Table of Contents

Impacts On Canadian Competitiveness Of International Climate Change Mitigation

Christopher Holling[1] *and Robin Somerville*[2]

[1,2]***Standard Poor's DRI***

ABSTRACT

This article summarizes and provides additional perspective on a study that contributes to the growing body of analyses of the costs of limiting greenhouse gas emissions. The study estimates the economic costs to Canada of six planning scenarios. Four of these scenarios involve the use of tradable emission permits and two involved a carbon tax. In each case, the mechanism's target is to stabilize greenhouse gas emissions at some percentage of 1990 levels (100% or 90%) by either 2010 or 2015. Policies that impose greater constraints on carbon dioxide emissions lead to higher economic costs in terms of foregone output. These costs, however, vary for the same objective, depending on the mechanism chosen and the economic assumptions made. In one typical scenario, in which tradable emission permits are used to achieve stabilization at 1990 levels by 2010, GDP is depressed from the "business−as−usual" scenario by about 2% for the first decade, after which it recovers to business−as−usual levels. Generally, for all scenarios, the economic impact of climate change mitigation imposes a transition cost on the economy, but the long−term productive capacity of the economy is not significantly affected.

KEY WORDS: Climate Change; Greenhouse Gas Emission Limits; Canada; Economic Impact; Costs.

INTRODUCTION

The scientific community has been intensively researching the effects of anthropogenic greenhouse gas (GHG) emissions on the world's climate for about 15 years. The economics and business community, including analysts involved in this study by Standard & Poor's DRI, have been researching the economic costs of GHG emission limitation strategies for about half of that period.

On both sides of the "fence," uncertainty reigns. The climate change that will result from the increase in atmospheric GHG concentrations is uncertain. The economic impact of actions to limit GHG emissions is also uncertain. Even more uncertain is the economic benefit of mitigating GHG−induced climate change. Although it is becoming increasingly clear that the future economic costs of failing to act now are potentially high, a large range of uncertainty is associated with each element of the cost/benefit equation of climate change mitigation. This high degree of uncertainty is partly responsible for slowing down the public policy decision−making process.

Yet, it is heartening that the degree of scientific and economic uncertainty has fallen steadily over the last 15 years. Furthermore, the parameters of the uncertainty are understood much more precisely. On the economics side, there is a growing, common understanding of the most sensitive assumptions, the range of potential policy instruments, and the process of technological innovation. In addition, there is a more general understanding of the strengths and weaknesses of different analytical tools such as "top−down" input−output, econometric, and computable general equilibrium models, as well as "bottom−up" technology analysis and hybrid "top−down/bottom−up" modeling frameworks.

In a recent study, Standard & Poor's DRI used its family of linked Canadian, U.S., and other international econometric and energy demand models to conduct an essentially "top−down" analysis. The study, funded by the Canadian government, helped to establish Canada's negotiating position at the Third Conference of the Parties in Kyoto, Japan. The study does not address the important challenge of quantifying the economic benefits of mitigating climate change by reducing GHG emissions.

The purpose of this article is to provide a brief summary of the study and some additional perspectives on modeling assumptions. Interested readers can find the full study and executive summary at the Standard & Poor's DRI web site.

PLANNING SCENARIOS

Table 1 presents an overview of the six planning scenarios examined in this study. The heart of each planning scenario is the target and mechanism adopted. The target refers to the quantified emissions limit and reduction objective (QELRO) assumed for the scenario. The mechanism is the means to achieve that goal: either a tradable emission permit system or a carbon tax. These scenarios were conducted under the assumption that all other Annex I countries would also adopt these targets and mechanisms (see Table 1 for a definition of the Annex I countries).

TABLE 1: Scenario summary for proposed reductions in greenhouse gas emissions.

QELRO	Tradable permit	Domestic carbon tax
Stabilize at 1990 levels by 2010	No international trading: “2010” scenario International trading within Annex I countries: “2010@ITP” scenario	Debt reduction: “2010@DEBT” scenario Revenue neutral: “2010@REV” scenario
Stabilize at 1990 levels by 2015	No international trading: “2015” scenario	
10% reduction from 1990 levels by 2010	No international trading: “2010@10%” scenario	

Annex I Countries: All OECD countries (except Mexico and South Korea), the European Union, and 12 countries undergoing the transition to a market economy.

Annex II Countries: All Annex I countries except the 12 countries undergoing the transition to a market economy.

The tradable permit scheme assumed in this study would be mandatory and would provide participants with permits entitling them to emit an amount equal to x% of their 1990 CO_2 emissions, starting in a specified future year. This free−of−charge distribution scheme is called `grandfathering.' These permits could be bought from or sold to other participants and would trade at a market price equal to the marginal cost of abatement of a tonne (1000 kg) of CO_2. Advantages of a system of tradable permits are that the national emissions target is met with certainty and the marginal cost of abatement is equalized among participants.

Permits are assumed to be allocated to energy users at the point of first purchase under both national and international trading schemes. In this case, electricity producers, industries, oil refiners, and natural gas distributors receive permits; the latter two groups do not require permits for oil and natural gas sold to the former two groups. Exports of fossil fuels are exempt, whereas imported fuels require a permit. The initial impact of a permit scheme is to raise the domestic price of energy that contains carbon.

STUDY ASSUMPTIONS

Interested readers are encouraged to review the discussion of detailed assumptions in either the full study or the executive summary at the Standard & Poor's DRI web site. In this article, we would like to give some perspective on the two most important assumptions: energy efficiency improvements and the disposition of financial flows generated by the policy instruments.

Energy Efficiency

Achieving a specified target requires less consumption of energy that generates carbon dioxide. This can be done by reducing demand for energy−intensive products/activities and/or improving the energy efficiency of those energy−intensive products/activities. For example, in the automotive sector, the miles−per−gallon of the vehicle stock can be improved and/or the number of vehicle−miles traveled can be reduced.

Considerable debate takes place about the degree to which innovation will generate increases in the energy efficiency of economic activity or decreases in the carbon intensity of energy. The time path of such innovations and what it will take to have them adopted are both an important set of assumptions and a source of uncertainty.

Less debate and research have focused on changes in detailed consumption and production patterns. Consumer preferences and real incomes are constantly changing, and successful firms continually pursue innovations to take advantage of these changes. Often, the result is increased consumption of energy−intensive products or activities, or development of new energy−consuming products or activities. These dynamics are a source of even more uncertainty.

For example, energy efficiency standards for many domestic appliances have improved dramatically over the last 10 years, but the GHG emission reductions associated with these improvements have been counteracted by changes in consumer choices. Consumers are now choosing to buy larger appliances with more features (e.g., refrigerators, microwaves, bathtubs), to own more appliances in general, or to purchase appliances that they had never even thought of 10 years ago (e.g., bread makers). Other examples include the proliferation of 50−inch televisions, 17−inch computer monitors, and the ever−expanding selection of computer peripherals. Similarly, there have been significant energy efficiency improvements in motor vehicles. However, these savings have been counteracted by an increase in the number of vehicle miles traveled and a shift in consumer tastes toward inherently less efficient vehicle types, such as minvans and sport utility vehicles. Our approach is to assume a continuation of this dynamic in the future. Consequently, large energy price increases are required to affect consumption patterns in a way that will achieve the GHG emission targets. These relative price changes impose significant short−term transition costs on the economy.

Financial Flows

Most GHG limitation policies involve internalizing an economic externality. Currently, the true cost of emitting GHGs is not falling on those who generate the emissions. Economists call this situation a negative externality. A tradable permit scheme or carbon tax causes these costs to be internalized into the decision−making processes of GHG emitters. However, internalization of this negative externality generates a financial flow. In the case of a carbon tax or tradable permit auction, the government will receive the money. In the case of a policy involving free distribution of tradable emission permits, the money will flow to the permit recipients. These flows can be used, for example, to reduce fiscal deficits or debt, reduce income or consumption taxes, increase corporate profits, fund investment tax incentive schemes, or subsidize affected segments of the economy. These flows can also be subject to varying degrees of "leakage" from an economy.

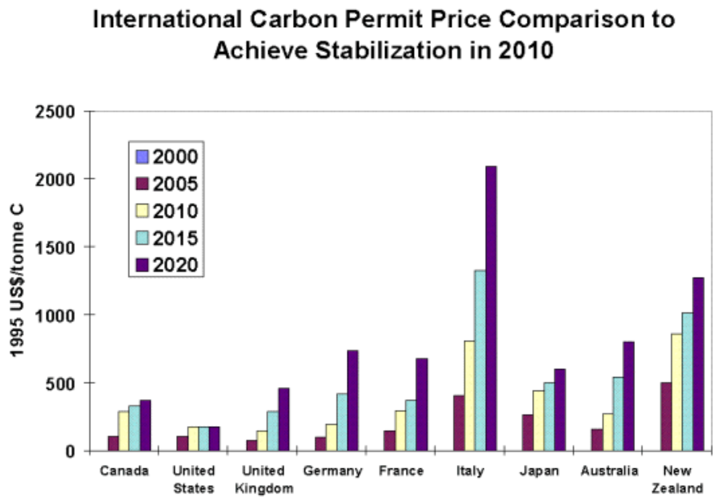
The size and distribution of these financial flows can have dramatic impact on economic costs of a policy measure. Flow sizes are a function of the size of the emission reduction target and the marginal cost of CO_2 abatement. Both factors are discussed in the next section.

FOCUS ON STABILIZATION AT 1990 LEVELS BY 2010

In this planning scenario, Annex I countries adopt a single target of stabilizing CO_2 emissions at 1990 levels by 2010. This target is achieved by means of individual national emissions trading schemes that are announced in 2000 and introduced in 2010. For Canada, meeting this target involves reducing CO_2 emissions by 34%, or 150 x 10^6 metric tonnes (150 x 10^9 kg) from business−as−usual levels in 2010, and by a further 50 x 10^6 metric tonnes in 2020.

Figure 1 illustrates carbon permit prices for nine large Annex II countries in the 2010 Scenario (see Table 1 for a definition of the Annex II countries). The tradable permit price, or marginal cost of CO_2 abatement, is about twice that of the United States, but is still significantly lower than the price needed to achieve stabilization in other Annex II countries.

FIG. 1. Tradable permit prices.



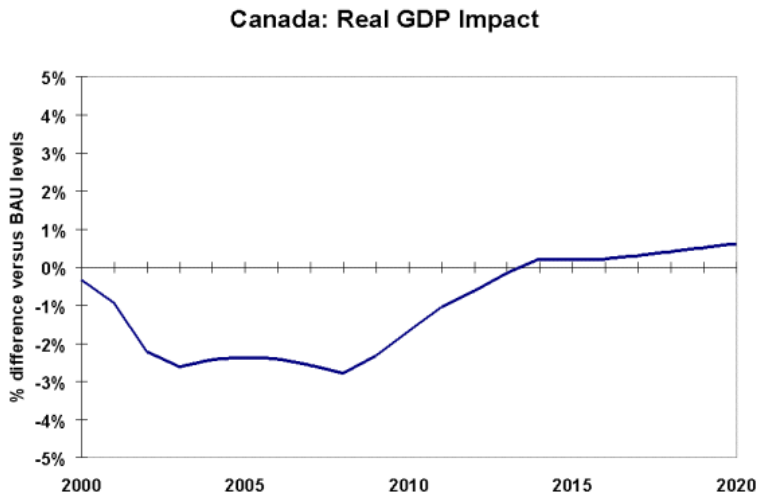
In Canada, end−user energy prices are higher under carbon stabilization as a result of permit prices that range from $325 (1995 Canadian dollars) per tonne of carbon (toc) in 2010 to $425 per toc by 2020. As a result, the energy cost, expressed in 1995 dollars, rises by about 50% for oil products and rises by > 400% for coal products by 2020, relative to the price level expected in the business−as−usual outlook.

To stabilize carbon dioxide emissions in Canada, DRI estimates that total primary energy consumption must be reduced by 17% in 2010 and 19% in 2020, compared with business−as−usual levels. In growth rate terms, the projected 1.1% average annual increase between 1995 and 2020 moderates to just 0.2% per year in the stabilization scenario. This lower consumption is achieved through energy efficiency gains as well as reduced consumption of carbon−intensive goods relative to less carbon−intensive goods.

Canadian Economic Impacts

Figure 2 displays the impact on Canada's real GDP of the 2010 scenario as the percentage difference from business−as−usual levels. The overall result shows a weaker economy through the first 13 years, with a modest improvement above the business−as−usual case for the last seven years of the simulation. Prices continue to rise throughout the forecast period.

FIG. 2. 2010 scenario impact.



Rising energy prices lead to reduced investment in the energy sector from business−as−usual levels, as both energy and non−energy sectors of the economy adjust their business plans to be consistent with operating in a carbon−constrained environment. The relative price of carbon−intensive goods rises, producing both substitution and income effects that reduce overall economic activity.

The international nature of this policy objective means that all Annex I countries will be going through this adjustment process at the same time. The adjustment costs experienced by Canada's trading partners translate into reduced demand for Canadian exports and, as a result, the Canadian economy must absorb both impacts simultaneously.

The economic impact of carbon constraints can be characterized as imposing a transition cost on the Canadian economy. The key finding from this analysis is that the Canadian economy would experience significant transition costs for at least a decade, but would produce about the same level of output in 2020, at a reduced level of CO_2 emissions, as it would have done in the business−as−usual scenario. It is important to note, however, that during this period of transition, certain sectors or regions will either permanently shrink or grow in importance, depending on changes in their cost structure and competitiveness and the resulting change in demand for their goods and services.

The following set of questions and answers is intended to help the reader understand the economic rationale for results obtained by this study.

Q. Why does the Canadian economy recover?

A. The productive capacity of the economy returns to business−as−usual levels by 2020.

The critical question to answer is: why does the Canadian economy recover? The answer depends on the interaction of a number of different factors. First and foremost, however, the long−term economic response depends on the evolution of its productive capacity. This "supply side" of the economy is determined by three factors in DRI's: model, labor, energy, and capital.

The largest determinant of Canada's productive capacity is labor, which is assumed to be unaffected by policies of climate change mitigation. This assumption means that net international migration, fertility, and mortality rates are left at business−as−usual levels (i.e., the population and its age structure are left unchanged).

Energy use in the economy declines 20% from business−as−usual levels by 2020, which contributes to a 0.5% decline by 2020 in the productive capacity of the economy relative to business−as−usual levels.

The third factor, capital stock, is 3.5% below business−as−usual levels in 2010, but returns to business−as−usual levels by 2020. Evolution of the capital stock is the key factor driving the cyclical response of the Canadian economy, and is explained more fully in the following sections.

Combining these three factors, the productive capacity of the Canadian economy is 0.2% below business−as−usual levels by 2020, but declines by as much as 2.1% in 2009−2010. The response in productive capacity of the economy indicates that the economic impact of climate change mitigation imposes a transition cost on the economy, but the long−term productive capacity is affected to a far lesser degree.

Q. Why does the capital stock rebound to business−as−usual levels?

A. Higher corporate profits fuel a rebound in investment.

The answer to why the capital stock rebounds can be found by examining the impact of the policy on the three factors that determine investment (outside of the energy sector): cost of capital, economic activity, and retained earnings.

The real cost of capital is higher as a result of this policy, and acts to reduce investment throughout the period. General economic activity declines by as much as 2.9% from business−as−usual levels before recovering to 0.9% above by 2020. This recovery contributes to the investment rebound, but to a far lesser degree than the rise in corporate profits. Driven by corporate profits, retained earnings adjusted for inflation are 27% higher in 2020 relative to business−as−usual levels. The increase in cash is used to finance investment in areas of the economy that are less significantly impacted by higher energy costs.

Q. Why do corporate profits rise?

A. Higher selling prices and lower costs leave participants with higher profits.

From the year 2000 on, the selling price of energy products rises relative to business−as−usual levels, but the world price of oil falls. This divergence between revenues and costs provides participants with higher profits. These are the financial flows previously discussed. Corporations receiving these higher profits are assumed to return some to shareholders in the form of dividends and to keep the remainder as retained earnings. Retained earnings are, in turn, used to finance new domestic investment. This new investment is assumed to take place in the sectors of the economy that will provide the highest rate of return.

Several alternative assumptions for distributing the windfall profits to participants have been suggested. One possibility involved distributing all the gains to shareholders in the form of dividends. This approach would have raised disposable income, which would have raised consumption, and this would have provided businesses with an incentive to invest. Alternatively, the windfall profits could have been invested outside Canada. This investment would eventually produce an income stream for Canadian organizations that would stimulate domestic activity (provided the original funds were invested and not just distributed to foreign nationals). The impact of these alternative assumptions was not determined for this study.

Q. What happens to labor?

A. Labor's share of income falls, leaving business with a larger take.

Goods and services produced by the economy provide income to households and corporations. By 2020, labor's share of nominal income falls to 67.5% from 68.5% under business−as−usual, while business' share rises to 11.6% from 9.1%.

The reduction in labor's share of nominal income must be considered in terms of both the number of people employed by the economy and the wage rate they receive.

By 2020, the overall level of employment is 0.7% higher than in the business−as−usual case. This increase is driven by two factors: higher output (0.6%) and a lower relative cost of labor (−1.5%). The lower relative cost of labor is also driven by two factors: unemployment rate and labor productivity. An initial rise in the unemployment rate depresses wage gains; this effect, coupled with a decline in output per worker, leaves real wage rates below business−as−usual levels throughout the simulation period.

Q. What happens to the household sector?

A. Spending patterns shift away from high−cost, energy−intensive goods.

By 2020, household spending on goods, services, and residential investment is 0.5% below business−as−usual levels, and falls by as much as 2.7% below business−as−usual levels in 2008. Three factors influence activity in the household sector: real income, real interest rate, and relative prices.

The real interest rate influences the timing of household purchases. The real rate of interest is assumed to be held fixed by the monetary authorities in these simulations, so it exerts no additional influence on household behavior. Real income is the key determinant of total household spending, whereas relative prices determine which goods and services households buy.

Real disposable income remains below business−as−usual levels throughout the simulation: down 1.2% in 2008 and down 0.2% in 2020. Net of interest payments, however, real disposable income returns to business−as−usual levels in 2010 and is 0.1% above those levels in 2020.

Initially, higher nominal interest rates raise the proportion of disposable income that households need to devote to paying off their existing stock of debt. A higher savings rate and lower expenditure levels, however, lead to a decline in the debt level as a share of disposable income throughout the forecast period: falling to 55% from 61% in 2020 in the business−as−usual case. Lower debt levels mean that, despite higher nominal interest rates, interest payments as a share of disposable income shrink from 2004 on and are 5.0% vs. 5.3% in the business−as−usual case in 2020, whereas the savings rate is still higher at 6.7% vs. 6.3%. This leaves the household sector in the position of being able to both spend and save more at the same time as interest payments take a smaller share of disposable income.

Changes in relative prices influence the goods and services purchased by households. The two hardest hit categories of personal expenditure are spending on energy, down 33% in 2020, and consumption of housing services, down 1.4% in 2020 relative to business−as−usual levels. Lower spending on energy products is a direct result of their higher relative cost, consistent with achieving policy objectives. Lower spending on housing services arises from a reduction in the housing stock, relative to business−as−usual levels, arising from lower housing starts as lower income and higher unemployment in the first decade help to postpone activity in this area. All other categories of consumption benefit from the stronger economy and the substitution away from energy consumption; as a result, they return to business−as−usual levels between 2009 and 2013.

Q. What happens to the external sector?

A. Composition of trade is affected by changing patterns of international demand.

A key assumption made in this study is that the Bank of Canada acts to keep the real exchange rate at business−as−usual levels. Because exports are determined by two factors, international demand and the relative price (terms of trade), Canadian exports, on average, are only reacting to changes in international demand in this simulation, because the terms of trade have not changed. In other words, the exchange rate has a neutral impact on Canadian trade.

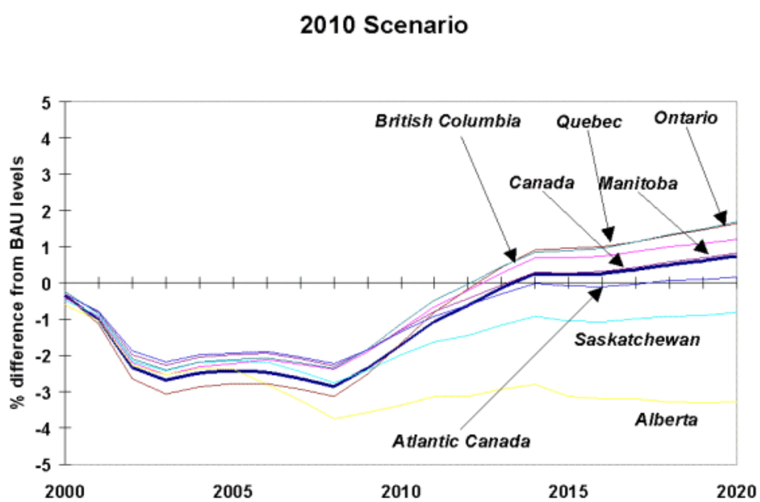
Although the terms of trade at an aggregate level remain unchanged at business−as−usual levels, the relative price of individual commodities will vary to the extent that they embody materials influenced by the permit price. The international demand terms for all commodities also vary and exert an impact on the ability of Canadian producers to sell into a given market.

The U.S. economy, Canada's major trade partner, is responsible for the initial reduction in export activity and its subsequent rebound relative to business−as−usual levels. Imports respond to domestic activity and, as a result, change in the same direction as output. The net effect leaves Canada's overall trade balance only minimally affected throughout the forecast period.

Regional Impacts

The regional real domestic product impacts depend on the geographic distribution of the industries affected. In the first decade, as can be seen in Figure 3, output in all regions declines by a similar amount. Ontario's decline is the largest, reflecting the general economic decline that reduces demand for goods and services usually produced in Ontario.

FIG. 3. Canadian regional impacts.



In the second decade, effects of the economic restructuring that results from carbon constraints become evident. Alberta and Saskatchewan, with their large, carbon−based sectors, suffer the most adverse economic results from this QELRO, followed to a lesser extent by Atlantic Canada. Manitoba's economic performance matches the national average, whereas British Columbia, Ontario, and Quebec benefit, with Quebec's output rising 1.7% above business−as−usual levels in 2020.

SUMMARY

Reducing CO_2 emissions will impose short− to medium−term transition costs on the Canadian economy. After 10−15 years (post−2013), the Canadian economy is expected to produce about the same level of output as under business−as−usual conditions, albeit at a reduced level of CO_2 emissions. Transition costs vary by region and sector.

The level and distribution of costs can vary greatly, depending on the choice of domestic implementation strategy. In a national permit trading scheme, the initial allocation of permits can influence distribution of costs and speed of the recovery. The size and disposition of the financial flows generated by tradable permits or carbon taxes can also influence the magnitude and distribution of the costs.

In addition, a more stringent target has a noticeable impact on costs. Further delaying stabilization by five years has smaller costs up to 2010, but higher costs for the following 10 years.

RESPONSES TO THIS ARTICLE

Responses to this article are invited. If accepted for publication, your response will be hyperlinked to the article. To submit a comment, follow this link. To read comments already accepted, follow this link.

Address of Correspondent:
Christopher Holling
Standard Poor's DRI
Suite 1100
PO Box 193
130 King Street West
Toronto, Ontario, Canada M5X 1A6
Phone: 1 416 682 7303
cholling@dri.mcgraw−hill.com
