Book Reviews

Canadian Competitiveness and the Control of Greenhouse Gas Emissions

by DRI/McGraw Hill, June 1993

Prepared for five federal government departments, this study seeks to integrate information from a benefit-cost framework with energy-modelling and macroeconomic impact tools, in order to assess the likely economic effects of taking unilateral Canadian action to reduce Greenhouse gas emissions. The first two components provide valuable insights about institutions and commodities. The macro-economic model holds the promise of incorporating information on indirect and induced effects, and on dynamic transmission mechanisms.

Effects are measured through several major indicators of overall national and provincial economic activity, and by focusing on the impacts for major energy producing and using industries. "Competi-tiveness" impacts are assessed by the effects on Total Factor Productivity (TFP), measured at the total-Canada level. Effects on energy demand and Greenhouse gas emissions are also measured.

Impacts are generated in two ways: (1) by utilizing one of a variety of low-cost, technically feasible, "no regrets" package of policy instruments, or (2) through imposition of a $150 (1990 $/tonne) carbon tax. In both cases, action begins in 1995 and continues through 2010.

Both cases represent "significant" action. Interpreting from tabulations in the report, it appears that cumulated incremental spending by households, industry, and governments over the 15 years amounts to more than $71 billion (at 1990 prices) in the "Instruments" Case. Through retrofitting of housing, R2000 applied to new housing, appliance efficiency standards, and mandatory vehicle inspection and maintenance programs, households bear three-fifths of the direct costs.

Business and governments account for approximately equal shares of the balance, and governments pass the financing burden of their own costs on by an *ex ante* increase in a "standard" mix of personal, corporate and indirect tax increases. Changes to the technology matrix reduce business requirements for energy inputs, pushing prices down. How upward pressures on unit costs associated with increased environmental

capital are accommodated in the price system is not clear, but positive effects on nominal pre-tax profits suggest strong increases in real returns. This should be adding to inflation, and feeding back, if evaluated at the industry level, through relative price effects, on final demand. Again, how this is handled is not immediately clear.

In the Carbon Tax Case, government revenues rise from an initial $8.8 billion (at 1990 prices) in 1995 to $18.8 billion in 2010. Additional revenues are recycled back to the economy in the form of reduced taxes using the standard mix. In both cases, an accommodating monetary policy (no change in nominal interest rates from that of the Base Case) is chosen, and nominal exchange rates are unchanged from the Base Case. For the Instruments Case, reduced annual price changes yield a higher real interest rate throughout the 15 years. Net of this and exogenous increases in investment to meet the emission-reduction requirements, *ex post* business investment is notably reduced throughout. For the Carbon Tax, there is a one-time drop in the real interest rate initially, followed by Base Case real interest rates through the balance of the impact period.

Phasing differences affect impacts over time, but in the end (2010), real GDP in the Carbon Tax Case is reduced by 1%, and in the Instruments Case, by 0.7%. If carbon taxes are used, the aggregate price level is increased steadily over time, to 3.9% for the GDP deflator, by 2010. However, it is reduced in the Instruments Case by 6.6%. All-government balances are adversely affected in both cases. Counter-intuitively for cases that assume this is unilateral Canadian action, net foreign borrowing requirements are reduced throughout the 15 years in both cases. TFP in 2010 is increased by 0.6% in the Instruments Case, and is unchanged in that year by the use of a carbon tax.

In January 1991, real GDP at factor cost fell by more than 1% from that of the preceding month. Combined increases in February and March of 1993 left the economy in March more than 1% larger than in January. Given month-to-month changes of these magnitudes, it is hard to get excited about changes of 1% after 15 years. Further, our own work, and most macroeconomic impact statements produced in North America and Europe, have usually concluded that impacts on overall economic activity are small. Indeed, DRI's results produced for Imperial Oil (no friend of any of this) in 1991, concluded that in the case of an "extreme" carbon tax ($200 per tonne), real GDP would be reduced by 0.4% after 15 years.

In short, there is nothing new in the message about overall impacts. The devil is in the details.

In both the Instruments and Carbon Tax cases, energy-producing sectors are adversely affected, particularly in upstream oil and gas, refineries, and electric utilities. There should be no surprise in this, since domestic energy demand is reduced. How much each industry is affected, however, will likely be heavily determined by institutional details affecting particular refineries and oil fields, since location-specific considerations and contracts can determine effects on net exports.

For example, the Instruments Case has lower inflation and appears to yield lower unit costs of production in the Canadian economy, which would suggest an enhanced competitive position for Canadian oil, coal and other energy producers. As "price takers," this might not yield near-term increases in exports using resources freed up by reduced domestic demand. However, to argue this is a long-term result, as DRI does, is questionable. Still, DRI has long experience in energy modelling, so they may have brought some institutional detail to bear on this. If so, it is not documented.

In the Instruments Case, all major energy-using industries are positively affected. In 2010, this includes notably larger output for manufacturers of plastics (14%), transportation equipment (12%), primary metals (8%), non-energy mining (6%), and the forestry (7%). In the Carbon Tax Case, output in 2010 is reduced from that of the Base Case for most of these, but generally by 3%, or less.

This distinction appears to follow from fundamentally different views of microeconomic behaviour between the two cases. In the Instruments Case, consumers and businesses seamlessly adopt technically feasible energy-savings devices and conserving behaviour. In the Carbon Tax Case, demand elasticities drive the view, and implicitly incorporate "private" economic reasons for slower adoption of energy savings devices

and behaviour.

In effect, the difference in the results occurs because of differing assumptions, not because of actual analysis of behaviour. Further, since the overall reduction in energy demand of the Instruments Case is twice that of the Carbon Tax Case, the benefits to real incomes and demands, and in the form of reduced unit costs of production, is exaggerated by the Base Case assumption that real oil prices rise by an average of 2.6% annually in 1990-2010.

To conclude, as the study does, that the "costs of removing GHG emissions, measured as cumulative lost dollars (1990$) of GDP per tonne of carbon removed, is higher under a carbon tax than under the instruments package" is conditioned by the very special assumptions made, and is not generalizable on the basis of this investigation. Indeed, there is no reason why governments cannot walk and chew gum at the same time, using some modest proportion of tax revenues to, for example, break down information barriers. Remember, however, that big thinkers at the centre had something to do with the urea formaldehyde insulation programs.

Still, the analysis of why instruments were selected or not represents an up-to-date view of what is known, and is a reason to have this report on your reference shelf. The view that impacts on particular industries will likely be modest mirrors our own results, and those reported for Imperial Oil in 1991. That there are externalities, and that government information or instruments can lead to expedited energy savings, is not new.

The specific benefits to the output of energy-using industries reported in this study are an effort to document the linkage, but I am not persuaded that the results are definitive. The view that there should be notably positive impacts on output in Ontario follows from the sectoral findings, and is similarly at risk. The finding that output of the chemical and allied industries will be increased regardless of the basis for emission reduction, and by much more in the Carbon Tax than the Instruments Case, is puzzling.

Sensitivity of the results to assumptions about fiscal and monetary policy, to Base Case views about the size of the output gap and relative prices, and to whether actions are being taken unilaterally, or in concert with other countries, is relevant to the results, and is not explored in the study. These assumptions are probably not important in determining the overall results, but they are likely crucial for industrial and regional results.

The report outlines the modelling framework used, rather than providing detail. It appears to me that the detailed industry model used does not endogenously detail production functions, notably excluding information on industry capital stocks. If this is the case, then the TFP conclusion developed from this framework is problematic.

I close with two suggestions to the sponsors of this kind of research. First, there is no effort in this study to feed back benefits to the economy of reduced emissions. Since the Canadian contribution to global Greenhouse Gases is so small, this is excusable on that ground. However, these reduced emissions also impact other forms of environmental stress, with local impacts. Attempts should be made to measure these, and incorporate them in this kind of analysis.

Second, our analysis of the *Green Plan* suggests that those energy-producing and using industries that are the focus of this study are the same industries most likely to be directly affected by concerns about water, toxic waste, and even packaging protocols. Cost curves for particular firms and establishments may not be continuous; attention to firm and establishment level detail is crucial if this is the case and if impacts are to be properly measured. Of course, for the sponsors of the research, it may mean making some choices about which environmental stresses are to be tackled, and in what order. That may take some courage, since as most of us already know, the analysis is likely to suggest priorities different from predispositions of the electorate.

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Petroleum Reserve Responsiveness in the United States

by J.R. FERRY
Garland Publishing Inc., 1993
163 pp.

and

Oil and Gas Forecasting: Reflections of a Petroleum Geologist

by L.J. DREW
Oxford University Press., 1990
252 pp.

Produced as part of the Garland Series of outstanding studies and recent dissertations on government and the economy, the central thesis of *Petroleum Reserve Responsiveness in the United States* is that profit expectations drive exploration activity. Exploration activity is modelled as a function of expected reserve values, which in turn depend on physical, market and fiscal assumptions. Against this background, the books sets as its objectives: (1) an increased understanding of petroleum reserve responsiveness from a policy perspective, and (2) the updating of the Fisher (1964) and Epple (1975) modelling frameworks for improved supply responsiveness forecasting. While it clearly achieves the latter goal, it falls well short of the former. The book provides a competent econometric description of the supply forecasting problem and succeeds in updating the Fisher model to include more detailed descriptions of the types of supply additions induced by changes in either price or policy. Unfortunately, as with most econometric-based approaches, the book fails to adequately account for, or understand, the significant body of geologic literature elucidating the influence of physical (non-market) factors on the occurrence, discovery and production of hydrocarbons. In this regard the approach adopted by the book suffers from the traditional economics-based approach to supply forecasting. Economists tend to view the resource estimation problem purely as one of predicting the marginal increase in reserves resulting from an increment in either price or exploration effort, rather than as an exercise in determining the total size of the resource base. Despite the lack of geological sophistication, econometric modelling approaches remain popular, largely because they hold the promise of policy analysis and produce outputs consistent with macroeconomic models.

Central to the book is the development of two supply forecasting frameworks that owe much to the pioneering work of Fisher (1964) and Epple (1975). In the tradition of both Fisher and Epple, the firm is modelled as a price taker in a competitive petroleum market. While it is standard to assume competitive petroleum markets, many may question the legitimacy of the assumption. However, it is fiscal policy which provides the true focus of the model. A comprehensive review of policies from the 1880s rule of capture through to the Windfall Profit Tax Act of 1980 provide a compelling argument for the inclusion of fiscal policy variables in the model because of their impact on the unit price, or discovery value, of the reserve base. There is a clear development of the theory behind the unit price equation, supported with necessary details in the appendix showing the derivation of the reduced form equations used for estimation purposes. However, the assumptions of price and policy constancy, required for model development, pose problems. Volatility in oil markets and market uncertainties have certainly had an effect on exploration and production decisions in a number of countries. Over the long-term it is probably unreasonable to assume that firms now presume that either price or policy constancy will prevail, a fact which limits the utility of the proposed modelling framework to the short-term.

The book's discussion of the theoretical underpinnings of the Epple model and the way in which it deals with physical constraints on the discovery process through the derivation of a land function are clear and concise. The view of land as a non-renewable input into the reserve production process has intuitive appeal.

Uncertainty regarding the quantity and quality of available lands are dismissed with the argument that the mere expectation that land is becoming less productive is sufficient to drive the exhaustion theory imbedded in the model. However, MacAvoy and Pindyck (1973), also following in Fisher's tradition, found it necessary to include specific consideration of variability. When combined with the poor estimation results for the Epple model, the evidence as to the importance of considering variability in both discovery size and land quality seems clear. It is precisely the heterogeneity of both oil-bearing lands and the discovery process which confound the discovery prediction process, making it the difficult problem that it is.

Much of the rest of the book is devoted to the detailed development of the *Ad-Hoc* supply model. Supply responsiveness is disaggregated into six categories: new field discoveries, new reservoir discoveries in old fields, extensions, revisions to previous discoveries, production and end-of-year reserves. The disaggregation is to the level allowed by available data. While the reader is given the impression that the disaggregation represents an advance in modelling practice, it is little more than the accumulation of suggestions given in previous work. Scant attention is paid to previous attempts to improve supply responsiveness, including Erickson and Spann (1971), MacAvoy and Pindyck (1973) and Eckbo, Jacoby and Smith (1978). Omitted altogether is Rice and Smith (1977). This is unfortunate in so far as a clear discussion of the debt owed to these other attempts would have done much to highlight the book's advances.

Simple logic is offered for the model equations. Though here, as elsewhere, more detail would have helped convince the reader of the rationale behind the inclusion of the chosen variables. Theoretical concerns detailed in Epple give way to the technical concerns of estimation and available data, justifying the *Ad-Hoc* model epithet. OLS techniques were used for parameter estimation and inherent model non-linearities removed through the use of log-transformations. There was no discussion of the potential impacts of heteroscedastic errors on parameter estimates. As the errors are clearly heteroscedastic (Fuller 1991), this represents a technical short-coming in the work.

An in-sample comparison of the *Ad-Hoc* model forecast performance with the updated Epple model was also completed. Given the debt the *Ad-Hoc* model owes to the Fisher framework, this is a curious choice. Surely it would have been better to compare the model with its immediate ancestor than to compare it to an updated model described as having problems with data availability. Finally, there is an analysis of the windfall profits tax policy. The analysis concluded that the tax reduced production by as much as 65 billion barrels per year by 1987. Here again, the analysis suffers from not being clearly connected to the available windfall profits tax literature. A comparison of model results to contemporary and retrospective studies of the effects of a windfall profits tax would have done much to enhance the book and to convince the reader of the power of the proposed policy analysis framework.

The book represents an important addition to the econometric based attempts to forecast supply responsiveness. For those seriously interested in the modelling of supply responsiveness the book will be an informative read. For those less interested in the mechanics of model specification and use, the demonstrated ability to construct energy models for policy analysis purposes should place the issue of energy policy analysis within the arena of public debate and help to connect energy policy issues to the wider issues of macroeconomic interest. To that extent the modelling work contained in the book provides a useful addition to the body of hydrocarbon supply related analysis.

However, like most econometric approaches *Petroleum Reserve Responsiveness in the United States* fails to recognize the large amount of geologically based supply forecasting work. Accordingly, a review of a recent contribution to the geologic literature, Lawrence Drew's *Oil and Gas Forecasting: Reflections of a Petroleum Geologist* may prove informative for those less familiar with this literature. As one of the early innovators of the US Geological Survey's (USGS) process discovery modelling approach to supply forecasting, Drew has displayed a consistent interest in determining whether available oil and gas statistical data were amenable to quantitative and predictive analytical techniques. His book is a largely personal account of the development of his own approach to

discovery rate forecasting. Though at times technical in nature, the technical detail is never allowed to become overwhelming. This, when combined with the many anecdotal asides about the USGS's approach to reserve estimation, the opposing schools of thought on the resource estimation problem and the interaction between economists and geologists, ensures that the book is an enjoyable read for all interested in the difficulties associated with making accurate resource assessments.

Chapters 1 and 2 deal with Drew's early experiences with attempts to model the exploration process and complete resource assessments. These experiences were critical to his conclusion that the analysis ought to be conducted at the level of the play, the play being the smallest homogeneous unit that makes both geologic and statistical sense. Further description of his early experiences at the USGS, and the unfolding of the resource assessment debate between the Hubbert and McKelvey resource assessment schools, highlights the disparities in the early resource assessments and the need for the development of scientifically based assessment methods.

Before embarking on a detailed discussion of his own contributions to the development of discovery process models, Drew gives a thoughtful account of the contributions made by Arps and Roberts (1958), J.T. Ryan (1973a, 1973b) and G.M. Kaufman (1975) to the development and practice of discovery process modelling. Critical to his own models were Kaufman's postulates that the size distribution of fields within a subpopulation was lognormal and that discoveries were made proportional to size through a sampling without replacement process. The material of chapters 3 and 4 serves as an excellent introduction to the geologic supply forecasting literature. For those unacquainted with the literature the book provides an adequate introduction to the most important contributions. For those more acquainted with the literature, the discussions surrounding the development of geologic-based supply forecasting provide a number of critical insights into important technical issues.

Chapter 5, though short, offers some rare and informative insights. Unlike many from a technical background, Drew made a conscious effort to bridge the gap between the geologic and economic perspectives to supply forecasting. His study of economics enables him to offer a balanced view of the differences in philosophy between the two professions and their resulting approaches to a problem of common interest. As Drew points out, geologists have "the propensity to identify everything as being unique. No detail is insignificant." Geologists are, in a word, reductionist. Economists differ from geologists because they are interested in motives and choices and are comfortable with the notion of oil fields as only vaguely defined in a physical sense. The gap between the two professions is unlikely to close soon. The geologist will continue to hold to the view of a finite earth and dwindling resources, while the economist, looking back over history, sees no problems as a result of substitution and price adjustments. It is the nature of that philosophical gap that explains the distinctiveness of the approaches taken to resource assessment by both professions. Drew concludes his comparison by noting that while the reductionist geologic approach yields an intuitive approach to supply forecasting, it is unlikely to match the supply and demand calculus of economics for tidy summaries of a complex problem.

The core of the book is contained in chapters 6 through 8, which relate in some detail the development of the discovery process modelling approach for which Drew is best known. As a group, geologists at the USGS were interested in the mechanics of how undiscovered resources were converted into reserves through the exploration process and the determination of which statistical distribution best described the underlying parent population of discovery sizes. The description of the problems associated with model development, calibration and validation are at times technical and may not be fully appreciated by those encountering a description of Drew's own approach to discovery rate forecasting for the first time. Nevertheless, the details contained in the book provide a careful synopsis of previously released journal and USGS publications. The discussion is carried out within the context of attempts to forecast the remaining discoveries in the Permian basin and offshore Gulf of Mexico. The specifics of the forecast results themselves are less interesting than the deductions concerning economic truncation

and the probable parent discovery size distribution. The ability of discovery process modelling to demonstrate the extent and effect of economic truncation on our perceptions about the undiscovered resource base constitutes one of the most important sections of the book. Following closely in importance is the discussion about the constancy of the relationship between the ratio of the number of fields in a given size class (F_i) and the number of fields in the next largest size class (F_{i+1}). The nearly constant ratios lead Drew and his associates to postulate a log-geometric parent distribution and to suggest that many small fields remained to be discovered in partially explored basins. Until its suggestion by Drew et al., the notion of J-shaped parent populations had been considered by few geologists. If the book is to be faulted for anything, it is that the ramifications of economic truncation and J-shaped parent populations are not as fully, and philosophically, explored as they might have been in a book of professional "reflections."

A consistent message in the book is the notion that the problems with resource forecasts do not lie in inadequate data sets, but instead in modelling approaches that do not explicitly recognize what goes into the process of resource exploration and estimation. If Drew intends any message to be remembered by the reader it is the message that the physical processes involved, be they geologic, technical or economic, determine the complexity of the resource estimation problem and create a need for models adapted to the particulars of the resulting information constraints. While recognizing the role of economics in determining marginal behaviour and influencing perceptions about parent populations, Drew remains at heart a petroleum geologist for whom reductionism is as much a tenet of his science as the role of price is for an economist. Nevertheless, he has succeeded in producing an informative, often entertaining, book that makes an all too rare attempt to truly blend and appreciate two distinctive approaches to a problem. As such the book is worthy of a careful read by any who are interested in the problem of oil and gas forecasting.

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Regulatory Incentives for Demand-Side Management

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Many energy utilities, especially in the electricity industry, now consider demand-side management (DSM) as an option when they face a gap between projected demand for their services and the capacity they will have to supply it. Proponents of DSM believe that much energy is consumed inefficiently, and that consumers are insufficiently aware of unnecessary costs they are incurring and too little inclined to do something about it when they are aware of it. As a result, there is scope for utility-run programs that lead some of their customers to install better equipment, use it more effectively, insulate buildings, and even sometimes to change fuels.

DSM should be viewed as part of a new approach to utility regulation, integrated resource planning (IRP), which focuses on minimizing the full-cycle cost of energy services consumed by customers. If utility-run DSM programs can deal with a supply shortage at lower cost than building new capacity, the regulator expects that choice to be made.

Think of yourself running a company and being told that you should engage in what might be called a negative marketing program: use company funds to entice people to buy less of your product rather than more. Not surprisingly, many energy utilities have not found this idea very appealing. Yet there are situations in which it is beneficial from society's viewpoint; in which, that is, a DSM program can make overall resource allocation more efficient. How, then, can one lead reluctant energy utilities to use DSM when it is a productive option?

At least part of the answer is that regulators themselves must take account of the incentives and disincentives for the DSM option within the regulatory framework. *Regulatory Incentives for Demand-Side Management* is devoted to that issue, particularly as it applies to investor-owned utilities in the United States. It is a series of 13 papers, nicely drawn together and well-edited for the American Council for an Energy-Efficient Economy. Some of the authors are people who work directly or indirectly for energy utilities, others take part in the regulatory process in other ways, and some are researchers at universities or other organizations.

Two aspects of the problem are distinguished. One involves analysis of existing regulatory models with an eye to how they treat supply expansion and DSM. In theory it might be desirable to seek a model that is neutral in regard to the choice between selling more or reducing demand. The other is concerned with ways to provide positive incentives for DSM (with or without removal of existing positive incentives for supply expansion).

In regard to existing regulatory processes, it is observed that the conventional approach to rate-of-return regulation often involves disincentives for DSM. At a theoretical level that approach simply allows a utility to collect enough revenue to cover its operating cost and the opportunity cost of its capital and it need not discriminate against DSM. In practice it is very difficult to operate a system that has ratepayers covering exactly the true resource cost of what they buy from the utility. The standard ways in which practical problems of implementation have been dealt with result in incentives for the utility to sell more electricity or natural gas rather than less. This has led some DSM proponents to advocate the decoupling of profits from sales, a complicated proposition in practice.

Decoupling schemes have been developed by some state regulatory commissions in the US. The best known is that introduced by the California Public Utilities Commission in 1982. It and other decoupling models are described and discussed in the book.

Other papers deal with positive incentive schemes which can be built into the calculation of a utility's revenue requirement in various ways; for instance, by allowing it to include the cost of DSM projects in its rate base and apply a

bonus-level rate of return to that portion of the base. Another class of scheme is based on the idea that the utility can be given a portion of the net resource savings generated by a DSM project.

Every scheme has problems associated with it. While this book is clearly sympathetic to expanded use of DSM, the editors and authors have taken care to convey criticisms that are made of each approach. One can nevertheless question whether they have been sufficiently critical. While they do an excellent job of methodically describing the strengths and weakness of the trees, a reader can still be left with some doubts about the forest.

An illustration is their noting a problem involved in decoupling revenue from sales: "... since decoupling shifts risk from utilities to ratepayers, it can have the side effect of making utilities indifferent to issues that could raise rates ... or degrade customer services." (p.257) This "side effect" relates to a key issue that helped to bring traditional economic regulation into disrepute and led to the deregulation movement of the 1970s and 1980s. (The well documented case I refer to here is from the airline industry, but the point applies to any natural monopoly subject to rate-of-return regulation.) Arranging it so that a utility will be paid exactly its revenue requirement removes an important incentive for cost control. The result can be unnecessarily high input costs (prudence tests and other devices applied by regulators are not up to catching everything) and a tendency for the regulated firm to court customer favour by increasing quality levels without regard for whether customers want to pay for more quality.

Despite that reservation, this is a valuable book. It contains a wealth of information on the regulatory treatment of DSM in the US and on the ideas in circulation about how to lead utilities to do more of it. It is the only comprehensive and compact source I know of for someone who is not involved in DSM activities but still wants to know how it is conditioned by regulatory practice.

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