 12.6 per cent because of the replacement of 2-BE with alternative formulations. Moreover, several product types, especially paints and coatings products, show a trend towards lower volatile organic compounds (VOCc) that are based on 2-BE alternatives. However, 2-BE use would not be expected to decline much beyond 2010, due to its intermediate demand in a variety of industrial processes.

9. Environment Canada, *Benefit-Cost Analysis of a Proposed Regulatory Instrument for 2-Butoxyethanol.* Report prepared by HLB Decision Economics Inc., in association with Douglas Environmental Solutions and Michael Holiday & Associates, April 2005.

- The total use of 2-BE is therefore projected to fall to about 2.6 kt by 2010, composed of about 0.5 kt of 2-BE used in consumer products and 2.1 kt used in industrial applications. With this trend, one would expect the quantities of 2-BE used in the baseline scenario to decline over the study period.
- The baseline scenario assumes that the current compliance levels would prevail. As all the manufacturers of products will be regulated and internal reviews will ensure their compliance, it is reasonable to assume a full compliance of the industry with the regulation.
- The regulations specify limits on the concentration of 2-BE in specific products. If the limits are at risk of being exceeded, the manufacturing process must switch to a less toxic alternative. The difference between the amount of 2-BE used in the baseline and with the regulation represents the incremental effect of the regulation.
- In order to assess the net benefits of the regulation, one ought to further calculate the number of people exposed to 2-BE contained in the affected products consumed in both the baseline scenario and the regulation scenario.

One can expect that the specification of baseline conditions can have profound influence on the measurement of benefits and costs. Therefore, the following aspects need to be properly addressed while establishing the baseline:

- identify the nature and size of the issues that the policy will address;
- assess the characteristics and magnitude of risk associated with the issues;
- specify the nature of uncertainty and risk involved in the baseline situation, including innovation and scientific risks;
- describe the assumptions made about the projection of benefits and costs in the future; and
- take into account the regulations imposed by other regulatory agencies, such as provincial governments.

STEP 2: Setting Objectives[10]

After policy issues are properly assessed, the regulatory authority will be required to determine whether government interventions are needed and, if so, to what extent the government will intervene. The objectives can be economic, environmental, or social. In the case of health, the environment, and safety, presumably setting the objectives would involve the degree of public tolerance of risk, the costs of government action, and private compliance. Consultations with Canadians and stakeholders in particular are warranted at this time.

The objectives should be precise and concrete. Wherever possible, the desired future state should be defined in terms of measurable norms so that one can determine if the objective has been achieved.

10. See Canada, *Cabinet Directive on Streamlining Regulation*, April 2007; and Canada, Privy Council Office, *Assessing, Selecting and Implementing Instruments for Government Action*, 2005.

The potential benefits of a policy can be represented by the gap between the baseline situation and the "with policy" scenario, as shown in Figure 1. It may be determined by the degree of government intervention or stringency of policy. The process of assessment and consultation will provide valuable information and help the regulatory authority set out alternative objectives for actions.

STEP 3: Developing Alternative Regulatory and Non-Regulatory Options[11]

A spectrum of tools is available to risk managers. They range from regulatory to voluntary tools. As a best practice, all promising tools should be objectively considered when managing risk. One should consider the tools that have the potential to be more efficient or cost-effective. The initial selection of alternatives is likely to be based on a preliminary analysis of their characteristics or on the prior experience of other jurisdictions that have employed such options.[12]

When regulating, one should consider alternative regulatory options within the regulatory framework, non-regulatory options, and the combination of regulatory and non-regulatory instruments. This is because the recommended regulatory policy has to be proven superior not only to other regulatory options, but also to the non-regulatory alternatives and their combination.

Regulatory options are a command and control approach where the government requires stakeholders to comply by law in order to attain a certain objective. This is in contrast to non-regulatory approaches that are designed to achieve the same objective through the forces of the market. Non-regulatory options are market-oriented approaches, including taxes, charges or fees, tradable permits, subsidies, deposit-refund systems, and so on. Nevertheless, one should consider those options that have the potential to be more efficient or cost-effective. The initial selection of alternatives is likely to be based on a preliminary analysis of their characteristics or on the prior experience of other jurisdictions that have employed such options.

It is important that departments and agencies also consider the mix of regulatory and non-regulatory options. *Temporal* and *spatial dimensions* are also important in designing regulatory programs. For example, a program may initially begin with a voluntary approach and then over time move to a mandatory approach that meets international standards with short-term financial support for small and medium-sized firms during the adjustment period. The regulatory program may also vary from one region of Canada to another.

Regulatory approaches

Even when regulating, departments and agencies will have at their disposal a variety of regulatory options. Each of the options will have different implications for the amount of cost

11. For a more extensive treatment of the alternatives to regulation, see Canada, Privy Council Office, *Assessing, Selecting and Implementing Instruments for Government Action*, 2005.
12. The Qualitative Screening of Management Tools (QSMT) of Environment Canada is a screening method that narrows the number of tools under consideration and helps identify the most promising tools for achieving the identified objective.

and benefits, and their distribution. Some of the main regulatory approaches include the following:

Performance standards vs engineering or design standards: Sometimes regulations specify in detail how the private sector must deal with a problem. In other instances, performance standards are set. Generally, they are a better alternative to setting specific engineering or design standards. Often the setting of performance standards leads to a lower overall compliance cost, as the private sector may be able to introduce new innovations and techniques that achieve these requirements at a lower cost than a government-directed solution.

Stringency of the standard and compliance level: When setting a standard, departments and agencies will often have alternative levels of stringency to choose from. For example, in reducing a certain pollutant, regulators should not automatically set a zero tolerance standard without first considering other levels and trying to maximize the net benefits. Compliance levels can also be varied. In most cases, a certain percentage of non-compliance is acceptable, since obtaining 100 per cent compliance is often not realistic or too costly.

Timing: The timing of the regulation will also affect both the costs and benefits. Regulators will often establish compliance dates as early as possible to maximize the benefits of the regulation. However, compliance costs will also need to be considered, since stakeholders will need time to adjust to the regulations. It is often much less efficient to establish a compliance date that is effective immediately than to give stakeholders adequate time to adjust to the regulation.

International and regional issues: Regulators also need to consider the international impacts of their regulations. By limiting the number of specific Canadian requirements, one can often obtain the same level of benefits with minimal trade impacts if any. Furthermore, regulations may also have to be tailored to each province and territory because of different geopolitical and economic systems across Canada. The benefits and costs of a regulation may also not be evenly distributed across Canada.

Size of firm: The costs of regulation are often proportionally higher for small business than large business. Consequently, regulations should also consider the needs of small business and tailor the regulations to meet their needs, but still be effective.

Enforcement methods: Enforcement methods are used to ensure compliance with the regulations. These can vary from stringent on-site inspections to complaints made by stakeholders. The types of penalties for non-compliance will also affect the costs and benefits of the regulation. For example, a minor financial penalty for non-compliance may be much less intrusive than an automatic loss of a licence but still achieve the intended compliance level.

Non-regulatory approaches

Alternative approaches to command and control regulations are non-regulatory measures. These approaches may include tradable permits, taxes, charges, or subsidies. Such instruments can affect consumer and producer behaviour in order to achieve the same regulatory objectives. These approaches may require different information and tools than those used to analyze the impact of command and control regulatory measures.

Tradable permits: This approach is applicable to environmental policies when a regulatory authority sets a ceiling on the total allowable emissions of a pollutant. It then allocates the total allowable emissions on some basis to the sources of the pollutant. Permits can be bought and sold.

In this case, the price of permits is determined by the demand and supply in the market. The cost of the permits purchased by firms is a transfer between firms and thus not a cost to society as a whole because no resource costs are directly incurred as a result of the purchase of the permit. However, the firms now incur additional costs when they install pollution control devices in response to the incentive. The systems also require the creation of a functioning market. This involves administrative and enforcement costs to be incurred by governments in order to ensure that the quantity of emissions does not exceed the target level. These costs are part of the total cost to be included in a cost-benefit analysis.

Taxes or charges: Taxes or charges are typically designed to create an incentive to influence the behaviour of consumers or producers. The most direct approach is to impose a tax or charges on the actual amount of emissions, effluents, or other types of waste being discharged into the environment. The tax or charge could be applied to the total amount of certain emissions or on inputs that are closely linked to a specific environmental problem. Taxes or charges are transfer payments from businesses to a government and should not be regarded as economic costs. However, the cost of the mitigation efforts made by the people on whom the taxes are levied is a cost of the regulations. If there are any incremental costs incurred by governments to administer these taxes or charges, they should also be considered in the resource cost of this option.

Firms may choose some combination of the installation of pollution control equipment and the payment of the tax to cut back production and emissions. In this case, the cost of the policy option is the cost of the purchase and installation of pollution control equipment plus any additional administrative cost that is incurred by the government.

Subsidies or tax incentives: Subsidies or tax incentives provided to polluters are designed to modify the behaviour of polluters so that pollution will be reduced to the same level as that imposed by the command and control regulation. This approach is similar to the imposition of taxes or charges, but the cost of the subsidies or tax incentives is a revenue cost of the government. These subsidies are transfer payments and thus should not be considered as a resource cost. It is the expenditures that the firms make on inputs as a response to the incentive provided by the subsidy that represent the cost of such a scheme. To be complete, one should also add to these costs the efficiency and administrative costs of raising the additional revenue to pay for such subsidies.

Deposit-refund schemes: Under such schemes, a charge is imposed on a product but the charge is refunded if the product is returned for reuse or for proper disposal. In Canada, they have been used primarily for beverage containers. They can also be used for lubricating oils, automobiles, and tires.

Under these schemes, compliance costs include the resources used, such as transportation and labour to return the regulated item and process it for reuse or disposal. As for the impact on the

government's budget, there will be only administrative costs because these schemes are voluntary in nature

In addition, there are other instruments such as information and education, standards, and other forms of voluntary action that can also be considered part of non-regulatory instruments.

STEP 4: Assessing Benefits and Costs

4.1 Identification of significant impacts

The impacts of a regulatory option can be classified into three sets of activities. The first is to identify all possible impacts for each of the regulatory and non-regulatory options. The second step is to determine how these impacts are related to the fundamental variables that will determine their magnitude over time, e.g. growth in real income, relative price changes, and technological trends. The third step is to make projections of these fundamental variables and use these values to make projections over time of the benefits and costs produced by the potential interventions. As was pointed out earlier, the incremental impacts of each of these options in excess of the baseline scenario are the values for the contributions of the options. For example, in the case of a workplace safety regulation, the impacts may include fewer workers' injuries, fewer poisonings, healthier air, etc. that are measured by comparing the estimated value of the key variables for the "with safety regulation" scenario with the values for the baseline scenario.

Initially, all the possible impacts should be listed and evaluated in consultation with experts in the field. Care needs to be taken to include all the potentially significant impacts and make a list of the minor impacts that can be expected to occur. Whenever possible, the likely sector or group should be identified that will be the beneficiary or bearer of the cost of the impact. Both direct and indirect significant effects of a given policy should be carefully assessed and then summed up over the various sectors or groups of individuals to arrive at the total net benefits. This may be termed the "effect-by-effect" approach.

Some impacts may be difficult to quantify because of their nature or the lack of data or scientific knowledge. These impacts should be described and documented.

4.2 Measurement of benefits

A fundamental tool of applied welfare economics is the willingness to pay (WTP) principle.[13] The amount (demand price) that an individual is willing to pay for an incremental unit of a good or service measures its economic value to the demander and hence its economic benefit to the economy. For example, this is the maximum amount of money an individual would be willing to pay to improve human health, to avoid getting hurt, to obtain an environmental improvement or

13. More explanation can be found in Harberger, Arnold C., "Three Basic Postulates for Applied Welfare Economics." In: *Journal of Economic Literature*, Vol. IX, No. 3, September, 1971; and Townley, Peter G. C., *Principles of Cost-Benefit Analysis in a Canadian Context*, Scarborough: Prentice Hall Canada Inc., 1998.

to preserve natural resources, etc. Conversely, willingness to accept (WTA) compensation is the minimum amount of money an individual is willing to accept for not receiving the improvement.

In competitive markets, market prices for goods or services essentially provide data for estimating their benefits and costs. Therefore, WTP is generally easier to use for the measurement of benefits and costs.

There is also the issue of whether changes in individuals' benefits can be simply summed up over the individuals affected, without taking into consideration the income levels of the people affected, to obtain an estimate of the total value of the benefits for the nation. These guidelines recommend evaluating the benefits and costs by adding them up over all those affected to obtain the net benefit of the regulation. At the same time, a careful analysis needs to be made of who will bear the costs and who will receive the benefits from the regulatory action.

It is the benefits and costs accruing to the individual residents of Canada that are totalled to generate the aggregate net benefit for the country in any period. If the benefits are accrued to non-residents or to third countries, those benefits are usually excluded from the total benefits for the implementation of the regulation in question. Consideration should be given, however, to how great an impact the regulation will have nationally and internationally. Identification of those benefits should be noted and properly allocated. In some instances, Canada will have concluded international agreements and made commitments with respect to the activities being regulated. Hence, the benefits that accrue to non-residents living in third countries might be very relevant to the evaluation of the regulation.

Estimation of WTP is closely related to the concept of consumer surplus. Consumer surplus is the difference between what consumers are willing to pay for the good or service and what they actually pay for it in the marketplace. Policies that affect market conditions in ways that decrease costs so that prices fall will generally increase consumer surplus. This change in consumer surplus can be a measure of the benefits of the policy; alternatively, the gross benefits can be measured by the reduction of the costs of supplying an item.

A regulation may increase the cost of goods or services and hence raise their prices in the market. This would reduce consumer surplus. However, the reduction in the consumer surplus is also reflected in the increase in cost. It is important not to engage in the double counting of the benefits or costs in these estimations.

The objective of a cost-benefit analysis is to determine the change in net benefits brought about by a new or amended policy.[14] The impacts of a policy can affect many different business sectors, people, and governments. However, some effects may offset each other as far as the nation is concerned. A typical example is the additional corporate income tax paid by business. It is a private cost but not a cost to society, as it is simply a transfer between business and governments.

14. In these guidelines, we use the term economic when we are referring to the benefits and costs that will affect economic welfare and economic growth. The term social will refer to the potential distributional impacts of the policies being evaluated.

The impacts of each of the alternative options should be assessed and compared with the baseline scenario to arrive at the incremental net benefits of the option. In carrying out cost-benefit analysis, all assumptions made for the values of the variables that affect the outcome must be carefully documented and clearly presented. It should also be kept in mind that the estimation of the benefits will often depend on the values for a number of variables that are known only with a considerable degree of uncertainty. The nature of this uncertainty and risk, in terms of likely ranges of the values of these variables or their distribution over time, should be documented and presented as an integral part of the cost-benefit analysis.

The types of impacts resulting from environmental, health, safety, security, and other regulatory policies are often not valued through a market process but affect human welfare directly through changes in living conditions or processes. Such impacts would include such things as a health improvement or an ecological improvement.

Quantification and valuation of these impacts is quite different from simply looking at conventional market prices. Nevertheless, monetary values of a policy's impact are very important because they allow decision makers to compare costs and benefits. The challenge facing analysts is how to value these effects in monetary terms. If an original estimation of the benefits for the specific situation is too difficult or will take too much time, then one must try to draw upon existing valuation estimates made by others in similar circumstances.

4.2.1 Methods for measuring benefits

A number of methods have been developed to measure the benefits of various programs or policies. WTP is still the guiding principle for the measurement. The most straightforward situation occurs when market prices are distorted in ways that are clearly defined. For example, there may be taxes, subsidies, or quantitative controls in these markets.

The evaluation of benefits is more challenging for most environmental, health, safety, and security initiatives because of the absence of markets. Examples include control of air and water pollutants; drug monitoring for health; privacy; and gun control for safety and security. Nevertheless, a variety of techniques have been developed to value these goods or services in a manner consistent with the valuation of marketed goods. The revealed preference and stated preference methods used to quantify the benefits of non-market goods and services are also discussed briefly below.

A. Correcting market prices for distortions

If markets for the goods and services affected by the policy are competitive and not distorted by taxes or subsidies, their market prices will provide the best estimates of benefits. This is based on the principle of WTP for measuring benefits or the opportunity cost of the resources used to measure costs. However, if the markets are not competitive or distorted, then economic prices of the goods or services need to be estimated in order to correctly value the costs and benefits. In Canada, two major areas need special attention.[15]

Taxes, subsidies, and imperfect competition

In Canada, the goods and services tax and provincial sales taxes are generally imposed on goods or services, hence consumers pay more than the market prices by the amount of taxes. In situations when consumers forgo their consumption of certain goods and services, they will be forgoing the value of the goods and services inclusive of taxes. It is the gross-of-tax values that should be measured as the benefits associated with changes in the level of consumption of the goods or services affected by the policy, as they reflect consumers' willingness to pay for these items.

In other markets, the prices of goods or services supplied may be quite different from the resource cost of production due to subsidies or taxes. Suppose the government provides a production subsidy to the producer as a fixed amount per unit of goods sold. In this case, the cost of producing this good will, on the margin, be measured by the market price plus the amount of subsidy received by the producer per unit. In addition, suppose a subsidy is provided to purchase intermediate inputs for the production; the resources paid for by the subsidy should be accounted for in the calculation of the resource cost of producing the product. Instead of a subsidy, if the intermediate inputs are subject to provincial sales taxes, these taxes should be deducted from the production cost of the good. Therefore, if the regulation under evaluation has an impact on these markets, then adjustments should be made to exclude taxes from the costs but include the cost of the resources paid for by the subsidies to derive the resource cost of production.

In some markets, Canada has introduced supply management policies such as the marketing boards for milk, chickens, and eggs. For example, the Canadian Dairy Commission, a Crown corporation, has the mandate of coordinating federal and provincial dairy policies, and creating a mechanism for milk production that will help control supply and stabilize sales revenues. The Commission sets up a benchmark price of milk for the provinces and monitors the national demand and supply of milk. In the cost-benefit analysis, adjustments for the market changes

15. The market exchange rate in Canada may also not reflect the true value of foreign currency because of distortions associated with the traded goods sector. In 1995, Industry Canada estimated that the shadow price of foreign exchange was greater than its market price by 3.5 per cent to 4.5 per cent. Thus, a premium of approximately 4 per cent should be added when valuing the tradable goods or services generated from the regulatory actions. Similarly, the 4 per cent premium should be counted as an additional cost to the spending on tradable goods or services. See Industry Canada and the Centre for the Study of International Economic Relations, University of Western Ontario, *The Shadow Price of Foreign Exchange in the Canadian Economy*, 1995.

should be made to account for the costs created by regulations that bring about such supply restrictions.

Labour markets

When the level of employment has been affected by regulatory actions, then labour market externalities may be created. This is because the opportunity costs of the workers who either fill new jobs or are displaced from previous employment are not necessarily the same as the market wages the workers receive. The main distortions in the Canadian labour markets are personal income taxes and unemployment insurance benefits. The differences between the opportunity costs of the labour being employed in jobs and the market wage paid will vary with the type of skills required, labour market unemployment rates, and the duration of the jobs. This is particularly important if regulations affect the levels of employment in temporary jobs that are complementary to the income support provided by the Canadian unemployment insurance system. The opportunity cost per month of labour employed in temporary jobs tends to be significantly higher than for permanent jobs. This is because in permanent jobs little or no unemployment insurance will be claimed because the employers retain the same workers on a year-round basis.[16]

B. Revealed preference methods

These methods estimate the values placed on health, the environment, and other goods using data obtained by observing the actual choices made by individuals in related markets. From this information, the analyst can infer the value of the policy impact being evaluated. The following are general applications of some of these methods. Care should be taken when they are applied because certain conditions must hold.

The hedonic price method

The hedonic price method estimates the value of a non-market good, such as noise, by observing behaviour in the market for a related good. It relates the price of a marketed good with a bundle of characteristics or attributes associated with the good. For example, the price of a car is a function of size, fuel efficiency, safety, comfort, noise, and reliability. Such a relationship expressed as a hedonic price function can be estimated using statistical techniques such as ordinary least squares (OLS). Once the functional relationship is established and coefficients are estimated, the implicit or shadow price of a characteristic can be obtained by partial differentiation. This allows the estimation of a demand curve for a characteristic of interest.

This method has been applied to labour and property markets for measuring the benefits of various regulatory improvements.[17] The former is based on the premise that individuals make

16. Harberger, Arnold C., *The Social Opportunity Cost of Labor: Problems of Concept and Measurement as Seen from a Canadian Perspective*. Report for the Canadian Immigration and Employment Commission Task Force on Labour Market Development, Ottawa, 1980.
17. United States, Environmental Protection Agency, *Guidelines for Preparing Economics*, September 2000; Organisation for Economic Co-operation and Development, *Cost-Benefit Analysis and the Environment: Recent Developments*, 2005.

trade-offs between higher wages and occupational risks of injury or death. The key lies in separating the portion of compensation associated with occupational health risks from other job characteristics, including managerial responsibility, job security, and other factors. The outcome of these models is an estimated value for small changes in mortality or morbidity risks. The key assumption is the provision of perfect labour markets in which workers are mobile and there is perfect information available regarding jobs and job risks.

The other application of the model is for the estimation of property values. For example, the value of a house can be a function of its location, size, age, proximity to amenities, and property tax as well as other factors such as the noise level in the neighbourhood, the quality of local schools, and crime rates. When sales are made, individuals make trade-offs between the prices they are willing to pay and these attributes. Using statistical techniques, one can estimate the value of a lakeside location by comparing the price of houses located on lakefronts with similar houses located elsewhere. It can also enable the analyst to separate from the effects of other attributes the effect of the relevant environmental attributes, such as air quality and a lakefront, on the price of a house.

This method has been used to estimate the value of non-market goods such as air pollution, water quality, and road traffic. Nevertheless, care must be taken where a good can have several intangible attributes. If the attributes included as explanatory variables are closely correlated with each other, coefficient estimates can be biased. Multi-collinearity can also bring instability to the parameter estimates and, if serious, can reduce the confidence attached to model predictions. Other problems with the hedonic price method include omitted variable bias and wrong choice of functional form. Analysts must decide which characteristics to include as explanatory variables; omitting a characteristic that has a significant impact on the market good can lead to biased coefficient estimates. Additionally, analysts must decide on the functional form for the hedonic price function.

The travel cost method

The travel cost method seeks to place a value on non-market environmental goods by using consumption behaviour in a related market. Specifically, the costs of consuming the services of the environmental asset are used as a proxy for price. This method has been used for valuing recreational premises. The recreational activity is a non-market good. However, the value of a recreational activity can be measured through the market for the costs of travelling to the area by individuals or households because there is a trade-off between the benefit gained from visiting the recreational area and the value of money and time spent to travel there. These costs can be estimated by the number of trips made by individuals or households and the amount of money they spend on the trips. The latter usually includes (a) the transportation costs in air fares, taxis, fuel, wear of tires, depreciation of vehicles, etc. and (b) the costs of time spent on travelling. In the cost-benefit analysis, time spent on travelling should be measured by the opportunity cost of time for the driver and passengers.

Problems with the travel cost method include the choice of dependent variable, multi-purpose trips, incorrect recording of preferences, and statistical technique.

Averting behaviour method

The averting behaviour method is similar to the travel cost method but differs to the extent that it infers values from observing how individuals change their behaviour in response to changes in the quality of the environment, health, or safety. For example, mortality risks can be estimated by observing the amount of money spent on averting activities such as the purchase of safety helmets to reduce the risk of dying in an accident. In the case of the environment, the value of a quiet location may be estimated by what people are paying to install double-glazed windows.

This technique has many applications in different areas. However, the situation can be complicated by the fact that many types of averting behaviour not only reduce the particular type of damage this policy addresses, but also provide other benefits. The joint nature of production may create a bias in the measurement of willingness to pay. Failure to account for the other benefits associated with averting behaviour will also bias the estimates. For example, double glazing of windows both reduces the noise coming from outside and also insulates the building against loss of heat or cold.

An approach to deal with these biases could be to use a survey involving a hypothetical product. For instance, a survey could be produced that asks respondents to value a sunscreen that might reduce the risk of developing skin cancer. By measuring the willingness to pay for such a risk reduction, the other benefits of the product would be controlled for.

Cost-of-illness method

The cost-of-illness method estimates the explicit market costs resulting from a change in the incidence of a given illness. It generally relies on direct costs such as medical treatment, rehabilitation, and accommodation. It does not account for indirect costs such as the loss of income or the loss of leisure time, let alone the cost of pain and suffering. Therefore, the reduction in medical costs incurred because of a health intervention should be considered a lower bound estimate of the WTP.

C. Stated preference methods

Stated preference methods refer to a direct survey approach to estimating the value placed on non-market goods or services. They rely on information obtained through surveys rather than on the indirect valuation through revealed preference methods. This approach attempts to measure the WTP directly through surveys that ask respondents about their evaluation of changes in the level of environmental quality, health, and safety.

The most common application of these methods is contingent valuation.[18] The contingent valuation method does not require the public goods or services to be linked to actual market transactions. It asks respondents in a hypothetical market if they would pay a specified amount

18. See e.g. Arrow, Kenneth, Robert Solow, Paul R. Portney, Edward E. Leamer, Roy Radner, and Howard Schuman, “Report of the Natural Oceanic and Atmospheric Administration A Panel on Contingent Valuation.” In: *Federal Register*, 58, No. 10, January 15, 1993; Carson, Richard T., “Contingent Valuation: A User’s Guide.” In: *Environmental Science & Technology*, Vol. 34, No. 8, 2000.

for a prescribed commodity. The approach has gained increased acceptance among many academics and policy makers as a versatile and powerful technique for estimating the monetary value of non-market impacts of regulatory policies.

While conducting the studies and surveys, the following principles and steps should be considered:

- the survey should be conducted within an acceptable length for a typical interview in order to collect adequate information and reduce refusal rates from respondents;
- a pilot survey is important to finalize the construction and design of the questionnaire;
- the good or service being evaluated should be clearly explained to the respondent, as well as the objectives of the study;
- the socio-economic and demographic characteristics should be part of the questionnaires in order to cross-check the respondent's WTP;
- WTP questions should be designed within the budget limits of the respondent;
- the selection and size of the sample should be stratified or clustered according to proper sampling techniques;
- statistical adjustments to the results should be made to account for non-response bias, if any; and
- statistical analysis should be transparent and properly documented.

Surveys can be conducted either by mail, by telephone, or in person. In-person interviews are most reliable but also expensive and time-consuming. In some cases, direct interviews are essential due to the complexity of the questions. Mail and telephone surveys are much cheaper to carry out, but the quality of both the responses and the analysis that can be performed using these results is lower.

When the value of the impacts on non-market goods cannot be found using revealed preference methods, the use of contingent valuation methods is one of the simplest ways to obtain estimated values. Thus, the technique has been widely used in valuing air and water quality, outdoor recreation, cultural heritage sites, improvements in public education, and the health effects of pollution. It is, however, worth noting that respondents may not be entirely objective in their responses to questions because of the hypothetical nature of the market and the description of the public goods in question may cause biases in the estimation of people's WTP. There are three potential biases that may be encountered in a contingent valuation method. First, strategic bias may arise when a respondent thinks he or she is able to influence a policy decision by not answering the questionnaire honestly. Second, a respondent may be unsure of a specific price (i.e. starting-point bias) he or she is willing to pay. Third, a respondent may not fully understand the questionnaire or the question posed by the interviewer. Thus, concerns are often raised about the validity and reliability of the findings of contingent valuation studies. Care must be taken in the design and implementation of such surveys so that any biases are minimized.

In addition to contingent valuation, there has been a growing interest in conjoint analysis or choice modelling approaches. This technique is considered a family of survey-based methodologies for modelling preferences for goods where goods are expressed in terms of their attributes and the categories of these attributes. Respondents are asked to make a choice of a good based on the preferences for the types and levels of the attributes associated with the good. The amount of WTP can be estimated indirectly from the prices of the relevant attributes of the good being valued.[19]

D. Benefit transfer methods

The benefit transfer approach relies on information from existing studies that have applied these non-market methods of valuation. This is in fact using the value of a good or service in an existing study as a proxy for the value of the same good or service in another study.

This method has been widely used in both the fields of health and environmental valuation. For example, this approach was adopted by the Joint Industry and Government Study to assess the impacts of lowering the levels of sulphur in gasoline on the environment and Canadian health.[20] It is nevertheless important to identify appropriate studies that are relevant for the policy.[21] Estimates derived using benefit transfer techniques cannot be expected to be exactly the same under all circumstances as the original estimates that were tailored specifically to the situation being evaluated. Thus, the analyst should review and assess the existing studies for their quality and applicability to the case under examination and determine whether the studies are suitable. It is important to see if adjustments can be made for any important differences between the circumstances of the existing studies and those of the situation now being evaluated.

The following basic steps should be undertaken in selecting benefit transfer studies for use:

- the selected case studies should be of the same nature as the policy case in terms of the good or service in question and socio-economic conditions, including the size of population, demographic characteristics, economic conditions, value judgment, etc.;
- the selected studies should be based on their comprehensiveness and quality of data, sound theoretical concepts, and careful analysis of empirical results; and
- the welfare measures (WTP versus WTA) should be comparable to the policy case.

19. Organisation for Economic Co-operation and Development, *Cost-Benefit Analysis and the Environment: Recent Developments*, 2005, Chapter 9.
20. Health and Environment Impact Assessment Panel, Joint Industry and Government Study: Sulphur in Gasoline and Diesel Fuels, *Health and Environment Impact Assessment Panel Report*, June 25, 1997.
21. For example, Environment Canada, the United States Environmental Protection Agency, and the United Kingdom Department for Environment, Food and Rural Affairs have collaborated and developed a substantial library, the Environmental Valuation Reference Inventory (EVRI), available at http://www.evri.ca/english/default.htm, to support valuations of environmental benefits and human health effects. The database provides a rich data source for countries undertaking benefit transfer analyses.

As a general rule, transferring unadjusted values of benefits from the selected studies to the policy option is rare because the underlying conditions may not hold. The commonly used adjustments for transferred benefits in determining WTP include changes in income per capita, changes in age structure, changes in population density, and levels of education. Adjustments can be made in either the point transfer or a function transfer expressed as a function of various relevant characteristics.

4.2.2 Valuation of some major benefit items

Programs or policies can generate many kinds of benefits. This section describes some of these benefits, including improvement of human health, ecological benefits, and reduction of physical damages to materials.

Human health

Health and environmental policies may affect human health in a number of ways. They may save lives by reducing the risk of mortality. They may also improve the health of those living with diseases, i.e. there may be a morbidity benefit. Other benefits may include some reduction in tension or stress, or an improvement in mental health. Presumably, individuals are willing to pay if some improvements are made in each of these areas. The question is how one can place a value on them, and how much.

Policies on health and safety generally are expected to reduce the risks of premature death. The benefits of these risk reductions are usually measured in terms of the value of statistical lives (VSL), a measure derived from the aggregation of many small risks over an exposed population. Mortality risks can be classified across two broad dimensions: the characteristics of the affected population and the characteristics of the risk itself, such as timing. Because original research is usually unfeasible, analysts will need to draw from the existing VSL that has been estimated using well-established methods.

The United States Environmental Protection Agency (2000) and Chestnut et al. (1999) did an extensive literature review of VSL studies.[22] Out of 26 policy-relevant risk VSL studies, the United States Environmental Protection Agency recommended a central risk VSL estimate of US$6.1 million in 1999 dollars be used in economic analysis. The risk VSL estimates range from a low US$0.7 million to a high US$6.3 million. In a report prepared for Environment Canada and Health Canada, Chestnut et al. (1999) did an extensive literature review of previous VSL studies. They found a mean VSL of $5.2 million with a range from a low of $3.1 million to a high of $10.4 million in 1996 dollars. Using their mean value of $5.2 million and adjusting it for inflation from 1996 to the end of 2004 gives us a value for the VSL of $6.11 million.[23] Consequently, departments are expected to use this value after adjusting it for inflation.

22. Chestnut, L.G., D. Mills, and R. D. Rowe, *Air Quality Valuation Model Version 3.0 (AQVM 3.0), Report 2: Methodology*, Colorado: Stratus Consulting, 1999.
23. The Canadian Consumer Price Index was used to reflect inflation.

A morbidity benefit is the reduction in the risk of non-fatal health effects that can be characterized by duration and severity. The preferred measure for morbidity benefit is WTP to reduce the risk of getting ill. This measure includes the direct costs of medical treatment and the indirect costs of time lost for work and other leisure activities imposed by an illness. A number of studies on morbidity values are available in the literature using contingent valuation or averting behaviour methods. However, there are methodological issues associated with the benefit transfer of morbidity valuations in assessing the impacts of regulatory actions. When considering a benefit transfer, analysts must assess the correspondence between the health effect valued in the existing studies and the health effect influenced by the policy option in question. The issue of the valuation of morbidity is a critical issue in estimation of the quality adjusted life years (QALYs) for different treatments of diseases. Estimates of QALYs for a wide range of diseases and treatments have been made by the World Health Organization and Health Canada. Much of this well-developed methodology is relevant to the valuation of the impact of regulations on morbidity.[24]

Ecological benefit

Ecosystems basically provide services that benefit humans. The benefits may be thought of as flows of services from a natural asset such as a scenic vista, wildlife viewing, hiking, and boating. The benefits of improved ecological conditions can be evaluated using averting behaviour, hedonic, or stated preference methods. Such evaluations move into some of the most controversial and fluid areas of the analysis of benefits and costs. As an active area of research, however, progress is being made and examples of high-quality published analysis are now available for most of these impacts.

Reduced material damages

These are welfare impacts that arise from changes in the provision of service flows from the material environment. Material damages include the changes in the provision of services flows from materials that are due to the impact that environmental changes have on the quality and quantity of materials. To measure the benefits, one must determine the extent to which the environmental quality and materials are linked, as well as evaluate the responses of consumers and producers to the service flows of the materials. These valuations are relatively straightforward, as technical data on the normal service lives and on the replacement costs of a wide range of material and equipment are usually available. The changes in the service lives and the benefit or costs that are created usually can be measured with a considerable degree of accuracy.

4.2.3 Treatment of non-monetized benefits

While quantifying the benefits assists the decision makers in understanding the magnitude of the effects of alternative regulatory policies, some benefits may be too difficult to quantify in monetary terms. However, they also can be too important to ignore. In this situation, one should:

24. Phillips, Ceri and Guy Thompson, “What is a QALY?” In: *Hayward Medical Communications*, Vol.1, no.6, 2003.

- list all quantitative information that cannot be monetized;
- explain why these physical quantitative items cannot be monetized;
- describe the timing and likelihood of such effects;
- describe unquantifiable effects such as ecological gains, improvement in quality of life, aesthetic considerations, etc.; and
- discuss the strengths and limitations of the qualitative information.

4.2.4 Treatment of uncertainty and risk

The consequences of regulatory options can be risky and uncertain because of a lack of scientific knowledge, technological innovation, or consumers' and producers' behavioural responses to regulatory actions. For example, there may be risk and uncertainty about the change in emissions on the quality of air and likewise the effect of the quality of air on health. In this case, professional experts should be consulted and sound scientific advice must be sought. The risk and uncertainty is further compounded as the effects would be spread over a long period of time in the future. In any event, the likely range of the outcomes and the probability distributions of key parameters should be sought from historical data or expert opinion should be sought.

Much can be learned about the effects of uncertain variables on the outcomes of a regulatory intervention through a thoughtful sensitivity analysis. Sensitivity analysis involves changing the parameters and studying how this affects the outcome. The purpose of the analysis is to identify the important assumptions upon which the analysis is based—those to which the outcome is sensitive. Such a sensitivity analysis should be conducted using a well-constructed model of the determination of the benefits and costs. Sensitivity analysis, however, has its limitations. First, sensitivity analysis does not assign probabilities to the different outcomes. Hence, the impact of infrequent but major events usually is not included in the expected values of the outcomes. Second, the correlations between specific variables might have a very important effect on the evaluation of the outcomes (e.g. annual rainfall and soil erosion). Third, as a consequence of how most people define the baseline scenario, it usually is structured around mode values of the input variables and not their mean or expected values. Hence, the usefulness of a sensitivity analysis conducted around the mode value of these variables is somewhat limited. Monte Carlo analysis is a natural extension of sensitivity analysis. Monte Carlo analysis is a computer-based technique of analysis that accepts information about the important input variables in the form of ranges of values and distributions of possible variables that are subject to uncertainty. The results of the analysis are expressed in terms of the expected outcome and the probabilities of key outcomes occurring.

Normally, one obtains information on most input variables in terms of a distribution of possible values. For example, consider the impact of a regulation on costs, on quantities consumed, or on their unit values. None of these values is known with certainty, and usually a range of values is obtained when the data are initially collected. The first task of the analyst is not to destroy this

valuable information by simply choosing to work with mode or mean values. Such information is needed in order to specify the likely ranges and approximate distributions of the input variables when conducting a quantitative risk analysis using Monte Carlo simulation techniques.[25] In other words, values of the uncertain and risk input variables (i.e. benefit and cost items) are selected according to their ranges of possible values and the specified probabilities, and are inserted into the cash flow model; the net present value of a policy or regulation option can then be calculated. This process is repeated numerous times to generate a probability distribution of the policy or regulatory outcomes.

The output of such an analysis provides estimates of the expected values of the outcomes and their probability distributions. From such an analysis, the decision makers can get a more accurate assessment of the probabilities of success or failure for such regulatory initiatives. Whenever it is possible, the analysis of uncertainty and risk should be carried out.

Monte Carlo simulations may be performed using a computer software program. The steps required in undertaking the analysis of a policy or regulatory option are described as follows:

- identify risk variables that not only constitute a large share of benefits or costs of the policy or regulation but that are also uncertain in nature;
- assess how likely the risk is to occur;
- select the probability distribution (e.g. uniform, triangular, normal, step, discrete) and the range of values for each risk variable;
- select the appropriate probability distribution based on a historical series of values or the opinions of experts in the field;
- identify the relationships between two variables to avoid inconsistent simulation results;
- specify the desired number of simulation runs; and
- present a series of statistical measures such as the expected present value of net benefits and the variability of the outcomes.

The identified scientific limitations and uncertainties that have a high likelihood of significant impact on the results of the analysis need to be disclosed and reported in a transparent manner. The analysts should include a discussion of the difficulties in trying to resolve the scientific limitations and uncertainties involved, e.g. feasibility, and financial and time constraints on research, etc.

The presence of scientific uncertainty often requires the analyst to make some key assumptions. The basis of these assumptions should be clearly explained. In a case where there are diverse scientific views leading to alternative assumptions, the effects of each alternative assumption on

25. Vaughan William J., Arthur H. Darling, and Diego J. Rodriguez, *Uncertainty in the Economic Appraisal of Water Quality Improvement Investments: The Case for Project Risk Analysis*, Inter-American Development Bank, July 2000.

the direction and magnitude of the results need to be discussed. If possible, a quantitative evaluation of the impacts of changes to the alternative assumptions on the estimates should be carried out. The expected results with the assumptions should be compared with the actual empirical results of the study and reported, whether they are in agreement or in conflict with each other. Whenever there is a need to combine several assumptions in the study, the rationale for doing so should also be clearly explained.

Another source of uncertainty is the presence of different models capable of explaining the same phenomenon. Each alternative model may yield different results, therefore the model uncertainty also needs to be well documented and disclosed. Whenever possible, the results should be evaluated for each alternative model separately and then compared with those obtained from the other alternative models. A central measure of the estimate in this case will be a weighted average of the results obtained from the alternative models. Expert judgment might be needed in estimating the probability weights to be used in the calculation of the central value.

4.3 Measurement of costs

The objective of a cost-benefit analysis is to estimate the net impact of a policy. The previous section dealt with the incremental benefits of the "with policy" scenario as compared to the baseline scenario. This section considers the other side of the equation, i.e. the incremental costs of each of the "with regulation" options as compared to the baseline scenario.

The costs are simply the costs of the resources used as a consequence of the implementation of the policy. There are generally two types of direct costs: one is the compliance costs incurred by the private sector and the other is the administrative costs incurred by government. There also may be other indirect costs associated with the particular cases.

4.3.1 Compliance costs incurred by the private sector

The compliance costs are the costs incurred by businesses or their private entities in order to operate within the rules set down by the policy. They include capital costs, as well as operating, maintenance, and administrative costs. In the case of pollution control, businesses may choose or be required to purchase and install new machinery and equipment in order to eliminate or reduce emissions of pollutants. In this case, a significant part of the compliance costs may be in the form of investment expenditures incurred. There may be changes in costs of the production process that require the installation of new capital equipment. These are also part of the expenditures that should be attributed to the policy.

Other than capital expenses, businesses will incur additional operating and maintenance costs over time. These costs will be incurred continuously through time. If waste products need to be disposed of in special ways, the additional costs of such processes are also part of the private costs that should be attributed to the policy.

In practice, the compliance costs are normally based on engineering cost estimates that examine firms' alternative compliance methods. It specifies the capital, operating, and maintenance costs that are likely to be needed to adopt different strategies or technologies in the case of controlling pollution. The costs of complying with the policy can be highly uncertain, as well

as having the potential to significantly affect the other costs and prices of other goods or services in the economy.

To meet the requirements laid down by the regulatory authorities, some businesses may need to close plants or factories in order to reduce the environmental damage they cause. The costs of liquidating these facilities and perhaps cleaning up the sites are also part of the costs of the policy.

Suppose there is a regulation by the federal government that sets the maximum automotive emission levels for carbon monoxide. The design and technology required to meet the standard are left to the automobile companies to decide. The additional investment costs required to meet the standard, and the number of new cars produced by various firms per year, have to be estimated in order to arrive at the cost of this regulation. For used cars, if a regulation is implemented to limit the amount of emissions to a particular level, all used cars will have to be inspected periodically to ensure they meet these standards. The inspection and repair costs involved are part of the compliance costs.

In the area of health and safety, the government may ban a certain drug from the market because of its side effects. The compliance costs are equal to the additional costs imposed on consumers in order to buy a substitute drug. If there are no equally effective substitutes, then the opportunity cost of banning the drug is measured by the decrease in the quality of health of those people who would have benefited from the drug without suffering the side effects.

All private costs may not be the same as resource costs for society as a whole. In the cost-benefit analysis, all private costs must be measured in terms of their opportunity costs. It is the opportunity costs that are the resource costs to be used in a cost-benefit analysis. For example, most, if not all, capital equipment is traded goods. Their cost should be measured by their prices net of all import tariffs, sales taxes, and excises.[26] This is because the cost of imported goods is lower than their financial costs because the tariffs, sales taxes, and excise imposed on the equipment are considered transfer payments and thus are not a net cost to society.

The labour costs required to install new equipment or operate the facilities should also be measured at their opportunity costs. This is because the wage bill does not necessarily represent the opportunity cost of labour involved. Adjustments will usually need to be made for the changes in income tax receipts and the unemployment insurance benefit payments brought about by the additional employment of labour.

4.3.2 Administrative costs to governments

In order to enforce a regulatory policy, governments will incur additional costs of administration, monitoring, and enforcement. As was discussed in the previous section, these costs can be either

26. There are studies that suggest that the foreign exchange premium should also be accounted for because of the higher economic cost of foreign exchange than is measured by the market exchange. See Industry Canada and the Centre for the Study of International Economic Relations, University of Western Ontario, *The Shadow Price of Foreign Exchange in the Canadian Economy*, 1995.

capital or operating costs. For example, in the case of setting up a system of tradable permits for pollution control, the government will first need to develop an operating system and will then need to spend resources to enforce the system. All capital and operating costs associated with the design and operation of the system of tradable permits should be accounted for.

Monitoring and enforcement costs are normally based on the budgetary cost of the necessary administrative activities. These costs should include both the direct costs and the overhead costs of the public administration that is given to this task. In addition to the compliance costs incurred by the private sector and the administrative costs incurred by governments, there may be transitional costs as a result of the implementation of the regulation. For further details, see the *Guide to the Costing of Outputs in the Government of Canada*.[27]

4.3.3 Transitional costs

Transitional costs refer to the costs incurred by producers, and consumers, during the transitional phase that may not be captured by the estimates of the private resource costs mentioned above. For example, when new equipment is installed, a production line may need to be stopped or slowed down. Presumably, some losses are incurred because of the lower level of production. The size of these costs depends upon the duration of the disruption and other factors. For example, if plants or factories are shut down in order to meet environmental regulations, workers will likely be laid off and will need to search for new jobs. To the extent that the incomes of the workers fall for a period of time until they find other employment, there is a cost imposed on labour by the transition that should be included. In most cases, the transitional costs tend to be small and can be ignored for all intents and purposes. If they are significant, these costs should be estimated and included.

There may be some other impacts such as the effect on the quality of the product, productivity, innovation, and the market structure. Measuring and predicting all of the consequences of a particular policy can involve a significant effort and can be complex to analyze. It is important to account for all significant spillover or indirect costs. A consultation with experts familiar with the technical and business operations of the sector will likely be necessary.

In general, the costs of a policy are measured by changes in business and government activities that are affected directly by the policy. As for the cost of the indirect impacts, it will depend upon the specific policy and the significance of the indirect impacts. If the effects on some markets are significant, the changes in the activity times the unit value of the distortion is the appropriate adjustment to be included in the appraisal. If output is expanded in any of these other markets and is taxed, there is a net benefit because what demanders are willing to pay is larger than the resource cost of production. If in any of the other markets there is a production subsidy, there will be an additional cost as a result of the intervention because the resource cost of additional production will be greater than the price people are willing to pay for the item. If the policy causes the output of another market to decline, then the signs of the adjustment for taxes and subsidies are simply reversed.

27. Canada, Treasury Board of Canada Secretariat, *Guide to the Costing of Outputs in the Government of Canada*, 1994.

4.4 Criteria

Once the incremental benefits and costs have been quantified in monetary terms for both the "with policy" scenario and the baseline scenario, we can calculate the net present value of the incremental benefits using the discount rate. The preferred option from an efficiency perspective would be the one with the largest net present value.

Another criterion is the cost-benefit ratio. Although the criterion is widely used, it is highly problematic especially when used in a regulatory policy analysis where one is choosing from strict alternatives. The main problem is that it does not consider the scale of the expenditures involved. A highly productive small expenditure will appear to be preferred to a much larger expenditure that is less productive per dollar spent but overall will produce much more surplus than will the small expenditure. The measurement of the cost-benefit ratio is also sensitive to whether the recurrent costs are subtracted from the flows of total benefits and total costs, or if they are not subtracted from the benefits and not deducted from total costs.

The most commonly used measure of the attractiveness of an investment is the internal rate of return. Unfortunately, it is neither an expenditure criterion nor a reliable indicator for decision making. The internal rate of return is the rate of discount that makes the net present value of the benefits minus the costs over time equal to zero. It is a mathematical concept and not an investment criterion for evaluating alternative cash flows. It may give multiple solutions and, hence, multiple internal rates of return. It will also give unreliable results with respect to the scale of the activity and the time period when such an activity should start and is sensitive in an unsystematic way to the length of life of the cash flows being discounted. Finally, when the cash flows are irregular, with net costs occurring in the later years of the project, it will give unreliable results in the ranking of alternative options. Although this criterion is still commonly used, it is not recommended for decision making.

In the analysis of policies, there are many benefit categories that cannot easily be expressed in monetary values. Even when they are monetized, they may not be directly measured through market prices. Nevertheless, quantification of the benefits and costs is important because it can provide policy makers with information on the magnitude of the benefits. A cost-effectiveness analysis may be the best approach to take when the measurement of the benefits in terms of monetary values is not practical, and yet it is important to compare the alternatives in such a way as to find the lowest cost solution to the problem.

The following example illustrates the development and assessment of a recent Canadian regulation to lower the sulphur content of gasoline.[28]

28. *The Canada Gazette*, Part II, Vol. 133, No. 13, (June 23, 1999), *Canadian Environmental Protection Act, Sulphur in Gasoline Regulations*.

Regulation Controlling Sulphur in Gasoline

Issues and Objectives

- High sulphur levels in gasoline increase emissions of sulphur dioxide and sulphate particles from vehicles.
- Emissions of pollutants from vehicles cause considerable harm to the environment and to the health of Canadians.
- Canadian gasoline had an average sulphur content of 350 parts per million (ppm) in the late 1990s, one of the highest levels in the world. A policy or regulation was considered to protect the environment and the health of Canadians.

Alternative Options

- The baseline option: In recommending an appropriate policy or regulation to deal with the above problems, one needs to establish the baseline scenario over the policy period, say 20 years from 2001 to 2020, including the likely regulations of the sulphur content in gasoline in Europe and the United States, since those areas supplied some of the gasoline consumed in eastern and central Canada.
- Alternative options included a complete ban of sulphur in gasoline, harmonization of the sulphur content of gasoline with that of the United States, economic instruments, or other options requiring varying levels of low sulphur in gasoline to be implemented in phases. For example, one option considered was the maximum annual average level of sulphur for each refinery to be 30 ppm, with the level of sulphur never exceeding 80 ppm at any time during the year.

Cost-Benefit Analysis

- The analysis should be carried out in an incremental manner. That is, the incremental benefits and costs of each of the alternative options are estimated and compared to the baseline option. For the purpose of illustration, we use the above example as one of the alternative options.
- Benefits: These refer to health and environmental benefits that result from the reductions of the adverse environmental and health effects as compared to the base scenarios. These include the following:
  - Reducing sulphur in gasoline over time would lower emissions of SO_2 proportionally to the reductions in the fuel sulphur content, as well as reducing emissions of CO, NO_x and VOCs. The Health and Environment Impact Assessment Panel estimated that over the 20-year period, there would be a reduction of approximately 2,100 premature deaths, 90,000 respiratory cases in children, 3,200,000 acute asthma symptom days, and other respiratory problems.
  - These impacts can be quantified in monetary values associated with premature mortality and illness costs over the 20-year period, using the benefit transfer methods.
- Costs: These costs include compliance costs to refineries and independent suppliers, costs borne by consumers, and enforcement costs to governments:
  - Canadian refineries were expected to incur $1.8 billion in capital expenditures and $119 million per annum in operating costs to produce low sulphur gasoline. Part of the costs was expected to be recovered by the refineries from their customers through an increase in the price of gasoline. The Panel estimated that about three to four refineries were expected to be shut down rather than making the necessary investment to produce 30 ppm gasoline. A typical refinery directly employed about 350 people (ranging from 100 to 800).
  - Importers and blenders of gasoline would be affected by the regulation. As Europe was the main source of imported gasoline, the types of gasoline produced by European countries would have a direct impact on the cost to importers.

  - There were compliance costs incurred by primary suppliers using a pool average, since they had to demonstrate that they must comply with the average, independent auditing records and reports. In addition, compliance must be met by all gasoline domestically produced or imported under a pool average that is subject to a never-to-be-exceeded cap of sulphur content.
  - The cost passed on by refineries was assumed to be borne by consumers. There should be no double counting with the costs borne by the refinery industry.
  - Administration and enforcement of the regulations by the government required a wide range of planned and ad hoc inspections, audits, samplings, analyses, investigations, and legal actions by Environment Canada.
  - All costs should be quantified annually and measured in the resource costs rather than the financial costs.
- Net benefits: The annual net benefits were estimated over the 20-year period and discounted by the discount rate in order to derive the present value of the option under consideration.

4.5 Cost-effectiveness analysis

When benefits cannot be expressed in monetary values in a meaningful way, a cost-effectiveness analysis (CEA) should be carried out to assist in making effective decisions. A CEA calculates cost-effectiveness ratios of different alternative policy options and then compares the resulting ratios so that the most efficient option is chosen. In a sense, a CEA ensures technical efficiency in the process of achieving a desired outcome.

The pure cost-effectiveness of a policy option is calculated by dividing the present value of total costs of the option by the present value of a non-monetary quantitative measure of the benefits it generates. The ratio is an estimate of the amount of costs incurred to achieve a unit of the outcome from a policy option. For example, in a health and safety scenario, what is the amount of costs expressed in Canadian dollars incurred in order to save a person's life? Presumably, there are alternative ways to save a life and what are their costs? The analysis does not evaluate benefits in monetized terms but is an attempt to find the least-cost option to achieve a desired quantitative outcome.

The cost-effectiveness analysis can be extended to more sophisticated and meaningful ways of measuring benefits. A quantitative measure can be made by constructing a composite index of two or more benefit categories, including quantity and quality. For example, the cost utility analysis (CUA) in healthcare uses the quality adjusted life years (QALYs) as a measure of benefits. The QALY measure integrates two dimensions of health improvement: One is the additional years of life (reduction in mortality) and the other is quality of life (morbidity) during these years. On the basis of the costs incurred, expressed in Canadian dollars, the decision maker would still choose the option with the least cost per QALY achieved by the program.[29] Cost

29. See e.g. Viscusi, W. Kip, "The Value of Risks to Life and Health." In: *Journal of Economic Literature*, Vol. XXXI, No. 4, December 1993; Garber, Alan M. and Charles Phelps, "Economic Foundations of Cost-effectiveness Analysis." In: *Journal of Health Economics*, 16, 1997.

utility analysis attempts to include some of the benefits excluded from the pure CEA, hence moving it a step closer to a full cost-benefit analysis.

Some caveats are noted below for the measurement of the associated costs.

- The marginal cost-effectiveness should be calculated. It is the marginal or incremental cost-effectiveness of the policy that should be compared with the baseline cost-effectiveness scenario. The policy that has the lowest marginal cost per unit of effectiveness will be the most efficient way to use resources.
- The costs include all compliance costs incurred by the private sector and the administrative costs to governments. They should be based on the resource or opportunity costs, not just the financial costs of goods and services.
- The costs should be properly defined and measured in the calculation of cost-effectiveness.
- The costs incurred may be capital or operating expenditures that are spread over many years. Both the costs and benefits should be discounted to a common time period in order to make a comparison of alternative options. It should be noted that the benefits are measured in physical units instead of monetary values. The quantities over time of the measure of effectiveness should be discounted to the same date in time as the costs.

One should be aware of some of the shortcomings inherent in the cost-effectiveness approach. It is a poor measure of the consumers' willingness to pay principle because there is no monetary value placed on the benefits. Furthermore, in the calculation of cost-effectiveness, the numerator does not take into account the scale of alternative options. Nevertheless, the cost-effectiveness ratio is still a very useful criterion for selection of alternative regulatory options when the benefits cannot be monetized.

4.6 Impacts on stakeholders

There are various entities or stakeholders that can be affected by a specific policy. The assumptions used for the stakeholder analysis must be consistent with those of the cost-benefit analysis. The cost-benefit analysis begins with the identification of the direct effects and then adjusts various goods and services affected for a variety of distortions in the markets. Central to the stakeholder analysis is the need to identify the affected subpopulations, whether they are winners or losers, and how much they would gain or lose as a result of the implementation of the policy. Most stakeholders are concerned about their private costs and benefits. In order to monitor and enforce the policy, governments are expected to incur certain administrative costs that should be included as part of the economic cost for implementation of the regulatory policy.

One must ask, "Who are the winners and who are the losers under the policy?" and "By how much does each class of stakeholders gain or lose?" A stakeholder analysis attempts to allocate the net benefits or losses generated by the policy. The output of the stakeholder analysis contains critical information for decision makers, as it indicates which groups will be the net beneficiaries and which groups will be the net losers and by how much.

The stakeholder analysis may begin with the estimation of the change in compliance costs for the affected sector that can be attributed to a policy and then assess their impacts on the production costs of the sector. The analysis must also estimate the change in the prices consumers will pay for the goods and services affected and the effect of this on other related sectors. The following are kinds of impacts that are likely to occur and need to be assessed.

4.6.1 Impacts on industry

Many policies are intended to change the way something is produced, input used in the production, or the quantity of a product being produced. The focus of the analysis will initially be on the change in compliance costs for the affected sector or how compliance with the policy affects the production costs of the sector or the item, the nature of the firm's supply response to this change in cost, and its competitive position in comparison with its rivals. At the same time, it is important to estimate how the demand and supply of substitute or complementary goods and services respond to changes in the prices of the affected item. The ultimate impact is the measurement of the implementation of the policy on the financial profitability of the regulated firms and industry.

Policies can unintentionally create barriers to entry for other firms and may result in market concentration. They might also restrict the level of international competition. The economic consequences are lack of competition and less incentive for innovation, eventually leading to lower productivity and slower economic growth.

4.6.2 Impacts on employment

Regulations may impair the competitiveness of certain firms. Some firms may close as a result of extremely high compliance costs and low financial profitability. Such closures might have serious political ramifications for the region where the firm is located. This can vary from case to case. The analysis should examine the viability of the firms affected in terms of their profitability, liquidity, and cash flow It should assess the number of firms being affected in the industry and by region. Since jobs are one of the most important concerns for workers and politicians, the number of workers affected by the plant closures should be estimated.

That being said, it should be noted that the social loss or loss of private incomes as a result of plant closures should be carefully assessed and included as part of the stakeholder analysis. It should be measured by the earnings prior to the closure in excess of the economic opportunity cost of the laid-off workers. The opportunity cost of workers will vary by occupation, skill level, working environment, market condition, region, and unemployment insurance scheme.[30]

30. See e.g. Harberger, Arnold C., *The Social Opportunity Cost of Labor: Problems of Concept and Measurement as Seen from a Canadian Perspective*. Report for the Canadian Immigration and Employment Commission Task Force on Labour Market Development, Ottawa 1980.

4.6.3 Impacts on consumers and individuals

An increase in compliance costs will likely affect the prices of goods or services in the regulated industry. The question is whether the increase in compliance costs will have direct impacts on the affected firms and, if positive, how and what portion of the compliance costs can be passed on to customers. It is a complicated question because one has to examine the demand and supply conditions in the affected markets. In these cases, the basic question is the nature of the competitive conditions within the country. The elasticities of supply and demand, as well as cross-price elasticities of demand for the goods and services affected, need to be used to measure the impacts on these markets.

If the compliance costs of the affected firms resulting from a policy are shifted forward to consumers and individuals or households, they should be properly assessed and quantified. For example, if the price of supplying electricity to households increases because of a regulation imposed on the sector, it would be important to assess the magnitude of the price change and how it affects the quantity of electricity demanded by households and how they are likely to react to this change in terms of consumption. In other cases, regulations may impact on the quality and availability of the goods and services consumers and households purchase.

The more the price of goods or services in the regulated sector is shifted forward, the greater the likelihood that the regulated firms will recover their initial compliance costs from their customers. The net impacts on the respective stakeholders should be properly assessed and double counting in terms of effects must be avoided.

4.6.4 Impacts on governments

A regulation may increase costs incurred by the government due to additional administration, monitoring, and enforcement. If the regulation has a significant impact on domestic demand or supply, it may also affect the tax revenues of governments. These impacts will usually affect the different levels of government differently and should be properly recorded as part of the stakeholder analysis.

4.6.5 Impacts on other stakeholders

Depending upon the types of policy, there can be different economic and social impacts on a variety of stakeholders. A stakeholder analysis first identifies the direct impact of a regulation and then analyzes the interactions between a regulated market and other related markets. For example, the production and prices of regulated industries can be affected by an environmental policy that requires additional investment in equipment to control emissions of pollutants. In the case of health and safety, a ban on a certain drug will create a change in prices that will set in motion a change in consumers' demand for substitute medications and the production of these substitutes. In the end, it seeks to allocate among stakeholders the net benefits or losses generated by a regulatory intervention.

The impacts of a policy can have significant implications for public entities and other non-profit organizations. These entities can include municipalities, universities, schools, hospitals, charities, and religious organizations. Since they are not profit-oriented, the decision-making criteria in

terms of the volume of services they provide and the prices charged are somewhat different from those of profit-seeking enterprises. As compared to profit-oriented firms, such organizations often have relatively large political voices. An increase in compliance costs may lead to the reduction in the organizations' ability to continue to provide goods and services to the community.

Equity is frequently raised in the stakeholder analysis. There is no doubt that the impacts of policy actions on disadvantaged or vulnerable groups should be properly assessed and documented by analysts. However, incorporation of these impacts quantitatively into a cost-benefit analysis is nonetheless controversial.[31] This reflects the complexity involved in trying to disentangle society's distributional preferences. Because of these important concerns, analysts should identify the impacts on disadvantaged groups. Decision makers will almost certainly use this information in conjunction with the efficiency measure as captured by the cost-benefit analysis to evaluate trade-offs between equity and efficiency.

In reality, efficiency will frequently not be the only criterion used to guide decision making. Decision makers may place great importance on society's distributional objectives. There may sometimes be a trade-off between efficiency and equity but not necessarily so. The issue is how far a cost-benefit test should be moderated in the light of equity and distributional considerations. For example, in the case of health care, decision makers may seek a balance between maximizing the overall benefits of health care interventions and directing interventions (and resources) toward certain groups such as low-income native communities.

In summary, the economic net benefits of a policy for society as a whole should be equal to the summation of the net benefits across all stakeholders. Therefore, the analysis is important to decision makers, as it lets them estimate the impact of a particular policy on specific segments of society and to predict which groups will be net beneficiaries and which groups will be net losers.

A recent study by Health Canada provides an example of a cost-benefit analysis and a stakeholder analysis of a regulation to address the public safety and health problems resulting from fires started by cigarettes.[32]

Cigarette Ignition Propensity Regulations

Issues

- Over the period from 1995 to 1999, more than 14,000 fires started from smokers' materials, including cigarettes, cigars, and pipes. These fires killed 356 people, injured 1,615 others, and caused more than $200 million in property damage. Most of the victims were children, the elderly, and low-income families.

31. See e.g. Organisation for Economic Co-operation and Development, *Cost-Benefit Analysis and Environment: Recent Developments*, 2005; and the European Commission, *Impact Assessment Guidelines*, June 15, 2005.
32. See *The Canada Gazette*, Part II, Vol. 139, No. 13 (June 29, 2005), *Tobacco Act*, *Cigarette Ignition Propsensity Regulations*; Industrial Economics, Incorporated, "Economic Evaluation of Health Canada's Regulatory Proposal for Reducing Fire Risk from Cigarettes." Paper prepared for the Economic Analysis and Evaluation Division, Healthy Environments and Consumer Safety Branch, Health Canada, March 2004.

Proposed Regulations

- To address the problem resulting from fires started by cigarettes, a regulation was proposed to reduce the ignition propensity of cigarette paper. Beginning October 1, 2005, all manufacturers and importers of cigarettes are required to ensure the cigarettes they supply will burn the full length no more than 25 per cent of the time when tested on 10 layers of filter paper using the ASTM E2187-04 Standard Test Method for Measuring the Ignition Strength of Cigarettes.
- It is a performance standard that prescribes an objective established by the regulatory authority.

Cost-Benefit Analysis

- Two alternative approaches were undertaken by the research team to estimate the amount of compliance costs to the private sector and their impacts on the economy: a modelled estimate based on a representative cigarette manufacturer and an estimate based on an industry outreach survey.
- The costs include capital and operating costs. They are expenses of purchasing and operating new equipment, changing production processes or inputs, undertaking additional quality assurance checks, and conducting toxicity tests to ensure compliance with the standard. On average, the cost of compliance was estimated at $0.126 per carton using the modelled estimate and at $0.257 per carton using the survey method. Using the annual production of 206.5 million cartons in 2002, this translates into annual costs of $26 million and $53 million, respectively.
- The benefits include three major categories, i.e. the reduction of deaths, injuries, and property damages. It is, however, important to estimate the annual incremental benefits of the proposed regulation against the baseline situation. The empirical estimates were mainly based on annual reports of the Canadian Council of Fire Marshals and Fire Commissioners, and data from Alberta and Ontario. The benefits are briefly described below:
  - reduction in property damages: the estimates are based on the estimated loss expressed in monetary values at markets;
  - reduction in fatalities: the analysis uses the VSL approach and adopted a benefit of $5.8 million in 2002 dollars; and
  - reduction in injuries: the analysis relies on benefit transfer techniques. The benefits include reduction costs such as emergency transportation and care, hospital stays, medication, and doctors' visits. However, it does not include WTP to avoid pain and suffering, the loss of work time, and the value of leisure time. It is a lower bound estimate.
- The annual net benefits are obtained from the estimated amounts of the benefits in excess of the costs. The stream of net annual benefits is then discounted by the discount rate to obtain the net present value to see if the proposed regulation would generate a positive benefit to Canadians as a whole.

Stakeholder Analysis

- The impact of the regulation on stakeholders depends on who bears the costs of complying with it, which, in turn, depends on the extent to which the cost can be shifted forward by manufacturers or importers of cigarettes to consumers.
- The stakeholders in this case include cigarette manufacturers, consumers, tobacco growers, paper suppliers, distributors, retailers and importers, and governments.
- The impact on each stakeholder should be examined independently with respect to the supply and demand of their individual market and their financial capability. For example, whether the compliance cost can be shifted to consumers will depend largely upon the demand elasticities for cigarettes and the available substitutes for cigarettes.
- The assumptions made in the stakeholder analysis should be properly assessed and clearly documented.

4.7 Discount rates

For each option under consideration, the stream of costs and benefits will usually not occur in the same year but is spread over several years. Discounting allows for the systematic comparison of costs and benefits that occur in different time periods by allowing one to calculate the net present value of the intervention. If the costs and benefits are expressed in current prices or nominal dollars, they should be deflated to become real prices or prices expressed in terms of the price level of a specific year. In this way, the changes in the reported values of benefits and costs over time that are due purely to inflation are removed.

The discounted present value of net benefits is the algebraic sum of the present values of the expected incremental net benefits of the policy option over and above the baseline scenario during the policy's anticipated impact time period. If the net present value (NPV) is greater than or equal to zero, then the policy is expected to generate more benefits than costs and should be recommended for implementation. However, if the NPV is less than zero, the policy should not be recommended for implementation on efficiency grounds.

4.7.1 Rational approaches to discount rates

Choosing a discount rate has been one of the most contentious and controversial aspects of the cost-benefit analysis of regulatory policies. The term *discount rate* refers to the time value of the costs and benefits from the viewpoint of society. It is similar to the concept of the private opportunity cost of capital used to discount a stream of net cash flows of an investment project, but the implications can be more complex.

With costs and benefits expressed in real values, people prefer to make payments later and receive benefits sooner. This is due to the fact there is a time preference for current consumption over future consumption. Similarly, there is an opportunity cost of the resources invested in any given activity, as they could have been invested elsewhere if they had not been spent on the activity being evaluated.

One approach to discounting is based on the fact that present consumption is valued differently from future consumption. Following this approach, all benefits and costs are first converted into quantities of consumption equivalents before being discounted. In this case, the discount rate is the rate of time preference at which individuals are willing to exchange consumption over time.

Another approach considers what society forgoes in terms of pre-tax returns of displaced investment in the country. Using this approach, no account is made for time preference in terms of present versus future consumption. The discount rate is based purely on the opportunity cost of forgone investments.

An approach that captures the essential features of both these two alternatives uses a weighted average of the economic rate of return on private investment and the time preference rate for

consumption.[33] Many professionals have chosen to use a discount rate that follows this weighted average opportunity cost of funds concept.

A natural place to look for the relative weights to place on the rate of time preference and the gross rate of return on investment is the response of the capital market to extractions or injections of funds. On the cost side, the marginal source of funds for both the public and private sectors is usually from borrowing either domestically or from abroad. Likewise, if benefits arise that create income, it will be in the first instance deposited in financial institutions, where it is available to finance other activities.

While this approach is not without its restrictions, these pale in comparison to the practical problems that arise if the rate of time preference is used as the rate of discount for such interventions.[34]

Other questions have been raised as to whether a lower rate should be used for intergenerational discounting because many of the people affected by some policy or regulation may no longer be alive in the distant future. However, there is little consensus in the literature on discounting for intergenerational policies. There are several reasons for not favouring the use of variable discount rates in the analysis. First, no genuine rationale can be found for use of different discount rates over the policy impact period, unless the opportunity cost of funds is abnormally high or low from one period to another. Second, applying one discount rate to the streams of costs and another to the streams of benefits can be tricky and empirically difficult for each policy because of the requirements for converting all the streams of costs into consumption equivalents in a consistent manner.

Moreover, a risk-adjusted discount rate has also been suggested elsewhere to account for the systematic risk of future uncertainty. Since the streams of uncertain future costs and benefits are mainly related to the input variables themselves, they are best dealt with in the Monte Carlo risk analysis rather than the adjusted discount rates.

33. See e.g. Agnar, Sandmo and Jacques H. Dreze, “Discount Rates for Public Investment in Closed and Open Economics.” In: *Economica*, November 1971; Harberger, Arnold C., “On Measuring the Social Opportunity Cost of Public Funds.” In: Arnold C. Harberger, ed., *Project Evaluation—Collected Papers*, Chicago: University of Chicago Press, 1972.

34. For an extensive theoretical discussion of these alternative methods of economic discounting, see Sjaastad, Larry A. and Daniel L. Wisecarver, “The Social Cost of Public Finance.” In: *The Journal of Political Economy*, Vol. 85, No. 3, June 1977.

4.7.2 Discount rates

When a program requires funds that are extracted from the capital markets, the funds are drawn from three sources. First, funds that would have been invested in other investment activities have now been displaced by expenditures required by the policy action. The cost of these funds is the return that would have been earned on the alternative investments. Second, funds come from different categories of savers in the country who postpone their consumption in the expectation of getting a return on their savings. The cost of this part of the funds is reflected in the interest rate that the savers earn net of personal income tax. Third, some funds may come from abroad, that is from foreign savers. The cost of these funds would be the marginal cost of foreign borrowing. At the margin, the cost associated with incremental foreign borrowing is measured by the interest expense on the incremental borrowings plus the marginal change in the cost of foreign borrowing times the quantity of the stock of foreign debt negotiated at variable interest rates.

The discount rate will be a weighted average of the costs of funds from the three sources outlined above: the rate of return on postponed investment, the rate of interest (net of tax) on domestic savings, and the marginal cost of additional foreign capital inflows. The weights are equal to the proportion of funds sourced from domestic private-sector investors, domestic private-sector savers, and foreign savers.

Based on the above approach, the discount rate for Canada was re-estimated recently by Jenkins and Kuo (2007). It is found to be a real rate of approximately 8 per cent.[35] This rate is lower than the real rate of discount of 10 per cent recommended by the Treasury Board of Canada Secretariat in 1998 but is higher than the 7 per cent real rate proposed by Burgess in 1981 and the 7.3 per cent real rate recommended by Brean et al.[36] This rate of 8 per cent is consistent with the 10 per cent estimated earlier and used in the Treasury Board guidelines of 1976 and 1998.[37] Over time, the effective rate of corporate income tax in Canada has been steadily decreasing. Furthermore, the introduction of the goods and services tax has removed much of the burden of the sales tax system from the value added of capital. Both these policy changes will tend to lower the required gross of tax rate of return on capital. We recommend that a real rate of 8 per cent be used as the discount rate for the evaluation of regulatory interventions in Canada.

In certain circumstances where consumer consumption is involved and there are no or minimal resources involving opportunity costs (such as certain human health and environmental goods and services), some federal departments, governments, and international organizations have taken into consideration factors other than the economic opportunity cost of funds when developing their recommendations for the value of the discount rate. Usually these social

35. Jenkins, Glenn and Chun-Yan Kuo, "The Economic Opportunity Cost of Capital for Canada—An Empirical update," QED Working Paper Number 1133, Department of Economics, Queen's University, Kingston, Canada, 2007.
36. See e.g. Burgess, David F., "The Social Discount Rate for Canada: Theory and Evidence." In: *Canadian Public Policy*, Summer 1981; Jenkins, Glenn P., "The Public-Sector Discount Rate for Canada: Some Further Observations." In: *Canadian Public Policy*, Summer 1981; Brean, Donald, David Burgess, Ronald Hirshhorn, and Joseph Schulman, *Treatment of Private and Public Charges for Capital in a "Full-Cost Accounting" of Transportation: Final Report*, March 2005.
37. Jenkins, Glenn P., "Measurement of Rates of Return and Taxation from Private Capital in Canada." In: W. A. Niskanen et al., eds., Benefit-Costs Analysis, Chicago: Aldine, 1972.

discount rates are lower than the 8 per cent recommended here. One approach is to estimate the social time preference rate, which is based on the rate at which individuals discount future consumption and projected growth rate in consumption.[38] For Canada, the social time preference rate has been estimated to be around 3 per cent.[39] In these circumstances, the net present value of the results of the analysis can also be carried out using a social discount rate of 3 per cent accompanied by the use of a shadow price of investment that is applied to all the costs of the intervention that results in a postponement or reduction of investment activity. However, there is still controversy in the literature on the use of these social discount rates and further guidance will be needed in the future. Whatever rate is used, the costs and benefits should be discounted using the same rate.

The government has established the Centre of Regulatory Expertise that for a period of five years will help departments and agencies adjust to the new approach to regulating, including cost-benefit analysis, instrument choice, and performance measurement. This assistance will include the provision of specialist analytical services. Departments and agencies are expected to discuss their approach to cost-benefit analysis with their Treasury Board of Canada Secretariat analyst, including the need for and approach to discounting any longer-term costs and benefits associated with proposals involving, for example, health and environmental regulation.

4.7.3 Annualized costs and benefits

Cost-benefit analysis results should also be presented in terms of annualized values. This is especially the case when alternative policies have different time horizons. Comparing the net present value between two policies will not be valid unless further adjustments are made.[40] However, once net benefits are annualized to become constant annual values, comparing annualized net benefits is equivalent to comparing the net present values of net benefits with further adjustments.

To annualize the net benefits of a policy, the following relationship holds between the present value of net benefits over the n policy impact periods and its annualized value:[41]

$$AV = [PV \cdot \rho]/[1 - (1+\rho)^{-n}]$$

where AV is the annualized value of net benefits over the n periods;

PV is the present value of net benefits over the n periods;

ρ is the economic discount rate; and

n is the duration of the policy impact periods.

38. Policy Research Initiative, *Social Discount Rates for Canada*, Ottawa, 2007.
39. Ibid.
40. One can adjust the costs and benefits of alternative options to the same length of periods. See e.g. Harberger, Arnold C. and Jenkins, Glenn P., *Manual on Cost-Benefit Analysis for Investment Decisions,* Queen's University, Kingston, Canada, 2002.
41. The formula can be found in the European Commission, *Impact Assessment Guidelines*, June 15, 2005.

This approach allows us to express and compare net benefits that occur in different policy impact time periods on a consistent basis. Annualization simply spreads the net benefits smoothly through time. An example is given below.

Annualization of Net Benefits

Suppose there are two mutually exclusive projects. Project A generates a present value of net benefits of $1,500 million over a five-year period. Project B generates a present value of net benefits of $1,700 million over a seven-year period. With the simple net present value criteria, Project B would be recommended. However, we have problems with a longer time horizon than that of Project A.

- We can calculate the annualized value of the net benefits as follows:

  For Project A, the annualized value of the benefits is:

  $$AV_A = [1{,}500 \cdot 0.08] / [1 - (1 + 0.08)^{-5}] = \$375.7 \text{ million}$$

  For Project B, the annualized value of the benefits is:

  $$AV_B = [1{,}750 \cdot 0.08] / [1 - (1 + 0.08)^{-7}] = \$336.1 \text{ million}$$

- Conclusion: The higher present value of the net benefits for Project B than for Project A is due to a longer time horizon. When the value of net benefits is normalized with respect to time period, it is shown that Project A is in fact preferred.

STEP 5: Preparing an Accounting Statement

After completing the analysis, it is expected that the results will be summarized in an accounting statement. Analysts are advised to adopt the format that is best suited for a specific policy, while remaining faithful to the intent of the accounting statement, as illustrated below. The purpose is to highlight key components of the benefits and costs associated with the policy and the total net outcome of the analysis.

5.1 Cost-benefit analysis for each option (accounting statement section A)

Table 1 provides the incremental benefits and costs of the policy as compared to the baseline scenario. For each option, two sets of analytical results can be shown. Part I presents the results of benefits and costs based on single (deterministic) values for all of the variables affecting the policy outcome, where no risk or uncertainty is assumed for the values. Part II presents Monte Carlo simulation results by dealing with uncertainty and risk surrounding the future value each of the key input variables contributes to the policy outcome.

In the deterministic case, one should present not only annual estimates of benefits and costs but also the present value or annualized value of the net benefits over the policy impact period. This is shown in Part IA of Table 1.

Annual estimates of the undiscounted streams of benefits and costs should be presented over the impacted period. The impacted period could vary from one policy to another and a time interval could also be used if more relevant. If the original estimates are expressed in nominal dollars, they should be deflated to become real prices or prices expressed in terms of the price level of a

specific year using the GDP deflator. If the GDP deflator is not readily available, the consumer price index should be used.

For the monetized category, the total benefits and costs should be discounted to the present value using a real discount rate of 8 per cent. The net incremental benefits (i.e. the benefits less the costs) should be provided in order to obtain the net present value of the policy. The net present value should also be converted to an annualized value for alternative presentation of the results. Although the results are the same as the net present value criterion, it is another way of presenting the results.

The expected benefits and costs can be grouped into the following three categories: monetized; physically quantified but not monetized; and qualitative or intangible, that is neither monetized nor quantifiable. As some of the benefits generated from regulatory policies are difficult to quantify, attempts should be made using alternative methods of quantification illustrated in this guide. However, for the items where the benefits or costs cannot be quantified, some can be physically quantified but not monetized, in which case they should be listed in physical units. Those intangible or qualitative items that are likely to have significant impacts on decision making should be listed and their importance briefly stated. Only those benefits and costs that are monetized can be aggregated to arrive at the net benefits.

When the main benefits generated by the policy are too difficult to monetize, one should present the cost-effectiveness ratios for each of the alternative options. Wherever possible, cost-utility analysis should be used, as it provides additional information and moves the analysis a step closer to a complete cost-benefit analysis.

In this situation, the analysis does not place a monetary value on the benefits. To get the overall result of the option, one should discount the physical quantities of the benefits produced with the same discount rate. In other words, both the monetary value of the costs and the units of effectiveness should be discounted to the present value using a real discount rate of 8 per cent. After the cost-effectiveness ratios are computed for each of the alternative options, one can rank the alternatives and take a decision. This is illustrated in Part IB of Table 1.

Projections of the future benefits and costs so far have been discussed in terms of deterministic values. In practice, it is highly unlikely that the values of all key benefit and cost items will be known with certainty in the future. The reasons for risk and uncertainty can be a lack of information, competitive forces, advances in scientific knowledge, or technological progress. One should build a set of data around the identified input risk variables (e.g. variables 1, 2, 3, as shown in Part II of Table 1) based on the historical data or judgment of experts in the fields to generate a range of possible values and different probability distributions. Using Monte Carlo simulations, one should present the expected net benefits with probabilities given for higher and lower ranges of the values for the outcome. The presentation of the results of the analysis in this way will be more meaningful for decision makers.

5.2 Stakeholder analysis for each option (accounting statement section B)

In addition to the cost-benefit analysis, one should also present the distribution of the impacts of the policy on various stakeholders and the environment. However, the impacts depend upon the

types of regulation that may have impacts on different kinds of stakeholders. If the impacts are on different types of business, it may be presented in terms of net financial profits by specific sector. Sectors can be grouped according to the North American Industrial Classification System. If policies have significant impacts on consumers, the effects should be shown as an incremental burden on individuals and households that may be presented in terms of income groups. In the case of governments, the effects on the budgets of the federal, provincial, and other governments should be shown separately. The effects should also be shown by region or by gender, if there are significant differences in impacts. In the end, the net impact on each of the stakeholders for the nation as a whole should be presented and double counting must be avoided.

The stakeholder impacts by category shown in Table 2 are presented for illustrative purposes. Details of the template could depend upon the specific issues and respective areas of departmental responsibilities.

Table 1

Accounting Statement Section A: Cost-Benefit Analysis for Each Option

PART I: DETERMINISTIC CASE

Category	Year 1	Year 2	Year 3	…	Total npv	Annualized value
A. Cost-Benefit Analysis						
Monetized						
Benefits						
Costs						
Net Benefits						
Quantified but Unmonetized						
Benefits						
Costs						
Unquantified						
Benefits Described					n/a	n/a
Costs Described					n/a	n/a
B. Cost-Effectiveness Analysis						n/a
Benefits (quantified but unmonetized)						n/a
Costs (monetized)						n/a
Cost-Effectiveness Ratio						n/a

PART II: DEALING WITH RISK/UNCERTAINTY

Category	Values of risk variable (range)	Type of probability distribution
Key Parameters:		
Risk Variable 1:		
Risk Variable 2:		
Monte Carlo Simulation Results	**Statistic Values of the Project Outcome**	
Expected Value:		
Range of the Outcome:		
Variance:		

Table 2

Accounting Statement Section B: Stakeholder Analysis for Each Option

Category	Year 1	Year 2	Year 3	…	Total npv	Annualized
Impacts on Business						
Small Firms						
Medium–Sized Firms						
Large Firms						
Impacts on Consumers and Households						
Impacts on Governments						
Federal						
Others						
Impacts on the Environment						
Impacts by Region						
Atlantic						
Quebec						
Ontario						
Prairies						
British Columbia						

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