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An Evaluation of the Utility of Large-Scale Economic Models for Socio-economic Impact Assessment

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AN EVALUATION OF THE UTILITY OF LARGE-SCALE ECONOMIC MODELS FOR SOCIO-ECONOMIC IMPACT ASSESSMENT

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SUMMARY

Large scale investment projects, such as the energy developments proposed for Atlantic Canada, the Arctic and Western Canada in the early 1980's, stimulated keen interest in the estimation of their social and economic impacts. The use of large-scale economic models was seen as a possible method of assessing these impacts.

The purpose of this report is to examine the utility of large-scale economic models for examining the socio-economic impact of private and public sector projects within a Social Impact Assessment (SIA) framework. It begins by examining the nature of the SIA in Canada to identify the types of questions and the variables that are normally of interest, and for which large-scale models should be able to assist in developing answers. A set of study models, chosen for their apparent usefulness for SIA work and public availability, are described in summary fashion to outline their main conceptual features.

Each of the study models is examined in terms of a set of technical characteristics to provide an overview of its capability to deal with SIA questions and issues. The strengths and limitations of multipliers and some issues of interpretation for SIA work are discussed. The features of the different classes of models, and the properties of specific models, especially suited to analyze and assess typical SIA economic impact concerns are identified.

RESUME

Les projets de développement énergétiques à grande échelle proposés durant les années 80 pour les provinces de l'atlantique, l'arctique et les provinces de l'ouest n'ont pas manqué de susciter un intérêt considérable face à l'estimation de leurs incidences sociales et économiques. L'utilisation de modèles économiques à grande échelle parut être une méthode possible pour l'évaluation de ces incidences.

Ce rapport tente d'examiner l'utilité des modèles économiques pour l'évaluation des incidences sociales et économiques de projets publiques et privés à l'intérieur d'un processus d'evaluation des incidences sociales et économiques (EIS). Le processus de l'EIS au Canada est tout d'abord examiné afin d'identifier les variables et les questions pertinentes pour l'examination des modèles économiques. Un groupe de modèles choisis pour leur apparente utilité pour l'EIS et leur disponibilité pour le grand public sont résumés dans leurs grandes lignes.

Chaque modèle est examiné d'un point de vue technique afin de déterminer l'ensemble des caractéristiques pouvant être utilisées afin de répondre aux questions de l'EIS. Les avantages et désavantages des multiplicateurs ainsi que quelques problèmes d'interprétation par rapport à l'EIS sont examinés. Les caractéristiques de chaque modèle qui conviennent plus particulièrement pour l'EIS type sont identifées.

CHAPTER ONE

SOCIO-ECONOMIC IMPACT ASSESSMENT

The Nature of SIA

Socio-economic impact assessment (SIA) is an evolving discipline. It traces its origins to the growing pressure in the 1960's for comprehensive study and public review of how major projects affect the environment. Initially such studies and reviews focussed narrowly on the bio-physical environment, examining how projects might affect wildlife and vegetation. The whole exercise was seen as an administrative mechanism for environmental protection.

As projects increased in size and began to be implemented in more remote and environmentally sensitive areas, the nature and scope of impact assessment changed. Studies became more prescriptive. Not only did they identify and describe environmental impacts, they also outlined how projects might be modified to avoid or minimize any negative impacts. The scope of impact assessment was broadened to include the socio-economic environment. SIA had similar objectives: to identify potential positive and negative socio-economic effects and to recommend how the former might be enhanced and the latter avoided or minimized.

In the United States, the implementation of the National Environment Protection Act (NEPA) in 1969 made the formulation of an environmental impact statement (EIS) a requirement. The EIS was designed to evaluate the impacts on the environment for all actions, funded or conducted by the federal government, which significantly affect the environment. The social environment was included in the Act's definition of the environment, and as a result SIA has traditionally been included in the formulation of the EIS in the United States.

The Canadian Experience

In Canada, the Environmental Assessment Review Process (EARP) was established in 1973 by a decision of Cabinet. EARP was based on the U.S. experience with environmental impact assessment. Similar processes and regulations now exist in all Canadian provinces to meet the requirements for environmental impact assessment. But, because the socio-economic impact assessment process is integrated as part of the environmental assessment process, separating specific SIA requirements is difficult.

The Canadian situation differs from that of the U.S. because of the federal-provincial division of legislative authority and responsibility. This division, particularly in relation to the issue of sovereignty of natural resources, has been a major constraint on the exercise of both environmental and socio-economic impact assessment as part of the overall project implementation decision-making process.

Numerous regulatory agencies and departments exist with varying responsibilities for the assessment of socio-economic impacts. There is often some overlap between the levels of government in their apparent jurisdictional authority. The result can be considerable uncertainty in the decision-making process, not only for the project developer but also for government officials.

Perhaps the most difficult problem is that the Canadian Constitution prior to 1982 did not address the environment, creating many problems in terms of protecting it. Yet, the patriation of the Constitution in 1982 has exacerbated the problems of defining resource ownership, the regulatory mechanisms for maintaining environmental standards, and ultimately the EIS/SIA decision-making process by simply not dealing with these issues.

The Decision-Making Process

SIA in Canada takes place generally as part of an environmental impact assessment; a separate decision-making process dealing with socio-economic matters has not been defined. Socio-economic impact concerns are dealt with as part of the overall EIS process. Still, within this context, the role of socio-economic impact assessment can be distinguished.

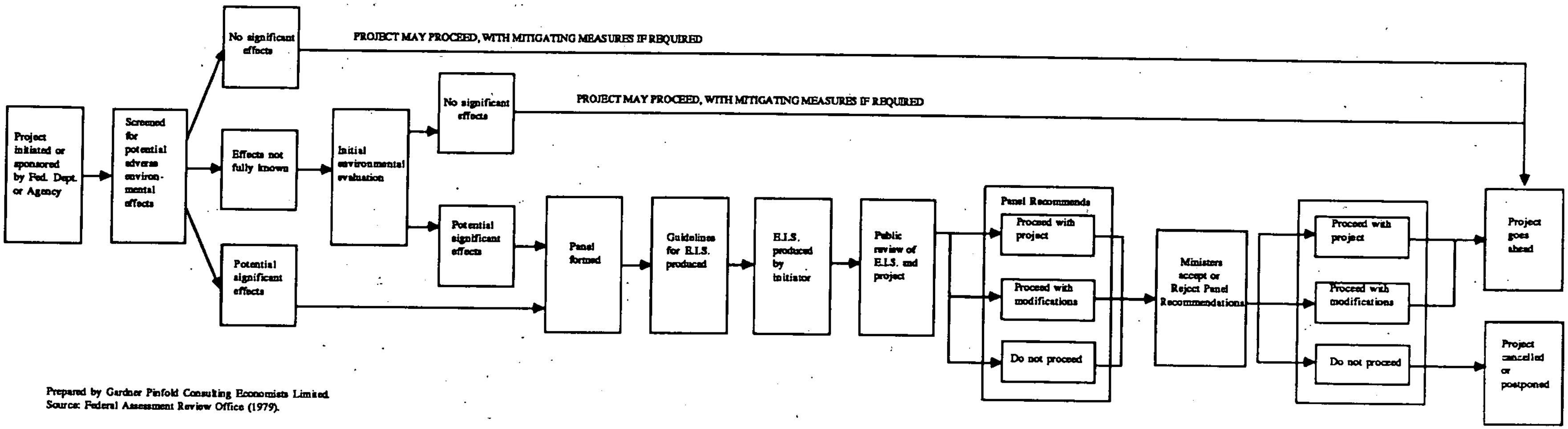
Socio-economic impact assessments evaluate project development alternatives in terms of their estimated socio-economic consequences. The complete project development process involves four stages:

- the formulation of alternatives;
- the selection of an alternative for implementation;
- the actual implementation of the alternative; and,
- the evaluation and modification of the chosen alternative.

SIA is a decision tool for the second stage in which the project development alternative for implementation is selected following a thorough analysis of its technical, environmental, social and economic implications. In the process some new alternatives and modifications of the proposed project alternatives may be suggested, but primarily SIA occurs after the alternatives have been determined by the project proponent.

A detailed outline of the traditional EIS/SIA decision making process is shown in Figure 1. After the project has been brought to the proposal stage, it is screened for any potential adverse environmental effects. If there are no significant effects, the project can proceed without an EIS/SIA, but with mitigating measures if required. Alternatively, if there are potential significant effects or if the effects are not fully known, then an Environmental Assessment Panel is formed. Following established EIS/SIA guidelines, the project proponent performs the EIS, (and the SIA). The Panel reviews the EIS/SIA and recommends whether or not to proceed with the project, or to proceed with the project with modifications. The final decision is left to the Minister(s) in charge.

Figure 1: Schematic Diagram of the Federal Environmental Assessment and Review Process



Prepared by Gardner Pinfold Consulting Economists Limited.
Source: Federal Assessment Review Office (1979).

SIA Guidelines

Beginning in the mid-1970s, EIS guidelines were issued for proposed large energy developments and other large projects across Canada. These guidelines ranged from minimal to extensive in their attention to socio-economic matters. Typically, socio-economic issues were listed under the general heading, People, and the main concerns were the distribution and characteristics of the population of the project area, the cultural, social and economic setting, and expected population changes. In some cases, employment impacts were explicitly identified. The Polar Gas Project guidelines issued in December 1977 contained one of the most extensive lists of socio-economic issues including:

- lifestyle and quality of life
- demographic matters, including population, migration and employment
- housing and infrastructure
- health, education and social services
- local government
- labour market impacts, including both the immediate project area and the provincial labour market impacts
- economic impacts such as changes in income levels and distribution and changes in economic base and self-sufficiency

For the Venture gas development on the Scotian Shelf on Canada's east coast, the governments of Canada and Nova Scotia established a Socio-Economic Review Panel with terms of reference to:

> "...examine the socio-economic implications of the production systems options related to the development of natural gas and condensate production from the Sable Island area. The panel's analysis will include: economic aspects; labour and employment requirement; social services (e.g., health care and education); infrastructure requirements (e.g., transportation and municipal services); and socio-cultural impacts. The panel should also establish means of informing the public of the socio-economic implications of the proposed production systems." (Hortie, 1984)

The Venture EIS, completed in 1982, was the first one where a project proponent was called upon to prepare a separate socio-economic impact statement. It was also the first time that the federal government and a provincial government had agreed that a SIA panel (separate from the Environmental Assessment Panel) should review the SIA document with public participation.

For the proposed Hibernia oil project on the Grand Banks of Newfoundland, separate guidelines were issued by the federal government (FEARO) and by the provincial government (Newfoundland Petroleum Directorate). The federal guidelines were much less detailed than those for the Polar Gas Project but similar to the guidelines issued for other projects. The provincial socio-economic guidelines requested detailed labour market information at the occupational level as well as estimates of the impact of the project on the province's labour force, participation rates and unemployment rate, and other labour market effects such as local wage rate changes and job switching. Other information requirements included an assessment of the project's demand for goods and services locally produced and purchased from outside the province, an estimate of the macro-economic impacts such as the growth in the level of income in the province, the growth of the provincial tax bases and the provincial inflation rate. The demand for and the supply of energy in the province and the country, and the magnitude, type and location of indirect employment, also matters of concern. Though separate guidelines were issues for Hibernia, a single EIS was prepared encompassing both federal and provincial concerns. The statement, completed in 1984, was reviewed in the conventional manner by a single panel with public participation.

The Focus of the SIA

The issues dealt with by socio-economic impact assessment fall into two broad categories: allocative effects and non-allocative effects. Allocative effects are concerned with the efficiency of resource use, that is, does the project in question make better use of resources than an alternative? Non-allocative effects are those concerned with the distribution of income (e.g. equity considerations), employment and demography, socio-cultural impacts, regional balance, technological progress, market structure, the balance of payments, aggregate and industrial output, and inflation. The review of EIS guidelines indicates that, for most of the SIAs, non-allocative issues ranging from the micro-level impacts on individuals or small groups to the macro level economic impacts at the provincial, regional or national level were the main, if not the exclusive, focus of attention. For that reason, allocative effects and the methodology used to assess them, cost-benefit analysis, are ignored in this study.

The Study Focus

Non-allocative effects can be analyzed using a variety of economic and statistical tools including large scale economic models. The purpose of this study is to evaluate the utility of large-scale economic models for SIA. More specifically, it is to identify the ways in which output from the models can improve the decision-making process in which SIA is an integral element.

The models evaluated in this study fall into four groups:

Econometric models, which are multiple-equation systems that attempt to describe the structure of their subject economy and forecast aggregate variables such as income, employment and output over time;

Input-Output Models, which provide considerable detail on the economic transactions that take place in the subject economy at a point in time and allow the user to assess how impacts originating in one sector are transmitted throughout the economy;

Systems Dynamics Models, which are systems of equations incorporating delay mechanisms, feedback mechanisms and policy/technical information to determine the state of economic system in the future. Trend extrapolations are conducted using relatively simple numerical techniques; and,

Economic Base Models, which dichotomize economic activity in the subject economy into an export sector and a local service sector. Impacts registered by new projects in the export sector transmitted via economic linkages to the service sector.

The study models are examined in terms of criteria relevant to the uses made of non-allocative impact material in the SIA process. The review of the guidelines for past EIS/SIA work and discussions with participants in the process indicates two particular areas of concern:

- the magnitude and location of economic impacts; and,
- the distribution of project impacts geographically.

The priority economic indicators which the models should be able to generate include:

- the change in the rate of growth of Gross Domestic Product, with emphasis on regional or provincial forecasts, although national level estimates would be of interest for very large projects;
- the provincial distribution of economic impacts as measured by:
  - changes in the growth of output in selected industries or sectors,
  - changes in population, migration and housing demand; and,
  - changes in the regional/provincial unemployment rate.

Other possible indicators such as changes in the inflation rate, changes in the foreign exchange rate and changes in the balance of payments current and/or capital account are assigned a low priority in SIA.

Technical characteristics of the study models are also examined. The most important of these are the models' data requirements, the credibility of the models' results as determined by the accuracy of the impact data and the believability of the output, the explicit and implicit assumptions required to operate each model and the comparability of the results produced by different models including a comparative assessment of the multipliers associated with each model. The research concerning technical characteristics is based on the state of the models as of the first quarter of 1986.

CHAPTER TWO

THE STUDY MODELS

This chapter presents brief outlines of the models analyzed in this study. These outlines are meant to give the reader a general appreciation of the four types of models and to highlight some of the particular characteristics of the study models. Although the models are technically complex, as far as possible this aspect is ignored except where technical characteristics have a real bearing on the usefulness of the models for SIA work.

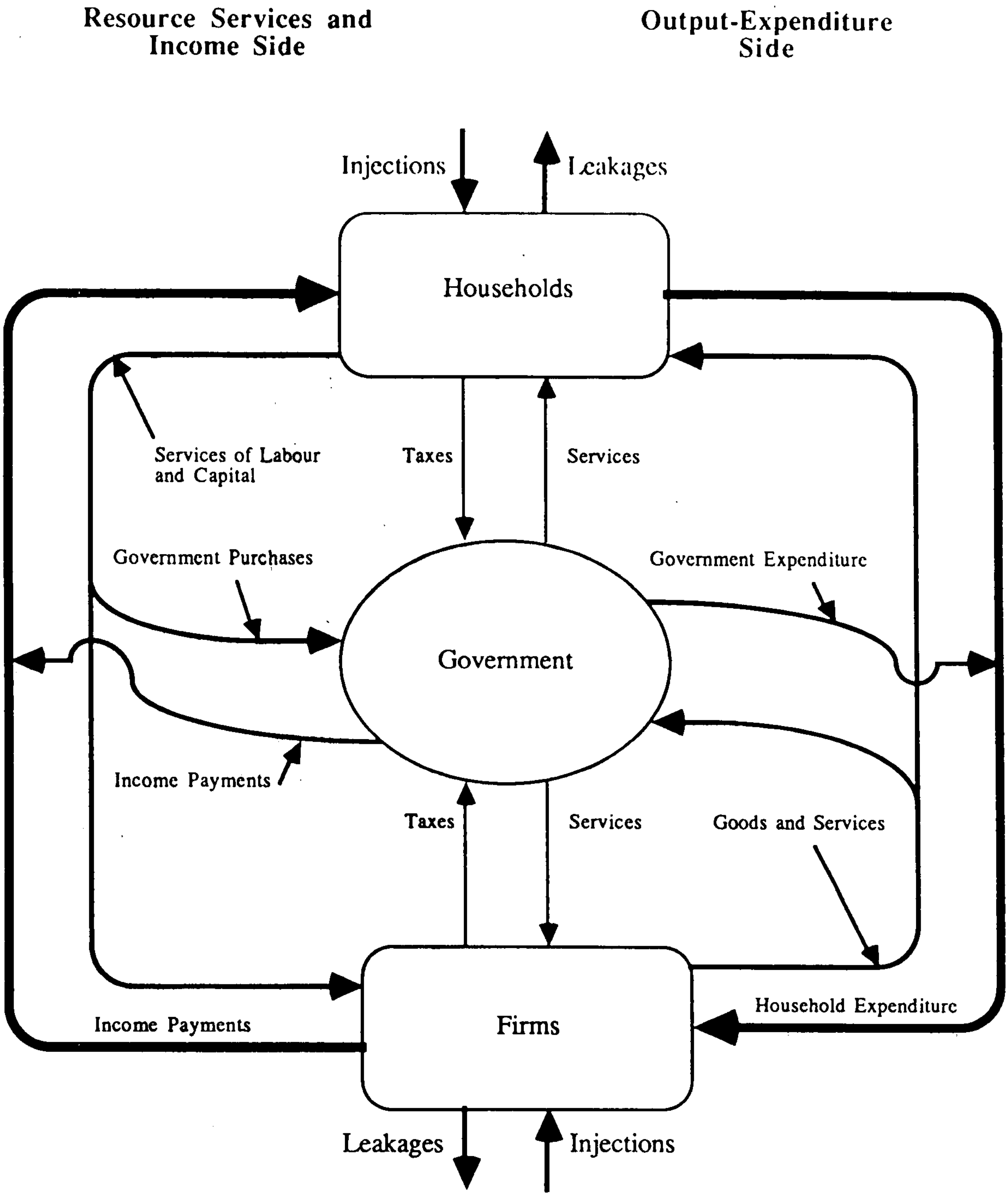
The Circular Flow Model

One of the simplest conceptual representations of an economy is the circular flow model. A basic circular flow model is used here as a central frame of reference for comparison with the four classes of study models. Like all models, the circular flow includes some elements of the economy and excludes others. The model in Figure 2 shows a simplified economy with three main sectors. Economic activity is measured in terms of two flows. The *real* flow captures the labour and capital resources used and the goods and services produced. The *money* flow represents the income payments to owners of resources, the expenditures on goods and services and tax payments. *Households* are assumed to be the owners of resources (capital and labour) and consumers of goods and services. *Businesses* produce goods and services using the services of the resources and pay incomes to the resource owners (households). *Government* collects taxes from both households and businesses, purchases the services of household-owned resources, and in turn provides government services to both households and businesses. For simplicity, transfer payments are ignored.

The circular flow model portrays economic activity as a circular or repetitive process. Income spent on goods and services becomes income again to the owners of the resources used to produce the goods and services. The continuity of the circular flow is disrupted by *leakages* from and *injections* to the economic system. *Leakages* refer to any portion of income not spent in the economy by the resource owner. In this sense, savings, imports and taxes (to the extent they are not spent by government) are leakages. *Injections* are expenditures for goods and services arising outside the basic circular flow. Investment on new plant and equipment, exports and government spending (to the extent it exceeds government tax revenue) are regarded as injections. If *injections* exceed *leakages*, the income-expenditure flow of the economy will grow, that is, the economy expands. The economy contracts if *injections* are less than *leakages*.

Large-scale economic models, including the four classes of models assessed in this study, attempt to capture empirically and in greater detail the basic economic characteristics demonstrated by the circular flow model. Their empirical nature permits the analyst to estimate quantitatively the impact of a change in the economy, such as the introduction of a new development project.

Figure 2 : The Circular Flow of the Economy



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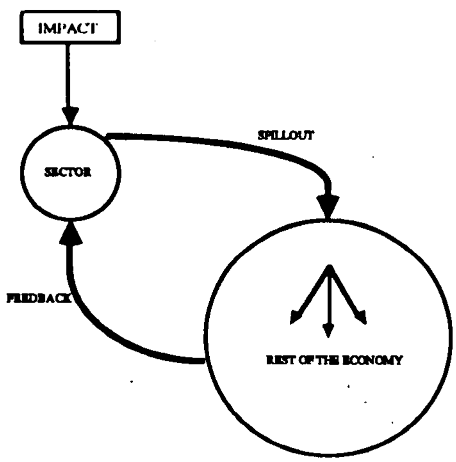
Impact Analysis

A development project, large scale or otherwise, can be regarded as an exogenous shock to the economy surrounding it. In this sense, the project will enter the circular flow as an *injection,* possibly split between direct injections to households in the form of wages for labour and injections to business in the form of purchases of goods and services. In terms of economic accounting, a project will be located within a sector and its impacts will be registered there first. Thereafter, the impacts will spill out into other sectors and then can feed back into the original sector. This process is summarized in Figure 3.

Figure 3 : The Impact Process



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Virtually every project will produce all three effects: inital sector impacts, spillout and feedback. A strength of the large scale models is their ability to trace these effects quantitatively and report them in both aggregate (e.g. gross domestic product, total employment) and disaggregate (e.g. industry output, employment by industry, national and regional) form. Moreover, the models enable the analyst to deal with the highly complex economic effects of a project in a consistent and, if necessary, detailed manner.

ECONOMETRIC MODELS

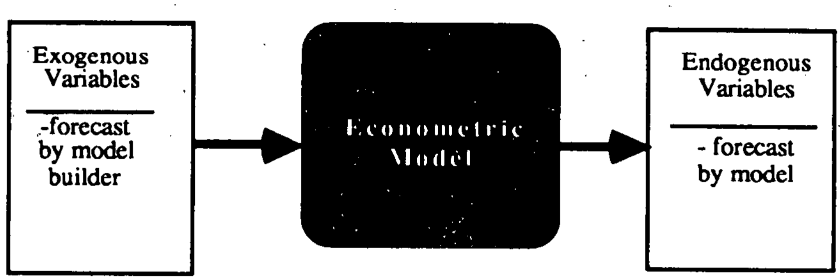
General Description

Econometric models are multiple-equation systems that attempt to describe the structure of an economy and forecast aggregate variables such as income, employment, and output over time. In essence, these models decompose the circular flow into a number of components such as final demand (comprised of, for example, consumption, investment, government spending and exports less imports), output by industry, labour force activity, wage and price components, a monetary sector and sometimes a separate energy sector. Further sectoral and regional detail on some variables may be included in the large scale models. An economic impact registered in the final demand component will spill out into the other model components and then feed back throughout the system. These effects are dynamic; that is, they take place over several years. So, econometric models usually contain dynamic adjustment mechanisms to estimate the impacts on an annual basis over an impact period.

Generally, an econometric model attempts to explain the behaviour of one set of economic variables (the endogenous variables) by relating them through the model's equations to another set of variables whose behaviour is determined independently of the model (the exogenous variables) (Figure 4). The model builder prepares a forecast for the values of the exogenous variables over the time period of interest. The model's forecast for the endogenous variables is thus conditional on the exogenous variable forecast.

There is no single theory of national or regional economic growth implicit in the development of an econometric model, but rather, model builders design models specifically to deal with the economies being examined. Econometric models employ data covering a series of years, quarters or months (time-series data), as opposed to the single year reference period of the economic base and input-output models, to estimate hypothesized economic relationships by means of regression analysis.

Figure 4: Econometric Model - A Simple Schematic



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In their most elementary form, econometric models attribute economic growth or decline in a country or region to exogenous factors like exports and in this (limited) way are similar to an economic base framework. They are demand oriented, and treat wages and prices as given. On the other hand, more sophisticated, larger models consider both exogenous and endogenous sources of growth. In these models, prices and wages are determined within the system. More importantly, these models can incorporate aspects of structural change such as productivity growth, demographic composition, and industrial mix, thus providing a variety of sources for growth that are unavailable in the other models. Although econometric models can be static, (that is, they take no explicit account of time), the larger scale models usually incorporate dynamic elements. This allows them to trace the effects of specific economic events over time.

The models can estimate the effects of exogenous shocks (e.g., the introduction of a large scale development project into the model) on the modelled economy. These effects are measured by changes in aggregate economic variables (e.g. Gross Domestic Product, industry output, aggregate employment and so on) but, depending on the model, impacts such as changes in the labour supply or changes in inter-provincial migration may also be estimated. In this regard, considerably more sectoral detail is provided by a major econometric model than by its counterparts, the economic base model and the input-output model.

Like the other models, an econometric model represents a hypothesized relationship between demand and supply, or expenditure and income. Traditional Keynesian models are demand driven. They assume no constraints exist on the supply of goods and services, and that prices remain constant. The majority of Canadian macroeconometric models are demand driven in the short-run. By the medium to long-term, feedback mechanisms in some of the models related to supply bottlenecks and changes in prices have had a chance to influence the demand side.

Unlike economic base models and input-output models, econometric models can provide both short-run and long-run impact assessments. (As noted later, this is also true for Systems Dynamics models.) This feature is especially useful where a project's impacts are expected to occur over a five, ten or twenty year period and developing a time profile of the impacts is a high priority requirement. Still, the reliability of long-run impact studies is limited by the quality of forecasts for exogenous variables and the viability of the model's underlying behavioural assumptions.

The distinction between forecasting and impact analysis econometric models is not easy to pinpoint. The underlying objective of the model builder will differ, depending on the purpose of the model being developed. A forecasting model should be able to forecast accurately and an impact analysis model should be able to capture the effects of the exogenous shock under study. These differing objectives can colour the choice of variables to be included in particular equations. However, in both cases, economic theory provides the guide as to what explanatory variables belong in a particular equation. Furthermore, a single econometric model can be used for both forecasting and impact analysis, so the distinction is not of practical importance for this study.

Conceptual Issues

Some of the large scale econometric models studied have both national and regional versions. On the one hand, a national model attempts to capture the characteristics of a national economy, and generates output for aggregate economic variables such as national GDP, output, income and employment. On the other hand, a regional model attempts to capture the economic characteristics of economic regions defined within the national economy, and the economic interdependencies between these regions. Maintaining a consistent relationship between the national model and its regional counterparts is an important conceptual issue. The principal difficulty is to ensure the sum of the regional economic activity estimated by the regional models is the same as the national economic activity captured by the aggregate variables from the national model.

This problem can be dealt with using either a bottom-up approach or a top-down approach. In the bottom-up approach, the regional model forms the base and generates economic input for the national model. Alternatively, the two models could be designed in a top-down fashion, where the national variables generated in the national model are disaggregated by region in the regional model.

Although a bottom-up regional to national model is a better approximation of the way the Canadian economy functions, it is much more difficult to implement than a top-down model. For example, a bottom-up model requires the modelling of regional markets for wage and price formation, investment and capital flows, goods and services output and so on (preferably on a sectoral level). The regional results must then be integrated into a national context to generate the overall national results, and feed back appropriately into the determination of expenditures and the rest of the macro-economy. In fact, until recently, the data, theory, and econometric experience required for the bottom-up approach did not exist and only top-down regional models were technically feasible.

Being the only practicable choice did not protect the top-down design from legitimate criticism. For example, in some cases this design is equivalent to reducing regional analysis to a sharing-out of the national variables among the regions. This is done on the basis of the historical shares each province has maintained of a particular industry. Output and employment by industry can then be calculated and aggregated to produce regional/provincial totals. The sharing-out approach leads to other problems such as the omission of current variations in intra-regional resource allocation, or regional import substitution. Recognizing the inherent limitations of the top-down models, model builders have been directing significant effort towards improving the bottom-up characteristics of their regional models in the last several years.

Technical Issues

The major technical problem arises from data availability. For many economic variables only annual data are available. Thus, to obtain a reasonable degree of statistical precision, observations must be obtained for a considerable period of time. The consequence is that the greater the reliance on historical data, the more likely it is that the model will not truly represent the current situation.

When a bottom-up approach is used, the data problem is more severe for the regional models than for the national models. Data constraints may, for example, result in fewer explanatory variables being included in the regional model than economic theory would suggest. In other words, the regional model will be incompletely specified and may be incapable of handling the full complexity of the regional economy. Its potential for regional impact assessment will therefore be compromised as well.

Summary

Econometric models are comprised of linked components which characterize the various sectors of the economy. The model equations are estimated by linear regression using mainly time series data. The models are appropriate for longer-run problems, in addition to short and medium-term problems, and provide a great deal of information and detail often unavailable from other types of models. The use of time-series data allows the modeler to examine underlying trends and to test hypothesized economic behavioural relationships. A high level of expertise is required to implement an econometric model. The rich variety of the output from a large scale econometric model allows the user to develop a detailed appreciation of the impact of a development project on both the national economy and the regional economies within Canada.

The CANDIDE 3.0 Model

CANDIDE is a medium-term model founded upon Keynesian economic theory, which generates both macroeconomic and industry level output. The overall level of economic activity is determined by the interaction of aggregate supply and demand functions.

The CANDIDE 3.0 model is the second largest of the econometric study models, containing 2,490 equations and requiring the input of 1,046 exogenous variables (Economic Council of Canada, 1985). The size of the model is a function of the high level of industry and commodity disaggregation. For example, in the final demand component private investment is evaluated for 38 different industries.

The principal uses of the CANDIDE 3.0 model are to produce medium and long-term forecasts of the national economy, and to assess the impact of changing fiscal and monetary policy. CANDIDE can also be used to assess the impact of large scale projects.

The CHASE Model

The CHASE model is founded upon Keynesian economic theory, though there is no requirement that aggregate demand and supply be equilibrated in the long-run. In the final demand component, private investment is evaluated for non-energy investment in business non-residential construction, and machinery and equipment. Energy investment is treated as exogenous, although the model has a detailed energy component which incorporates the policies of the National Energy Program, and subsequent agreements.

The CHASE model is currently composed of slightly over 900 equations with about 1,200 variables. The model design is based on the RDX family of models, whose modular framework allows tailored simulations to be done.

CHASE has developed a strictly top-down regional model which disaggregates national GDP by industry for 32 industries. Currently, they are trying to build in bottom-up capabilities.

The CHASE model is used to produce short and long-run forecasts, in addition to assessing the impact of changes in fiscal and monetary policy, and alternative scenario simulations. The model does not have a formal impact routine, but can be altered to accommodate impact assessment.

The Bank of Canada RDXF Model

The RDXF model consists of 400 equations, describing the major sectors of the Canadian economy. Supply constraints are relatively weak in the model. As a result, an increase in demand is generally always accompanied by an increase in production.

According to its developers, the RDXF model was developed to forecast economic developments over a two-year period and to generate alternative scenarios over a medium-term forecast horizon to aid in evaluating different forecasting hypotheses (Bank of Canada, 1980). The Bank of Canada uses the RDXF model to produce a regular quarterly short and medium-term forecast. In addition, the model is also used for policy analysis. The model is not available for private sector use.

The MACE Model

The unique characteristic of the MACE model is its small size in comparison to the other study macroeconomic models. Developed primarily by J. Helliwell at the University of British Columbia, MACE incorporates Helliwell's feelings that current macroeconometric models are too large and fragmented. As a consequence, he set out to develop a core macro model which is aggregated enough to guarantee both timeliness and economic coherence. The result is the macro core block of MACE.

The other reason for Helliwell's undertaking is to express empirically his feelings about the role of energy in economic development. The result is an energy block which highlights the role of energy, and which can reflect the impact of the world price shocks associated with the formation of OPEC, (specifically the shocks of 1973-74 and 1979-80).

MACE is a highly aggregated two-block macro model developed to analyze the linkages between the energy-using and energy producing sectors of the economy, both in the short and the long-run. Examples of energy developments simulated with the MACE model include pipelines, oil sands plants, gas exports, alternative energy pricing, and revenue sharing regimes. The model is not designed for short and medium term forecasting, and lacks many fiscal policy levers because of its degree of aggregation.

NATIONAL-REGIONAL ECONOMETRIC MODELS

The Conference Board Models

The Conference Board currently operates and maintains a national quarterly macroeconometric model of the economy, MTFM, and a Quarterly Provincial Forecasting Model, QPF.

The Medium Term Forecasting Model, (MTFM), is a large scale econometric model with 850 endogenous variables, and 800 exogenous variables. Approximately 350 of the endogenous variables form a large single simultaneous block in the model reflecting the interdependence of the model's different sectors. Industry output is disaggregated into 40 industries.

The QPF model is a top-down model with some bottom-up characteristics. The national totals are not simply allocated among the various regions on the basis of pre-determined shares. Provincial output, employment, income and expenditure are determined by their counterpart national variables and by developments in the province concerned and in other provinces. A notable feature of the model is that the summed values of provincial variables need not agree with the corresponding national total, though the model has the ability to impose such agreement.

MTFM is designed for forecasting and simulation over the short to medium-term. QPF is used primarily for producing short-term forecasts (one or two years), though it is also used for medium-term forecasts (up to five years), and for doing impact analysis.

The Data Resources Models

The Data Resources of Canada national model, (DRI), is a quarterly econometric model containing 816 variables and 551 equations, of which 208 are identities and the remainder are behavioural/technical relationships. Industry output is disaggregated into 33 industrial categories of Real Domestic Product and runs recursively with the remainder of the model.

The principal design uses of the DRI model are forecasting and policy analysis. The model is used to prepare short-term quarterly forecasts on a monthly basis, medium-term (10 to 12 year) forecasts on a quarterly basis, and long-term (25 year) forecasts twice a year. Typical applications include adjusting international economic assumptions, fiscal and monetary policy analysis, industry analysis, and strategic planning issues. The results generated by the DRI model are used to feed the regional model, designed primarily for regional forecasting.

Data Resources has also developed a Canadian regional model called MARV, the acronym for Model, A Regional Variety. The regional model combines both top-down and bottom-up characteristics, and is driven by industry detail. MARV disaggregates and distributes the national values from the DRI model amongst seven regions. The output block, the largest component of the regional model, contains 26 equations for each of the seven regions, and can be disaggregated into 14 goods producing sectors, and 4 service sectors.

The FOCUS and PRISM Econometric Models

FOCUS is a large-scale macroeconomic model, consisting of 300 behavioural equations and identities. The basic assumptions of the model are based on standard Keynesian economic theory. FOCUS is demand-driven in the short-run, with supply-side constraints coming into play in the long run.

PRISM is an exclusively top-down model, whose national sectoral detail consists of real value-added, employment, hours and domestic-product deflators for 22 industries, plus government. Industrial detail is conveyed to PRISM from the real final demands generated by FOCUS, which allows for intermediate production. Sectoral detail from PRISM is forced to add to the national aggregates derived in FOCUS.

The FOCUS model is designed to carry out medium and long-term forecasting, as well as policy analysis and simulation exercises. For impact analysis, the annual macroeconomic variables from FOCUS are fed into PRISM to induce the first demand allowing for intermediate production shock. PRISM in combination with FOCUS performs as an instrument for policy analysis around a given base case.

The Informetrica Macroeconomic and Regional Models

The Informetrica Model (TIM) is a large annual simultaneous equation econometric model containing about 4,000 equations which produce estimates for most National Accounts variables. TIM has highly developed industry output and labour market components. There are 73 categories of industrial output used in the determination of imports, exports, inventories, business investment, and employment. In the labour block, employment by industry is derived and used to determine labour income.

Informetrica's Regional Industrial Model (RIM) is used recursively with TIM. The major goal of RIM is to provide long-term regional forecasts and impact statements consistent with the national view of the economy provided by TIM. RIM shares out national goods production across the provinces in a conventional top-down fashion. With goods production given, RIM then determines the level of retail trade, services and so on endogenously for each provincial economy.

The TIM-RIM combination of models permits the user to do short, medium, and long-term forecasting, impact analysis and policy analysis, at both the national and regional levels. The Regional Industrial Model is closely integrated with TIM, the Provincial Construction Forecasts Service, and the Major Projects File. (The Major Projects File is a compendium of all large planned construction project, particularly those in the energy and resource sectors.)

PROVINCIAL ECONOMETRIC MODELS

Stand-alone provincial economic models exist for all provinces except Newfoundland, New Brunswick, P.E.I., and Manitoba. Only the models for Alberta, British Columbia, Nova Scotia and Quebec are available for public use.

The British Columbia Econometric Model

In 1980, the British Columbia government hired Data Resources of Canada to develop a provincial econometric model. The result was an incomes-expenditure model whose driving force is the export component of final demand.

To date the model has been used exclusively by the provincial government for medium-term forecasting, (approximately 6 years), and impact analysis. The model contains 325 equations, with considerable industrial detail. Output is determined for 23 major industrial sectors, and often each major industrial sector is broken down into more specific sub-components. According to the operator, the model has not been used by the private sector in the past, but there is no reason it could not be used for impact analysis.

The Nova Scotia Econometric Model

The Nova Scotia Econometric Model contains 63 endogenous variables describing the Nova Scotia economy, with 23 exogenous variables driving the model. These variables indicate that four principal factors determine economic behaviour in the province: the Nova Scotian population, the Canadian National economy, government spending and taxation, and the United States economy. The NSEM contains both linear and non-linear econometric relationships. The model forecasts economic behaviour at two levels: highly aggregated economic variables, (e.g., provincial gross domestic product) and sector-specific detail (e.g., manufacturing, retail trade).

The NSEM is a traditional demand driven income-expenditure model. On the expenditure side, consumption is a function of personal disposable income; current investment expenditure is determined by the change in output and past investment expenditure; federal, provincial, and municipal government expenditure are related to population growth; and federal expenditure is related to the unemployment rate in Nova Scotia. Exports are a function of the growth in the United States GNP and the Canadian GNP. Imports are determined as a function of the Nova Scotia Gross Provincial Product.

The model has evolved from initially being a forecasting tool to one capable of policy simulation and impact analysis. The NSEM is capable of carrying out short and medium-term forecasting, as well as impact analysis for development projects across most sectors. In addition, it has three sub-models which deal with the energy sector, the housing sector and telephone communications.

The Quebec Econometric Model

The Quebec econometric model is a large-scale annual provincial model containing 1,200 equations. It is used primarily for long-term forecasting in the range of 15 years. The components of final demand, particularly consumption and investment are highly disaggregated. Other than government expenditure and residential housing, components of final demand are defined exogenously. Output is determined for 31 private sector industries and 7 government sectors. The model is currently being redesigned to allow for the calculation of variable coefficients, associated with examining the problems of changing technology and increasing returns to scale. The model is available for use by the private sector at no cost, but in the past has not been used extensively.

INPUT-OUTPUT MODELS

General Description

Input-output or inter-industry analysis was developed by W. Leontief during the 1930's. The input-output method is an empirical representation of a general theory of production based on the notion of economic interdependence. Leontief's original table shows how each sector of the economy depends upon every other sector, either to supply its inputs or to purchase its outputs. This is still the basic characteristic of all input-output models.

Today, input-output tables are available for about forty national economies, and the number of regional and local input-output tables is growing at a rapid rate. The development of computers and efficient computational methods permits a great deal of industrial disaggregation, providing a great deal of detail on the economic transactions that occur within a local economy, as well as offering some understanding of how demand shocks are transmitted throughout the economy.

In an input-output model each industry in the local economy is dependent upon every other industry for the supply of intermediate goods. Industry production functions are linear and inputs must be used in fixed proportions. (In other words, economies and diseconomies of scale are not permitted.) The other generally strict assumption of input-output models is that prices and wages are fixed, and the supply of both intermediate goods and final goods is unlimited.

Main Uses

In general, the input-output model has three distinguishable but related applications. These are impact analysis, structural simulation, and final demand conversion.

The basic question traditionally asked in economic impact analysis is "what are the gross-output and income flows associated with a specified economic change?". An input-output model provides the answer by tracing the transmission of a demand shock throughout the economic system. The impacts are usually estimated in terms of increases in industry output, incomes earned by resource owners and employment.

As mentioned earlier, the models are not supply-oriented. They omit any consideration of pressures on resources, production bottlenecks, or input restrictions. In other words, an input-output model will not identify any negative aspects associated with the impact of a development project. The fixed price assumption and the lack of a dynamic time frame preclude any assessment of inflation impacts.

The second use of the input-output model is to perform structural simulations, i.e., to investigate the effect of a change in the parameters of the model. This is equivalent to introducing a change in industrial and/or regional structure. Sometimes data problems can arise in these simulations.

Finally, the input-output model can be used as a final demand converter. In other words, categories of gross national expenditure, such as consumer expenditures, gross fixed capital formation and exports are converted or transformed into their respective income components, i.e., labour income, indirect taxes, profits and depreciation by industry.

Two versions of the input-output model have been developed. In an *open* model the household incomes generated in the production process are not respent. In other words, they are treated as leakages from the system. Alternatively, in a *closed* model, incomes generated in the production process are spent on goods and services, taxes and savings. The closed variant is generally closed with respect to the household sector. Hence, incomes generated by final demands are respent by the household sector on consumer goods and services, and taxes, or are saved. In the closed model, personal income taxes and savings are leakages from the household sector.

Conceptual Issues

The major conceptual problem associated with input-output modelling arises from the assumption of linear production functions. These imply that any changes introduced into the system cause an equiproportionate increase or decrease in the existing levels of resource use. The consequence, as mentioned above, is that linearity implies the absence of scale economies, which runs contrary to much of the theory underlying regional and urban economics and industrial organization.

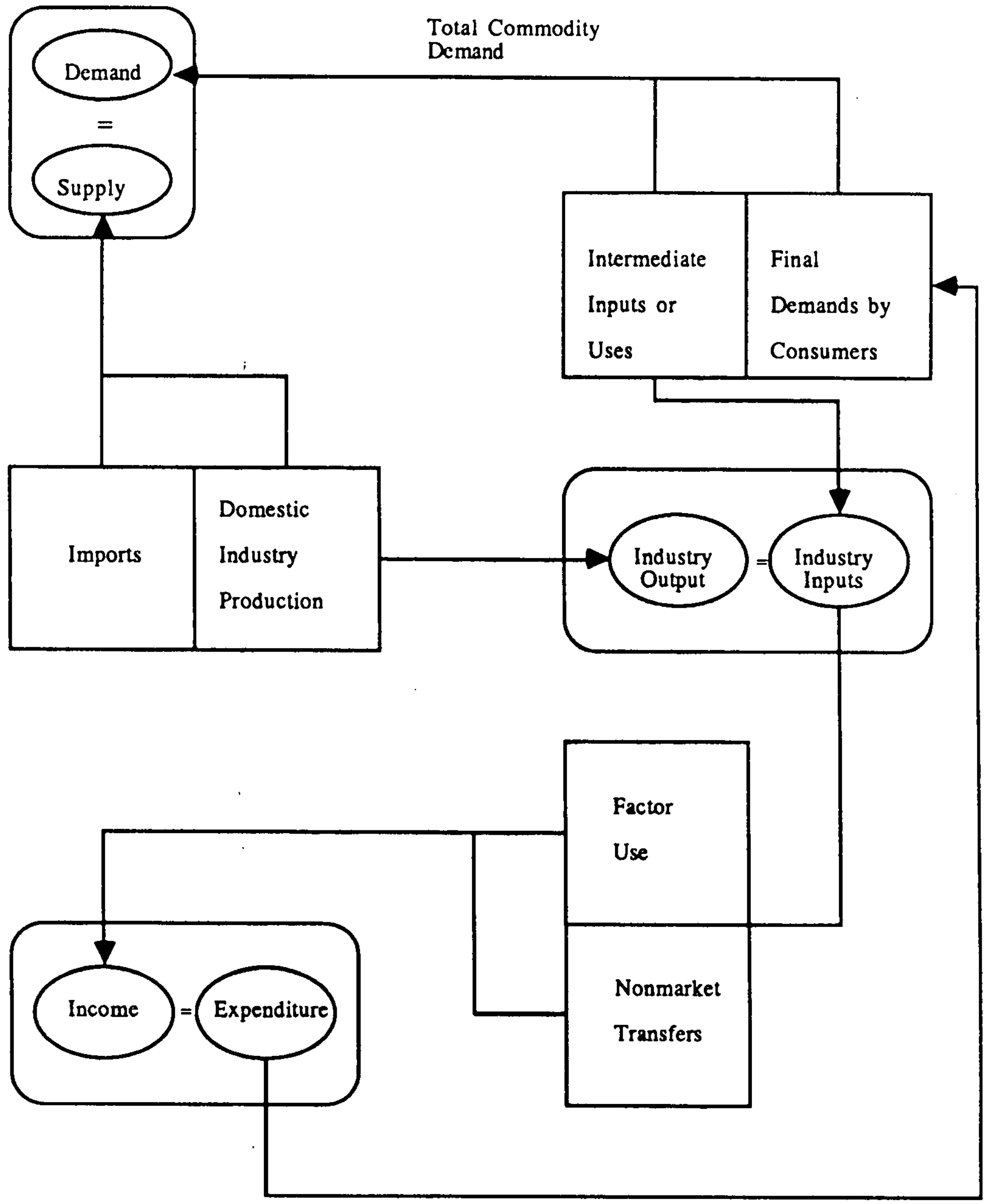
The technical coefficients which describe inter-industry transactions are assumed to be constant. This makes it difficult to represent technological change and productivity adjustments in the system. As well, the models are static and are therefore unable to deal with changes over time in their analysis.

For those models that are capable of dealing with the problem, the impact of a change in regional structure is difficult to assess because it is equivalent to adding a new row and column to the input-output table. This may necessitate calculating a number of new coefficients and possibly considerable data collection.

Summary

In sum, input-output analysis is based on the premise that there is an economic interdependence of each industry in the economy upon every other industry. A production process links the inputs of an industry to the corresponding output, and the supply of inputs to the production process is assumed to be perfectly elastic. The ultimate goal of the input-output model is to trace the transmission of demand through the economy. Figure 5 illustrates the flow through an input-output model.

Figure 5: General Schematic of an Input-Output Model



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The input-output model is capable of carrying out three types of economic applications: impact analysis, structural simulations, and the conversion of final demand. A principal drawback of the model is its static nature. As a result, the model cannot examine industrial relationships through time. In addition, because the process of updating an input-output model is often time consuming and expensive process, the model's coefficients may be historically valid but an inaccurate description of the current economy.

STATISTICS CANADA INPUT-OUTPUT MODELS

The models embody the theory of the more traditional models illustrated in the previous section. The major difference arises from the development and use of a commodity by industry accounting framework. In this framework, the one-to-one correspondance between industries and commodities developed by Leontief is abandoned. Instead, each industry is allowed to produce more than one commodity, and each commodity may be produced by more than one industry.

The inter-regional or 'inter-provincial' model is composed of the same main sectoral components as the national model, though the former incorporates inter-provincial trade relationships. Currently, both *open* and *closed* versions of the Statistics Canada output determination models are operational. The latter is *closed* with respect to the household sector. In other words, consumer expenditure is differentiated from final demand, and income payments to the household sector feed back into the consumer expenditure. Effectively, in the *open* model, incomes generated in the production process are not respent, whereas in the *closed* model they feed back to the household sector and are spent on goods and services and leakages (taxes, savings and imports) until the model converges to an equilibrium value.

The national model produce results at one of three levels of industry aggregation - 191 industries, 43 industries, or 16 industries. The interregional model has two levels of aggregation which distinguish 191 industries which produce and/or utilize 602 commodities, and four industries which produce 43 commodities. Both models can be used for impact analysis, structural simulation, or as final demand converters. However, the models are mainly used for impact analysis.

PROVINCIAL INPUT-OUTPUT MODELS

The Alberta Input-Output Model

The Alberta input-output model design is based on the Leontief input-output framework, and is open with respect to both the household and the government sectors. The model was formed by taking the Alberta provincial component of the Statistics Canada Interregional model, and adapting it to accomodate the input-output framework designed in 1974 by the Alberta government to trace the impacts of changing final demand on the characteristics of the Alberta economy.

The Alberta input-output tables are relatively aggregated compared with Statistics Canada models. There are three levels of aggregation, with the most disaggregated level having an industry-commodity detail of 108 industries, 204 commodities and 10 final demand categories. At a medium aggregation there are 41 industries and 83 commodities, while the highly aggregated model has 15 industries and 45 commodities.

Exogenous shocks must be introduced to the model as a change in final demand. Potential users of the model can perform their own analysis using the published impact multipliers (Alberta Bureau of Statistics, 1982, 1984) or submit data to the Alberta Bureau of Statistics for a special run of the model.

The Nova Scotia Input-Output System

The first version of the Nova Scotia input-output system (NSIO) was developed at the Institute of Public Affairs, Dalhousie University in Halifax during 1974. In 1979 the input-output tables were revised and a new version of the model was released. The system was specifically designed for impact analysis of the Nova Scotia economy.

Two analytic options are available. The simple impact routine traces changes in the exogenous sales of Nova Scotia industries, assuming that the basic input-output structure remains the same. The other option is general impact analysis. This permits the user to introduce a new industry into the system, represented by a new sales row and a new purchase column, and to simulate its effect on the Nova Scotia economy. The impact of a development project is analyzed in this way. The user can also select an open model or a closed model (closure with respect to households or with respect to government).

The NSIO represents a complete set of economic accounts for the province. They present the data in a commodity-by-industry format, and contain accounts showing the supply and demand conditions for commodities, the inputs and outputs of industries, and the incomes and expenditures of households, business, and government.

The Quebec Input-Output Model

The Quebec input-output model is used to conduct impact analysis by measuring the effects of an exogenous shock to final demand. The model is open with respect to government expenditures and residential housing. Output is determined using an industry-commodity detail of 74 industries and 276 commodities.

The model is available to the private sector for conducting impact analysis. Currently the Quebec government undertakes about 800 simulations per year for private interests.

ECONOMIC BASE MODELS

Introduction

Economic base theory was first formalized in the 1930's. The underlying aim was to develop a simple model of urban or regional economic performance. To a large extent, when the theory is compared with other methods, simplicity remains its leading virtue today. The theory is readily understood and calibrating an economic base model requires less data than the other impact assessment methods. The price of this simplicity is the rather limited output detail produced, the lack of any dynamic context for the impact results, the short time period for which the model may remain valid and the likelihood that the introduction of a large project in a small region would render the model's assumptions invalid. Still, for some situations, the relatively low cost of constructing an economic base model may make it an attractive option.

Main Characteristics

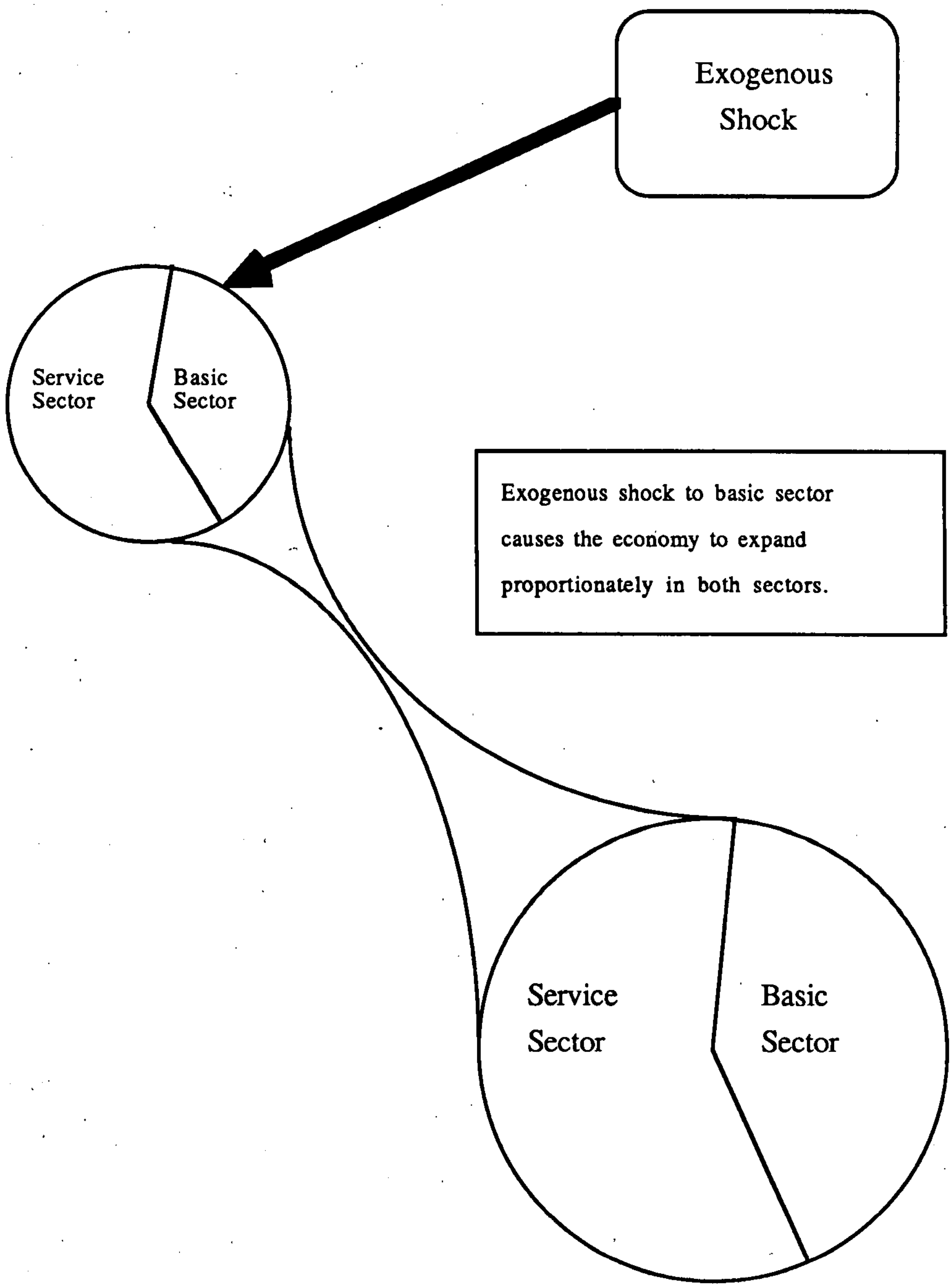
Economic base models split economic activity in a region into a basic sector and a non-basic sector. The basic sector serves export markets, and the non-basic or service sector serves only the local market. An exogenous increase in export activity increases income and employment in the export industries. In turn, these gains are transmitted to the local service sector, causing activity in local services to change by a multiple of the original stimulus as the new injection of funds is spent and respent in the local economy. This induced effect occurs when households employed in the basic sector spend their increased incomes. Recirculation continues until the leakages from the system, such as imports, savings and taxes exhaust the initial injection. The general process is summarized in Figure 6.

The constant relationship between the size of the export sector and the size of the service sector shown in Figure 6 is intentional. In economic base theory, a region's export industries are its economic foundation and the source of growth. The basic assumption of the economic base model is that the ratio of non-basic to basic economic activity, usually measured in terms of employment, remains constant. Thus, future changes in employment can be derived from forecasts of basic employment.

This relationship is normally summarized by the economic base multiplier. In effect, if economic activity is measured in terms of employment, the employment multiplier measures the change in the total employment induced by a small initial change of employment in the basic sector. Where the model is expressed in income terms, an income multiplier can be defined analogously.

The short-run and long-run versions of the economic base multipliers differ according to the analyst's migration assumptions. The short-run or "pure local multiplier", assumes that excess capacity exists in the regional economy. The employment generated by the exogenous shock to the base sector is taken up by local residents in this case.

Figure 6: Economic Base Model Schematic



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Alternatively, the long-run or "pure migrant multiplier", assumes that no excess capacity exists in the local economy. As a result, new jobs can only be filled by migrant labour. A mixed multiplier combining both the short-run and long-run assumptions is also possible. (The methodology is explained in detail in Schwartz (1982).)

The main task in constructing an economic base model is the allocation of regional employment between the basic sector and the non-basic sector. Two methods are available for this work. The direct approach employs regional surveys of businesses and public sector agencies to collect primary data on their export or service sector orientation. The indirect approach allocates economic activity on the basis of existing data, often Census of Canada employment data when an employment based model is chosen. In implementing the indirect approach, the analyst can make the allocations by assumptions based on qualitative knowledge of the regional economy; by developing measures of regional concentration of employment by industry in export oriented and local service sector activities (called location quotients); or by developing measures of the minimum requirements for an industry to satisfy local demand. Production capacity in excess of the minimum requirement is assumed to be export oriented and therefore part of the economic base.

Conceptual Issues

Economic base models have been criticized for a number of conceptual problems whose empirical significance must be judged by the analyst on a case-by-case basis. They must also be considered against the simplicity and relatively small data requirements of the base model. The latter property may be considered important for regions where data are scarce.

Economic base theory emphasizes regional exports, determined by exogenous demand, as the primary impetus for regional economic growth. However, exports may not be the only source of growth since local investment and local government expenditures may stimulate growth. Furthermore, as the region grows, the local service sector may acquire its own sources of endogenous growth.

The demand side orientation is further emphasized by the lack of any consideration of the supply side of the regional economy. If the local economy is large relative to the size of the project under analysis, this may not be a serious issue. Moreover, the ease of acquiring goods and services from outside sources and a relatively high propensity of labour to migrate may deal with any temporary shortages satisfactorily. Still, any local infrastructure capacity constraints will not be dealt with by the economic base model. Such issues must be handled separately by the analyst.

Indirect exports can occur when a local firm sells some of its output to another local firm heavily engaged in exporting. In measuring the economic base, the analyst must be alert to this issue since failing to do so could lead to an understatement of the size of the economic base and a corresponding overstatement of the multiplier.

The economic base model is highly aggregated. It reduces the division of activity to two classes and ignores all inter-industry relationships. In effect, the model represents the average response of the service sector to changes in the basic sector. To the extent that the project under analysis deviates significantly from the average, e.g., uses a higher proportion of imports and thus has a lower impact on the service sector, the model will give an incorrect prediction about the change in total economic activity. Resolving this problem is possible through a more detailed analysis along the input-output model lines, but data limitations may preclude this option.

There is some evidence that the multiplier in the short-run may be unreliable. This arises because the data used for its calculation (normally based on single year) fail to take into account adjustments occuring in the regional economy. This problem is dealt with in detail in Isard (1960). Although one might hope that a base model would be more effective to predict long-run growth in employment and population, that is not true. In the long-run, the variables of taste, technology, population size and economic structure, which must be held constant in order for a true base to service ratio to exist, are free to vary. On this basis, the base to service ratio is bound to change over time. All things considered, the analyst must decide whether using a model which can at best represent the average relationship between the base sector and the service sector at a point in time is adequate for the desired impact assessment.

Technical Issues

The major technical issue concerns the methods used to measure the economic base. Both theoretical and empirical reasons have been advanced as evidence of the inaccuracy of the methods. These are summarized in Pleeter (1980). Both the direct and indirect methods have their faults and no clear winner emerges from the research. Empirically, the choice of method does make a difference and the analyst will have to develop a detailed knowledge of the regional data in order to have confidence in the model's predictions.

Summary

The virtue of an economic base model is its ease of implementation at moderate cost. When the questions raised in an economic impact analysis concern highly aggregated variables such as total employment, income and taxes, the impact period is less than five years, the research budget is limited and there is a need for quick answers, constructing an economic base model may be feasible. The data necessary for implementation of the model are modest and usually available in published sources. The major drawbacks to the use of the economic base model are its inability to consider industry detail in analyzing impacts and the lack of any recognition of possible supply side constraints affecting the real impacts.

SYSTEMS DYNAMICS MODELS

Background and Evolution

The systems dynamics approach was developed during the early 1960's, primarily as a result of the work of Dr. J. Forrester and his colleagues at M.I.T. The systems approach was based on the concept of a system as an isolated behavioural pattern in a controlled environment. Where social behaviour was involved, it was recognized that often the experimental techniques of the natural sciences were insufficient to comprehend the workings of a system. Instead, system behaviour was modelled in terms of mathematical equations. Explaining and predicting changes in behaviour over time was the main objective.

The systems dynamics methodology was gradually refined and specialized to deal with socio-economic and business phenomena. In particular, regional economic models were built specifically with the aim of conducting impact analysis for regional development projects. The ability to project the annual behaviour of the model's variables over a ten to twenty year time period was considered one of the strengths of the systems dynamics approach. For this study, two regional simulation models are used as examples of the systems dynamics approach: a model of the region around Lethbridge in southern Alberta where Petro-Canada was proposing to develop a thermal coal mine (DPA,1980); and a Regional Simulation Model, prepared as a generic regional economic model adaptable to specific sub-provincial regions in Nova Scotia (DPA, 1979).

Main Characteristics

The systems dynamics approach places a strong emphasis on developing the model structure, hypothesizing relationships among the model's variables and establishing feedback loops. Unlike the econometric models, statistical methods are not the only technique used in estimating the characteristics of the system being modelled. Past experience and the insights of people knowledgeable of a specific field are used to develop quantitative hypotheses for the model. In addition, previously published information and new statistical analyses may be conducted to quantify the model structure.

In theory, because it models system behaviour through time, a Systems Dynamics model involves the simultaneous solution of differential equations. In practice, however, for the regional models the use of sophisticated numerical methods is replaced by a specially designed computer programming language employing relatively simple numerical techniques. This enables the analyst to approximate and extrapolate trend equations for the desired period of time, and to integrate this information to yield further insights about the quasi-dynamic system.

Systems Dynamics models are similar to the econometric models in their use of stock and flow variables and equations to calculate changes in the model's variables. Housing stock, population and unemployment are examples of typical stock variables in the regional models. Flow variables are measured in some customary unit of time, such as month or year. Income, output by industry, births and deaths are typical examples.

Systems can be modelled in terms of either *open* or *closed* models. In systems dynamics terminology, the *closed* model represents a self-contained system without connection to external, or exogenous, inputs. Since a project represents an exogenous input to the system, *closed* models are not useful for impact analysis. Instead, an *open* model with a special project component is used to conduct the impact analysis. The shock to the system created by the introduction of the project is modelled by linking the project component to other relevant components of the model.

The general structure of the Regional Simulation Model (RSM) shown in Figure 7 illustrates a typical systems dynamics regional economic model. The RSM has nineteen components including the Special Projects component. Figure 7 shows only the major linkages between the project components. Minor linkages and the factors affecting behaviour within the components are omitted. The similarity of the component linkages to the linkages in the econometric models examined previously is evident. For example, one linkage runs from income to retail/wholesale sales to employment. Employment is then linked directly to income, and also indirectly through the migration-population-transfer payment-income route. The impact of a special project is injected into the model through its direct employment effects, through the construction industry and through migration effects. The KIPP model shown in Figure 8, though less detailed in terms of sector components, exhibits some of the same basic linkages.

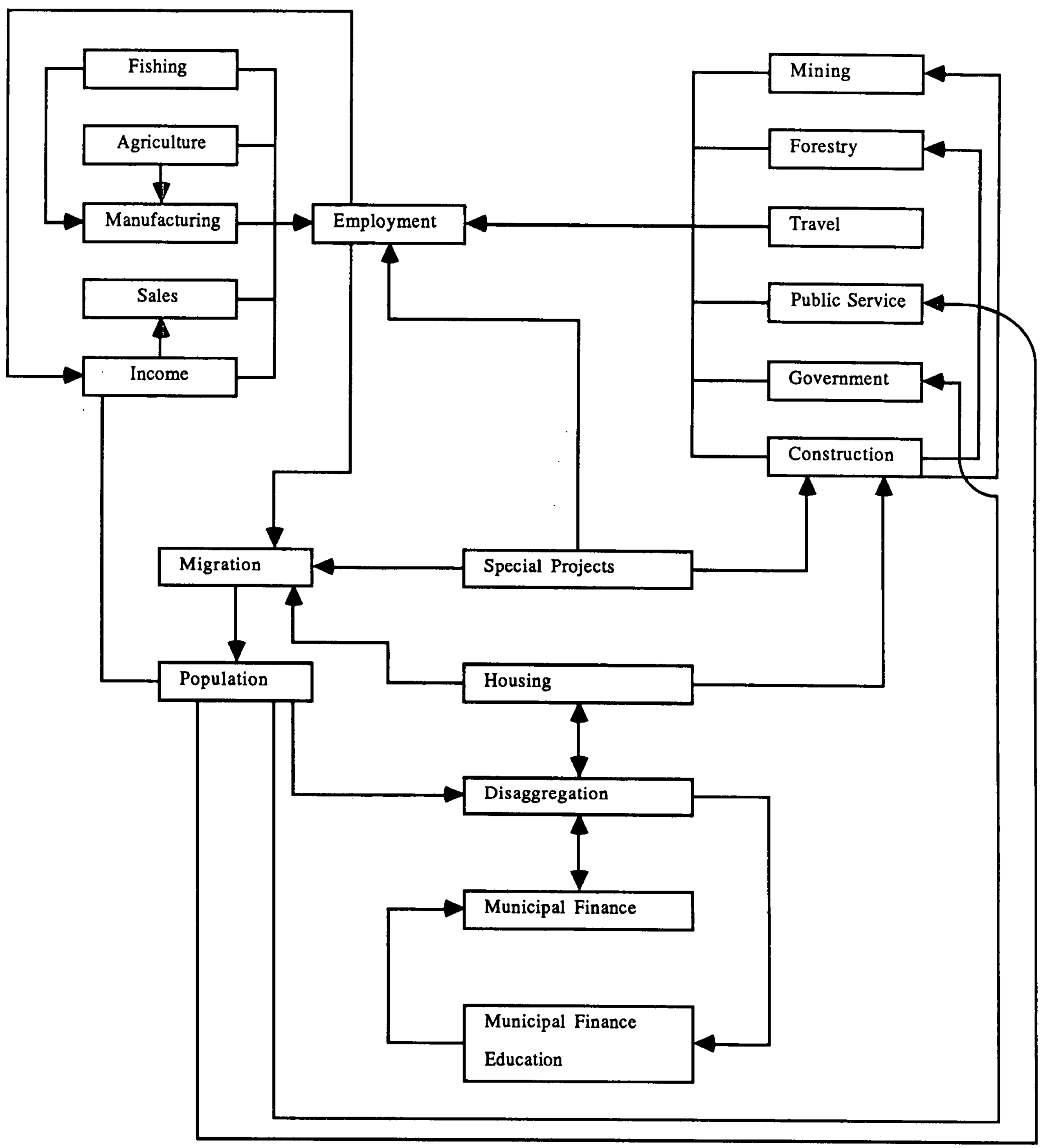
Conceptual Issues

Because of their regional (sub-provincial) character, these models exclude consideration of several sectors which figure prominently in the national, although not the regional, econometric models. Monetary, international trade and price formation sectors are notable in this regard. To the extent variables from these sectors and other national or provincial measures of economic activity are important at the regional level, they enter the regional Systems Dynamics model as exogenous input into one or more of the model's components.

Technical Issues

The Systems Dynamics regional models use three types of data. **Exogenous data** inputs are national or provincial trends such as Gross Domestic Product, aggregate employment or provincial population. It is assumed the behaviour of such variables will affect the region but will not be affected significantly by regional performance. **Region specific data** refers to published or readily available quantitative information on the regional economy. This information includes such items as the region's housing stock, the region's population, the region's employment level and so on. Census material can be an important source of region specific data. **Qualitative data** covers the often valuable insights and rule of thumb relationships that key informants and local experts can provide on the regional economy. This data may be the only source of information for provincial or

Figure 7: Structure of the Regional Simulation Model



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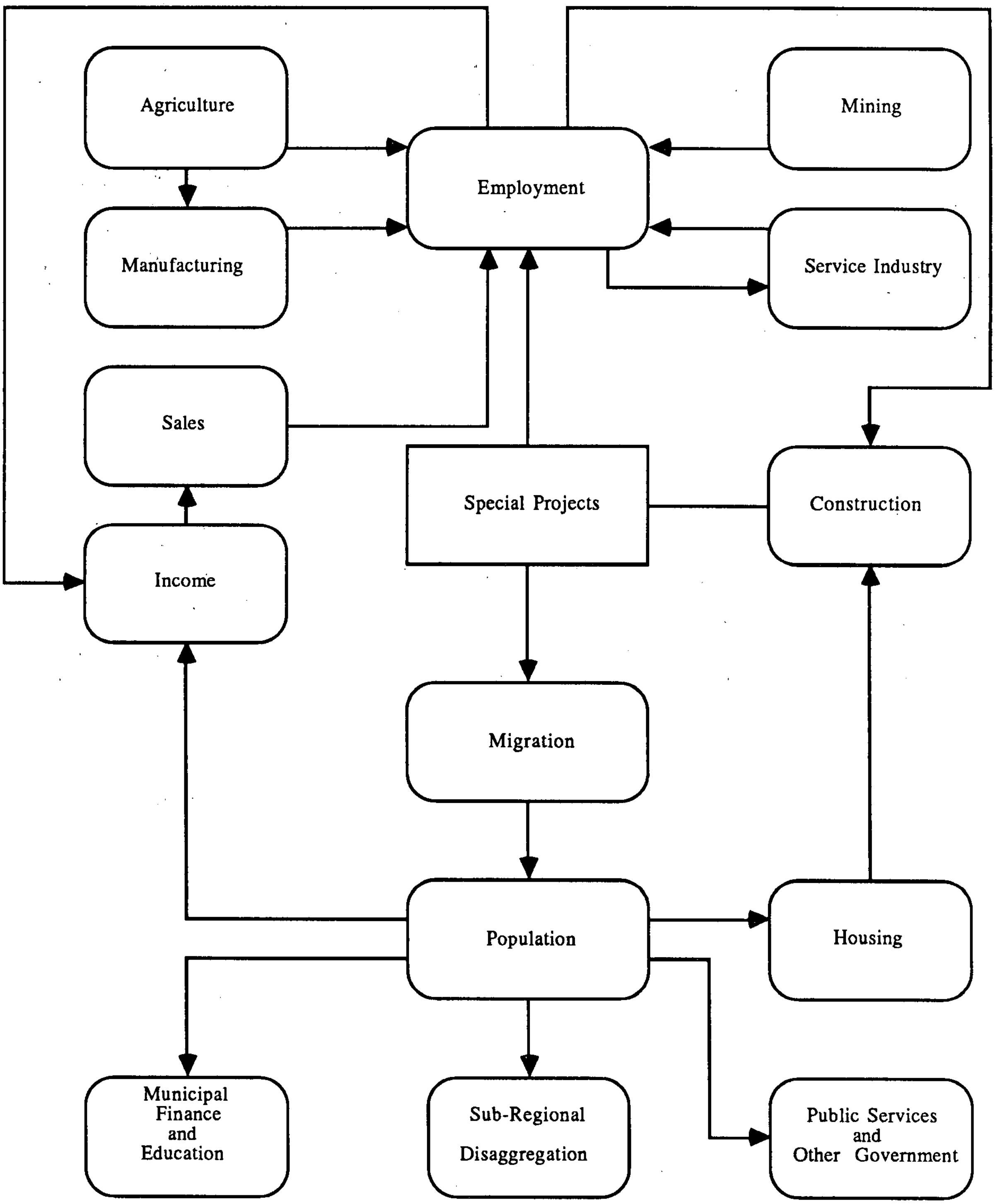
Source : DPA (1981)

Figure 8: Overview of the Kipp Simulation Model



Note : Income component is linked to every economic sector.

Prepared by Gardner Pinfold Consulting Economists Limited
Source: DPA (1980)

regional policy variables. For some relationships, the analyst must rely on qualitative data to calibrate the model. The estimates for the qualitative data based relationships are refined during the testing of the model.

The Special Projects component presents a special data collection problem. The model user will determine the form, type and level of disaggregation for the project data by the way in which the Special Project component is linked to the rest of the model. The Regional Simulation Model and KIPP examples suggest that project wage data and direct project employment data, broken down according to their regional and non-regional components, will be required.

In both the Regional Simulation Model and the KIPP Model, the special project data requirements are for construction and operation employment and wage data, and construction expenditure, by year. It is a noteworthy fact that direct project expenditure data on goods and services inputs are not required. Rather, the wage data enters the income block and then the retail sales block. Impacts associated with goods and service inputs are not included. This is a specific characteristic of these two models, and does not prevent the model builder from incorporating more detail into the model.

Summary

Systems Dynamics models provide a way to simulate economic impact behaviour in relatively small sub-provincial regions. Their dynamic properties allow the analyst to trace project impacts over time periods up to 20 years and more. These models generally do not analyze national or province-wide economic impacts. Although the impact focus of the models is usually sub-provincial, exogenous data on national or provincial economic trends as well as region specific data, qualitative data pertaining to relevant local and provincial policy variables and detailed project wage and employment data are required. The models tend to concentrate on employment and related impacts rather than impacts related to the purchase of goods and services by the project.

CHAPTER THREE

CHARACTERISTICS OF THE STUDY MODELS

The usefulness of economic models in the SIA decision-making process depends on their ability to capture the effects of demand shocks on priority economic indicators. In turn, the effectiveness of these models in capturing project impacts depends on their technical and non-technical characteristics. For each of the study models, these characteristics are summarized in Tables 1 and 2. In this review of model characteristics, two models described in Chapter Two, RDFX and MACE, are dropped from further consideration. The Bank of Canada RDFX model is not reviewed because it is not available for public use. MACE provides considerable energy sector detail, but the model is considered more highly aggregated than desirable for the type of impact analysis considered in this study.

TECHNICAL CHARACTERISTICS

The technical characteristics examined relate to the technical ability of the various types of study models to conduct project impact assessment. Among the technical characteristics considered are: whether the model has a specific impact routine, the issue of data requirements to carry out the impact analysis, the model base year, the level of aggregation, and the level of industry and commodity detail in the model, the length of the estimation time frame, as well as the time span of the model, static and dynamic properties, policy assumptions, supply side constraints, and model output.

Impact Routine

All of the study models examined are capable of carrying out an impact analysis, and the majority of them have some type of formal impact routine (Column 3, Table 1). The economic base and input-output models are specifically designed for quantifying the economic effects of a demand shock associated with project development. On the other hand, systems dynamics models and econometric models can be designed and used for both forecasting and impact analysis. The distinction between forecasting and impact analysis models is not easy to pinpoint, but the issue is not pursued here since all the study models can be used for impact analysis.

Data Requirements

Evaluating project impacts using economic models requires project data to shock the private investment sector of final demand, and/or the employment block, irrespective of the type of model being used. Each model sets its own conditions for the level of detail at which project data must be generated. This basic requirement applies for all models: project data must be identified as domestic (Canadian) content versus imports. Following this, the three most important considerations are: whether expenditure data, employment data, or both are required; the geographic level of aggregation of the model; and if expenditure data are required, the commodity/industry level of aggregation necessary (Columns 2 and 4, Table 1).

For national econometric models, the level of detail of investment expenditure data required varies with the structural detail of the model. With the exception of TIM, all the national models require project expenditure data for non-residential construction, and machinery and equipment, at varying levels of industrial detail. For example, CANDIDE requires expenditure data for non-residential construction and machinery and equipment, for 44 industries. TIM, on the other hand, prefers project expenditure data by commodity, (accommodating a maximum of 602 commodities), but will accept project data at the industry level (as defined in TIM), or aggregate expenditure data by industry.

Employment data (expressed in person-years) may or may not be required by national models, depending on the assumptions made in designing the labour block. With the exceptions of CHASE and FOCUS, all of the national models can use project employment data, but do not require it. Generally, in these cases, employment data are required only if project expenditure data is not available in a suitable form, or for comparison with model generated employment impacts.

Econometric models with both national and regional components, such as TIM, RIM, FOCUS/PRISM, and DRI/MARV, require input data to be sourced by province. The regional components generally require the same level of commodity/industry detail for the expenditure data as their national counterpart.

The Statistics Canada national and interregional models have fairly stringent data requirements. For the national model, a 602-commodity breakdown of project expenditure, including wages paid to labour, is desirable, although data at the 191-industry level (as defined by Statistics Canada) are acceptable. Although less desirable, these models can use average expenditure or input profile information, relying on model coefficients to allocate expenditures at the commodity level. The same commodity or industry disaggregation is used by the interregional model, with expenditures further specified by province of source and international imports. If provincial source information is unavailable, the model can allocate expenditures to provinces according to its embedded 1979 average interprovincial trade and industry structure.

Stand-alone provincial models, such as the British Columbia econometric model or the Alberta input-output model, obviously need data sourced according to expenditure and employment occurring within and without the reference province. Input-output models needs industry level detail satisfying their own industry definitions (e.g., 32 or 64 industries in Nova Scotia). The provincial econometric models vary in their detail from relatively aggregate investment expenditure (e.g., non-residential investment for the Nova Scotia Econometric Model) to investment by industry (for 23 industries), quarterly data preferred, for the B.C. econometric model.

The study system dynamics models utilize project investment expenditure (construction cost) in annual terms. The models require annual construction employment data which can be estimated directly or derived from the construction cost data using an

Table 1: Study Model Technical Characteristics

Model (1)	Level of Aggregation (2)	Impact Routine (3)	Project Data (4)	Base Year (5)	Industry/Commodity Detail (6)
ECONOMETRIC MODELS					
NATIONAL ECONOMETRIC MODELS					
CANDIDE	- national	- yes	- expenditure data (annual) for non-residential construction and machinery and equipment (44 industries) - employment data useful for comparison, but not required	- 1971	- 44 industries (SIC)
CHASE	- currently a single model with both national and provincial levels of aggregation	- not formally	- aggregate investment in non-residential construction, machinery and equipment, and contract services; quarterly data preferred - employment data; person-years, can use wage bill	- 1971	- 31 industries
NATIONAL - REGIONAL ECONOMETRIC MODELS					
Conference Board: - MTFM	- national	- yes	- expenditure data for non-residential fixed investment in construction, and machinery and equipment (7 industrial sectors) - quarterly data preferred - employment data required only if expenditure data isn't available in required form	- 1971	- 41 industries - 7 industry disaggregations for employment
- QPF	- provincial	- yes	- expenditure data for non-residential fixed investment in construction and machinery and equipment by province (7 industrial sectors) - employment data required only if expenditure data isn't available in required form	- 1971	- 12 SIC Industry divisions

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Table 1: Study Model Technical Characteristics (cont'd)

Model (1)	Level of Aggregation (2)	Impact Routine (3)	Project Data (4)	Base Year (5)	Industry/Commodity Detail (6)
DRI	- national	- available	- investment by industry (33 industries) in non-residential construction and machinery and equipment, plus energy investment (quarterly preferred) - employment data is optional	- 1971	- 33 industries (SIC)
MARV	- provincial	- yes	- industry expenditure (18 industries) by province for non-residential construction and machinery and equipment, plus energy investment - employment data is optional	- 1971	- 18 industries (SIC)
FOCUS	- national	- no set impact routine, but model has a built-in override feature	- aggregate expenditure for non-residential construction and machinery and equipment - employment data preferred - foreign financing requirement desirable	- 1971	- private and government output
PRISM	- provincial	- no set impact routine, however, it is possible to set up impact routine	- breakdown of expenditure on machinery and equipment in terms of 23 industries and province of source; employment data preferred	- 1971	- 22 industries plus government
TIM	- national	- yes	- investment expenditure by commodity for 602 commodities desired, but can use non-residential construction, machinery and equipment breakdown by industry (45 industrial sectors) - employment data is optional (person-years)	- 1971	- 73 industries
RIM	- provincial	- yes	- investment expenditure same as TIM but investment must be identified by province of source - employment data is desired but optional (person-years)	- 1971	- provincial shares of each of 60 industries for GDP, and 17 industries for employment

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Table 1: Study Model Technical Characteristics (cont'd)

Model (1)	Level of Aggregation (2)	Impact Routine (3)	Project Data (4)	Base Year (5)	Industry/Commodity Detail (6)
PROVINCIAL ECONOMETRIC MODELS					
B.C. Econometric	- provincial	- yes	- provincial expenditure data for 23industries - employment data; quarterly data preferred	- 1971	- 23 industries
NSEM	- provincial	- yes	- aggregate provincial non-residential investment - employment data (person-years)		- 3 sectors: (1) Government (2) Business, (3) Manufacturing
Quebec EM	- provincial	- yes	- aggregate provincial expenditure in non-residential construction and machinery and equipment - employment data (person-years)	- 1971	- 38 sectors composed of 20 manufacturing sectors, 7 government sectors and 11 primary industries
INPUT-OUTPUT MODELS					
STATISTICS CANADA MODELS					
Stat Can I/O (National and Interregional)	- national and interregional	- yes	- expenditure data: by commodity at one of three levels of aggregation or by industry - employment data: wage information required - for interregional model - need to specify province of production or can apply trade mix to allocate by provincial source	- national: 1981 - provincial: 1979	- three levels of aggregation (i) 191 industries; 602 commodities (ii) 43 industries; 100 commodities (iii) 16 industries; 49 commodities
PROVINCIAL INPUT-OUTPUT MODELS					
Alberta I/O	- provincial	- yes	- expenditure data by industry for one of three different levels of disaggregation (108 industries, 41 industries, and 15 industries) - 108 industry breakdown used exclusively by provincial government - employment data (person-years)	- 1974	- output by industry at one of three levels of disaggregation - most disaggregated level used only by government

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Table 1: Study Model Technical Characteristics (cont'd)

Model (1)	Level of Aggregation (2)	Impact Routine (3)	Project Data (4)	Base Year (5)	Industry/Commodity Detail (6)
NS I/O	- provincial	- yes	- expenditure data by industry (32 industries) - 64 industry breakdown used exclusively by provincial government - employment data (person-years)	- 1979	- 32 or 64 industries - 64 industry level output resricted to government use
Quebec I/O	- provincial	- yes	- provincial expenditure data by commodity (276 commodities), or by industry (74 industries) - employment data: wage information	- 1979	- 74 industries; 276 commodities
ECONOMIC BASE MODELS					
	- sub-provincial, could be provincial	- yes	- employment data or income data, depends on model specification	- base year can be chosen if survey is done - alternatively, if census data, then 1981	
SYSTEMS DYNAMIC MODELS					
	- provincial, but more frequently sub-provincial	- yes	- depends on model specification; may use actual employment (person-years) or estimate based on	- model specific	- depends on model specification
ECONOMETRIC MODELS					
NATIONAL ECONOMETRIC MODELS					
CANDIDE	- stand alone	- 1960-1981	- no clear minimum ($10-20 million) - $100 million (real) is a good guide	- investment lag - up to 6 years - lag on trade price effects of 3 years	

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Table 1: Study Model Technical Characteristics cont'd

Model	Options (7)	Estimation Time Frame (8)	Threshold (9)	Dynamics (10)
CHASE	- top-down - shares out of provinces - trying to build in bottom-up features	- 1965-1980/82 - depends on quality of most recent data	- $1-2 billion	- peak impact after 4-6 quarters - induced impact declines, only remains positive if there is a capacity increase
NATIONAL - REGIONAL ECONOMETRIC MODELS				
Conference Board: - MTFM	- stand alone	- quarterly data from 1966 to 4th quarter of 1981	- not certain on project basis - no estimate given	- can't say in general - depends on project characterization
- QPF	- top-down or stand alone	- quarterly data from 1966 to 1981	- depends on province	- again, depends on project characterization
DRI	- stand alone	- 1975-1983 (some 1984) - 1966-1983 (employment)	- $50-100 million ($1985)	- 3 year lags on spending, employment related to output, and real wage change
MARV	- mix of top-down and bottom-up	- 1975-1983 (some 1984) - 1966-1983 (employment)	- province specific impacts show up at smaller levels	- maximum impacts after about 3 years - impacts tail off between 4 and 6 years
FOCUS	- stand alone	- quarterly data from the mid-50's to 1981	- $200-300 million in current dollars	- maximum of 6 year lag - generally lag on output is 4-5 years - lag on employment approximately 3 years
PRISM	- top-down - provincial shares must add up to national aggregates	- annual data from 1961 to 1981	- $200-300 million	- generally lag on output is 4-5 years - lag on employment approximatel 3 years
TIM	- stand alone	- 1966-1982, 83	- not established	- peak impacts about 1 year after the direct shock - for a single year shock, the effects
RIM	- top-down in the goods sector - construction and services are endogenous at the provincial level	- 1966-1982, 83	- not established	- similar to TIM

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Table 1: Study Model Technical Characteristics cont'd

Model	Options (7)	Estimation Time Frame (8)	Threshold (9)	Dynamics (10)
PROVINCIAL ECONOMETRIC MODELS				
B.C. Econometrics	- stand alone	- (1971/72-1983) quarterly	- 10% change on variables of interest	- depends on sectors shocked - capital intensive industries shocked -- peak impact at about 4th quarter - labour intensive industries shocked -- peak impact at end of 1st quarter
NSEM	- stand alone	- 1963-1984	- no estimate has been made	- peak impact after 1 year
Quebec E.M.	- stand alone	- 1966-1985 for the labour market - 1961-1982 for other sectors	- approximately 1% change in the reference value of the variable	- annual model with long-run dynamic peak
INPUT-OUTPUT MODELS				
STATISTICS CANADA MODELS				
Stat Can I/O	- stand alone	- national - 1981 - regional - 1979	- at least $1 million	- not applicable - left to operator or analyst to infer time span of impacts
PROVINCIAL INPUT-OUTPUT MODELS				
Alberta I/O	- stand alone	- 1974	- not established	- not applicable - analyst may try and infer time span of impacts
NS I/O	- stand alone	- 1 year (1979)	- approximately $1 million range	- not applicable - left to operator or analyst to infer time span of impacts
Quebec I/O	- stand alone	- 1979	- 1% change from reference case	- not applicable - left to operator or analyst to infer time span of impacts
ECONOMIC BASE MODELS				
	- stand alone	- 1 period (base year)	- can deal with project employment less than 100 persons	- no dynamic aspects

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Table 1: Study Model Technical Characteristics (cont'd)

Model	Policy Assumptions (11)	Model Output (12)	Comparability (13)
SYSTEMS DYNAMIC MODELS			
- stand alone	- generally 15-20 years, but is the choice of the model builder	- depends on model characteristics - can deal with small projects (i.e., less than $1 million)	- model specific - builder may incorporate lag structures
ECONOMETRIC MODELS			
NATIONAL ECONOMETRIC MODELS			
CANDIDE	- the base case is developed using the latest Annual Economic Review - policy assumptions made for fiscal, monetary and energy sectors	- 50 tables which give National Accounts variables at the Industry level - 5-10 year time span	- comparable at National Accounts and SIC Industry levels
CHASE	- key policy assumption is embodied in the need to neutralize impact on the deficit before channelling funds back into the economy	- breakdown of GNP, and aggregate unemployment rate - short-term: 5-6 year time span - long-term: 20-25 year time span	- very similar to Bank of Canada and DRI models
NATIONAL - REGIONAL ECONOMETRIC MODELS			
Conference Board: - MTFM	- fiscal and monetary policy assumptions required	- GNP National Accounts, variables, plus industry output, employment, unemployment rate, and prices - 5 year time span	- can compare at National Accounts level, but difficult at lower aggregation levels
- QPF	- fiscal and monetary policy assumptions required (same as MTFM)	- less detail than national model - output by industry, employment, income and expenditure, housing data - 5 year time span	- difficult to compare because of bottom-up detail of model
DRI	- not possible to change policy assumptions by changing model coefficients because of software limitations, but possible to set some variables at a given level	- all categories of GNE, Industry Output (33 industries), Total Employment, Index of Manufacturers - 25 year time span	- comparison with other models has never been done - comparison is difficult because of differences in base assumptions and policy assumptions

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Table 1: Study Model Technical Characteristics (cont'd)

Model	Policy Assumptions (11)	Model Output (12)	Comparability (13)
MARV	- not possible to change policy assumptions by simply changing coefficients as a personal computer model - in the on-line version of MARV, it is possible to change coefficients at will	- output by industry for 18 industries, income, wages and salaries, retail sales, population, labour force and housing starts - 25 year time span	- comparison with other models has never been done - comparison is difficult because of differences in base assumptions and policy assumptions
FOCUS	- fiscal, monetary and exchange rate policy assumptions required key policy assumptions is the - assessment of the response of the Bank of Canada to changes in the exchange rate	- breakdown of GNP National Accounts Variables - 10-25 year time span	- comparable in terms of aggregate National Accounts variables - less able to compare employment because of differences in wage deflators
PRISM	- straight top-down model with no interprovincial trade	- output by industry (22 industries) - 10-15 year time span	- difficult to compare regional output because of varied design of models (i.e., assessment of total employment by industry, and industry by province will differ because of varied survey techniques
TIM	- need fiscal and monetary policy, exchange rate, and energy policy	- GNP National Accounts variables, more detail on request up to 73 industry level, employment data - 15-20 year time span	- comparable at National Accounts level and SIC level
RIM	- same requirements as for TIM, because of dependency of RIM on TIM	- GDP by province, and output by industry (13 industry breakdown), employment - 15-20 year time span	- comparable for provincial GDP variables and SIC industry division levels
PROVINCIAL ECONOMETRIC MODELS			
B.C. Econometric	- no policy assumptions necessary to carry out impact assessment - maintain the status quo	- output by industry, GDP by industry, employment by industry, prices - 15 year time span	- comparisons haven't been done - may be difficulties for comparison purposes arising from differing methodologies
NSEM	- implicitly there are policy assumptions used to produce national variables used as input - policy assumptions about provincial fiscal and taxation measures	- Gross Provincial Product, employment, unemployment, wages and salaries, PDI, CPI, Manufacturing Output - 15-20 year time span	- at provincial GDP levels (e.g., employment, unemployment...)

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Table 1: Study Model Technical Characteristics (cont'd)

Model	Policy Assumptions (11)	Model Output (12)	Comparability (13)
Quebec E.M.	- detailed government sector - government expenditure is exogenous - therefore, when conducting an impact assessment, must make assumptions about government policy	- output for 38 industrial sectors, employment for 25 sectors - 15 year time span	- comparisons possible with other regional models - viability of output assessed on basis of operator's knowledge of the economy
INPUT-OUTPUT MODELS			
STATISTICS CANADA MODELS			
Stat Can I/O	- no monetary policy - fiscal policy (e.g., tax rates, transfer payments) cannot be altered	- output by industry (191 industries, 43 industries, or 16 industries for National Model and 191 or 43 industries for Interprovincial model)	- no comparisons have been made - compare results of Interregional model with those of provincial I/O models
PROVINCIAL INPUT-OUTPUT MODELS			
Alberta I/O	- no monetary policy - fiscal policy cannot be altered	- output by industry at one of three different levels of industrial disaggregation - employment	- no comparisons have been made - possible to compare results with that of Stat Can Interregional I/O model
N.S. I/O	- no monetary policy - fiscal policy (e.g., tax rates) cannot be altered	- output by industry (32 or 64 industries) - 64 industry output restricted to goverment use - no time span	- no comparisons have been made - possible to compare results from Stat Can Interregional model
Quebec I/O	- no monetary policy - fiscal policy can be altered to a minor extent - not necessary to alter policy to conduct impact analysis	- output by industry (74 industries) and employment - no time span	- no comparisons have been made - possible to compare results from Stat Can Interregional model
ECONOMIC BASE MODELS			
	- no explicit policy assumptions are made - implicit assumption about the fixed nature of the relationship between the base and service sectors	- employment and income for sub-region being studied - no time span	- employment measured as a unit of account, making comparison with I/O model output difficult - sub-provincial nature leads to difficulty in comparing economic base models

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Table 1: Study Model Technical Characteristics (cont'd)

Model	Policy Assumptions (11)	Model Output (12)	Comparability (13)
SYSTEMS DYNAMICS MODELS			
	- possible to incorporate policy assumptions, but model usually sub-provincial - therefore, governmental policy in the macro sense is taken as given	- model specific - depends on model design - time span is generally 15-20 years	- may be comparable to output of the econometric model, depending on level of aggregation - difficulties may arise in direct comparison because of regional specification and differing methodology

Source: Gardner Pinfold Consulting Economists Limited average ratio of wages to total construction cost and an average construction wage figure. Annual operating employment is estimated for the model in a similar fashion. The study models do not use detailed information on non-labour project inputs or project output, since the main focus of attention is on employment-related impacts. However, such information could be required if the analyst chose to extend the impact scope to include a broader range of macro-economic impacts. This would involve constructing additional model components or extending the coverage of existing components.

For economic base models, the project data requirement is straightforward. Employment-based models use an estimate of the incremental employment in person-years associated with the project. If the model is expressed in income terms, investment expenditure by the project, disaggregated into a local component and an import component, is necessary.

Finally, ease of collection is an important factor in determining the marginal cost of using the model. The important question arises, whether the required data are readily available for extraction from the project description, or whether a special data collection or creation effort must be mounted. Effective criteria for determining which model may be most useful are to assess the data requirements of the model in relation to the size of the project, and secondly, to estimate the costs of collecting the data to allow the model to carry the assessment out.

Level of Industry/Commodity Detail

The level of industry or commodity detail at which the models can analyze project impacts is summarized in Column 6. The highest level of industry disaggregation is provided by the input-output models. The national-regional econometric models estimate industry output impacts in the 20-50 industry range. The industry detail of the system dynamics models tends to be limited to 3 or 4 selected industries. No industry detail is available from an economic base model.

Base Year

Each of the study models operates in constant dollars for a specific base year. The econometric models currently use a 1971 base year (Column 5). All model owners are planning to update the base year to 1981 when Statistics Canada completes the release of 1981 Census material in the spring of 1986.

The Statistics Canada national input-output model uses a 1981 year. The interregional model is based in 1979, as do the provincial input-output models in Quebec and Nova Scotia. Systems dynamics models are usually purpose-built for a specific project. The model-builder is at liberty to choose a suitable base year, constrained mainly by data availability. For the economic base model, if the model estimation data are obtained by survey, then the base year will be the survey year. Alternatively, if the model is developed using census employment data, then 1981, the most recent full census year, will be the base year.

Two issues arise concerning the model base year. Firstly, if the project data is supplied in constant dollars for a year other than the model base year (say, for example, $1985), these data must be deflated to the appropriate base year, e.g., $1971, using appropriate price indices. Secondly, the output of the model will be in the base year values. To be able to interpret the project impact in an appropriate context, the model output must be reflated either to current dollars, or at least to the reference year used for the project data.

The deflation-reflation procedure creates two problems. One problem is the choice of appropriate price deflators and price inflators. The other problem arises because the project impact is assessed in the context of the economic characteristics of the model base year. If relative price changes have occurred during the period between the model base year and the year chosen to express the impact results, e.g., 1971 versus 1985, the reflation process may distort the reported impact results. This type of reflation can have an effect on the values of the multipliers produced by the model. This problem is discussed in more detail in the section on multipliers.

Model Interdependence

All national models are standalone, that is, they do not depend on receiving the output from another model (Column 7). Input-output models, such as the national and regional Stat-Can I-O models, are strictly standalone models. Similarly, all provincial input-output models are stand-alone, as are all economic base models. Systems dynamics models can be designed to stand alone, or may depend on a national macro model for forecasts of exogenous variables such as GDP or employment. The provincial econometric models also rely on a forecast of national economic variables (usually taken from a national model) to drive them.

For the linked national-regional econometric models, the regional components are clearly dependent on their national counterpart. Where the regional model is a top-down model, such as the FOCUS/PRISM combination or CHASE model, the regional model shares out the macroeconomic data generated by the national model amongst the various regions. Regional totals are forced to sum to the national total. Regional activity in each sector depends completely on the national sector performance.

The extent of regional to national dependence is somewhat less in the regional models with some bottom-up characteristics, e.g., QPF, MARV or RIM. For example, regional service and retail rates, activity can be determined endogenously in each provincial model. However, the provincial models still depend on the national model for some of their exogenous inputs such as the level of goods production.

Length of the Estimation Time Frame

The estimation time frame (Column 8) describes the time period over which the equations of the econometric or systems dynamics model are estimated. Two factors determine the length of the estimation time frame: methodology and data availability.

Econometric models generally have an estimation time frame between 15 and 20 years. A similar time frame applies to the systems dynamics models. The major limitation in both cases is data availability. However, the systems dynamics model is generally more flexible in choosing the data time frame than the econometric models because they require less data.

In the case of the input-output models, and the economic base models, the estimation time frame is one year, the base year. The choice of the base year is generally determined by the availability of existing data.

Two general points should be noted about the length of the estimation time frame, and its effect on the utility of using the models for impact assessment. First, econometric models and systems dynamics models reflect an average view of the historical performance of the economy over the length of the estimation time frame. Second, input-output models and economic base models provide 'snapshots' of the economy, (i.e., they look at the impact of the project on an economy characterized by information from a single point in time). Significant deviations between the current structure and the historical structure of the economy portrayed in the economic models may reduce the accuracy of the impact results. Since knowledge of recent structural change in the economy is extremely limited, the user is unlikely to know how much accuracy has been lost.

Threshold

The concept of threshold (Column 9) deals with the minimum size of project expenditure necessary to make using a model worthwhile to assess economic impacts. The issue is clouded by the lack of any objective standard of comparison. As far as could be determined, the threshold must be determined on a model-specific basis, based on the model operator's judgement. The range of model threshold values obtained from the national econometric model operators varied from a low of $10 million to a high of $2 billion.

In our view, using national econometric models for projects less than $100 million is probably not worthwhile. Such projects are so small relative to the national economy that the impacts are unlikely to be detectable or statistically significant. However, relatively small projects could register detectable impacts in the private models. For smaller projects, the provincial models (top-down and stand-alone), systems dynamics models and economic base models all provide a means of assessing impacts at the provincial or sub-provincial level.

Supply Side Constraints

The issue of supply side constraints deals with the question of whether the model is constrained by projected capacity in producing output, (i.e., limitations on natural resources, technology, labour and capital). If real world constraints exist, and the project causes a demand shock which pushes the economy beyond its production capacity, then rapid inflation will occur along with relative price changes. If the model contains no supply side constraints, it will not predict the actual effects of the shock correctly.

The obvious question arises - "How likely is this to occur?" The answer depends largely on the size of the project relative to the size of the reference economy. A supply side constraint is more likely to be important if the reference economy is small. Yet, there is no general answer, so that the judgement of the analyst will be critical.

The two types of study models in which the supply side constraint is dealt with as an issue are the econometric models and the system dynamics models. Canadian econometric models are based on Keynesian economic theory, and are demand driven in the short-run, but in the long-run supply side constraints do enter the simulation. Systems dynamics models can incorporate supply side constraints in their definition and design. At the opposite end of the spectrum are the economic base models and the input-output models which embody no supply side constraints. An *a priori* view of the supply side issue may be necessary in selecting or building an analysis model.

Relative Price Changes

The question here is what if the demand shock associated with implementing the project is large enough to cause relative price changes. In these circumstances, the capability of the study models to deal with this problem may be an important factor for assessing their usefulness.

Methodologically, neither economic base models nor input-output models are capable of dealing with this problem. Economic base models contain no prices. Input-output models assume that input and output prices remain constant.

The systems dynamics models examined in this study are too aggregated at the regional level to deal with relative price behaviour. However, dealing with relative price changes is a possibility since the model builder could incorporate price behaviour if so desired.

Some of the study econometric models have detailed behavioural price formation equations. In these models, e.g., TIM, CANDIDE, changes in relative prices as they affect the demand for commodities are taken into account. However, the structural characteristics of the econometric models are estimated from the data in the estimation time frame and so reflect the average relative price over this period. The technical structure of the model is treated as fixed over the impact period, so that even if the project imposes relative price changes, there is no mechanism to adjust the input mix used (i.e., to allow for production factor substitution) at the industry level, let alone a mechanism allowing a change in industry structure itself. This is a methodological flaw of all Canadian state of the art econometric models, (even for those as highly disaggregated as CANDIDE and TIM (Angevine, 1980)) and currently there is no way of avoiding it.

Dynamic Properties

The dynamic properties of an economic model relates to the question of whether the model can associate specific project impacts with specific time periods (Column 10).

Neither input-output nor economic base models account for the passage of time. They provide a 'snapshot' view of the economy at one point in time and an impact estimate with no time dimension. Inferring the time span of the impacts is a matter of the analyst's judgement.

Econometric models and systems dynamics models are both capable of evaluating the time span of economy impacts. The evaluation is dependent on:

- the time pattern of project expenditures; and,
- the lag structure of the models.

(Lag structure refers to how the various model components are designed to spread the demand shock through time.) Econometric models each have their own lag structure as designed and estimated by the model builder. For example, in the CHASE model, the peak impact is estimated to occur 4-6 quarters after the initial shock. In the case of FOCUS, lagged effects may be spread over as much as 6 years. The CANDIDE model incorporates an (induced) investment lag of up to 6 years and a lag on trade-price effects of 3 years.

Another notable feature of the econometric models is the difference in the impact profiles of top-down and partial bottom-up regional models. On the one hand, the import profile of the former will match that of its national counterpart. On the other hand, the latter could exhibit a different impact profile for the same project, because of the incorporation of inter-provincial trade and the endogenous determination of service activity in the provincial models.

The systems dynamics models may have their own lag structure dependent on model design. The impacts can therefore be traced over time with these models. It is evident that the lag structures vary across the econometric and systems dynamics models. If the time profile of the impacts is likely to be important, some careful thought may have to be given to the choice of impact model.

Policy Assumptions

A model may require the analyst to make policy assumptions to conduct an impact analysis. The extent of this requirement (Column 11) depends on the government sector detail in the impact model.

Economic base models contain no government sector and therefore require no policy assumptions. Policy assumptions are embedded in the structure of the input-output models, at least as far as their effects are contained in the data used to construct the models. Explicit policy assumptions are not required to execute an impact analysis.

In the case of the systems dynamics models, it is possible to build in policy assumptions if the model is designed with a detailed government sector. Usually the models are sub-provincial, so that the policy variables would deal with issues at the municipal services level.

Econometric models generally include more government and international payments sectors than the other models. Consequently, fiscal, monetary and exchange rate assumptions are necessary to operate them, but the level of detail of these assumptions is model specific. In addition, for some models, energy policy assumptions may be necessary (e.g. CHASE, and the TIM/RIM combination of models). The nature of the policy assumptions will affect the impact results, so the user must be fully aware of the assumptions made and their implications.

Model Output

Model output varies with the geographic level of aggregation and the type of model (Column 12). At the national level the economic models generate output in the GDP, aggregate employment, the inflation rate (CPI), and the balance of payments. In other words, these models will generally produce a standard breakdown of aggregate economic variables covered by the system of National Accounts. In addition, industry output and/or gross domestic product is available for different levels of industry aggregation (Column 6).

The regional econometric models produce output on provincial level macroeconomic variables such as GDP, employment and inflation. In addition, output by industry, GDP by industry and employment by industry is available for the industry disaggregation supported by the model. Detailed demographic and labour force data are produced by some models such as RIM and QPF. The Statistics Canada national input-output model produces output on the main components of the income and expenditure sides of gross domestic product, estimates of employment impact and gross domestic product for up to 191 industries. The interregional model disaggregates the impact results to the provincial level, again reporting the major GDP aggregates and GDP by industry.

At the sub-provincial level, the economic base model will produce model specific output describing the effects on the service and basic sectors, as measured by changes in employment and/or income. The output generated by systems dynamics models depends on the specifications of the model. The minimum output generated would describe the effects of the demand shock on employment and income. Housing, manufacturing, retail sales, municipal services and population are among the variables for which impact estimates can be operated.

Another aspect of model output is the time span covered. Neither the imput-output nor the economic base models attach any time dimension to this output. Both the econometric models and the system dynamics models are technically capable of projecting impacts for as long as 15 to 20 years. The impact period chosen depends mainly on the professional judgement of the model builder/operator and the ability to project the exogenous variable values with acceptable accuracy. For the study econometric models, the output time span ranges from 5 years (e.g., MTFM, QPF) to 10-15 years (e.g., CANDIDE) to 20-25 years (e.g., CHASE, TIM/RIM). The system dynamics models can be projected for up to 25 years or longer.

Government Revenue

Large projects may have a significant impact on the tax revenues collected by government. These revenues can accrue at the federal, provincial and municipal levels. The ability of a model to predict the tax revenue impacts of large energy projects may be a special concern. The tax revenue characteristics of the study models are considered at two levels: the ability to predict tax revenue impacts for each level of government and the level of detail at which the energy sector impacts are handled.

The study models exhibit clear differences in their ability to analyze the tax revenue impacts of a development project. Economic base models are the least useful for this task because they have no capability to provide information on taxation in either the energy or non-energy sectors. Systems dynamics models have been constructed primarily to analyze impacts within a sub-provincial region. Consequently they possess no ability to estimate tax revenue impacts at either the provincial or the national level. However, municipal taxation effects are normally estimated by the systems dynamics impact models. Furthermore, these models are very flexible in their design. Given the time and resources, a model builder could construct a tax revenue component capable of generating provincial level and/or national taxation impacts. The level of detail would be a function of the users requirements and the resources available for the impact study.

A wider range of tax revenue impact information is produced by input-output models. The open model of the Statistics Canada national input-output system estimates the national level impact revenues arising from commodity taxes, non-commodity taxes, government revenue from production, resource taxes, import duties and corporation taxes. If the closed (up to households) model is used, personal income taxes and other transfers from households are included in the tax revenue calculation. Relevant subsidies are deducted where necessary. One drawback of these estimates is that they are based on the tax structure in place in 1981, the model base year. Furthermore, the model does not produce a detailed analysis of the tax revenue implications of an energy project. The provincial input-output models produce only provincial level information at a relatively aggregated level.

The national econometric models provide the most detailed tax impact analysis. Among the models discussed - TIM, DRI, CHASE, FOCUS, MTFM and CANDIDE 3.0 - the level of taxation detail varies as does the specific energy sector detail.

TIM estimates government revenues and expenditures (not including those generated by the energy sector) for different jurisdictional levels. Direct and indirect taxes on persons, and corporate and government enterprise rates are estimated at both the national and provincial levels. In addition, TIM also generates estimates of local government revenue, hospital revenue, and pension plan revenues, outside the energy sector. In TIM's detailed energy sector, estimates are made of oil and gas royalties, as well as for several tax and subsidy programs based on the most recently implemented energy policies.

The CHASE model has a detailed government revenue and expenditure sector used for estimation of energy related and non-energy related tax revenues at the national and provincial levels. In FOCUS, federal and provincial corporate income taxes are estimated in detail as a function of statutory corporate tax rates, and the estimated tax base. Indirect taxes are estimated at the federal, provincial and local levels. The model has a very detailed energy sector which approximates the corporate cashflow from oil and natural gas production, and then goes on to make estimates of associated energy taxes, (i.e., royalties, and direct taxes).

In the MTFM model, government revenue and expenditure is separated into five levels: federal, provincial, local, hospitals, and pension plans. Corporate tax equations are estimated on a rate base with capital cost allowances by industry. Most categories of indirect taxes including energy taxes are modelled. The government component of DRI estimates expenditures and revenues at four levels of aggregation: federal, provincial, local and hospitals. The model calculates estimates for federal and provincial corporate taxes, and indirect taxes. Indirect taxes at the federal level are divided into three categories: the federal sales tax, customs duties, and other taxes. At the provincial level there are two categories: retail sales tax and other.

The CANDIDE model also disaggregates government revenue by level of government. Corporate taxes are estimated at the federal and provincial levels, as are most indirect taxes (including those generated by energy projects). The general form is as a rate-base calculation.

Comparability

Comparability deals with the question of whether a user can directly and easily compare the results from two or more models for a single project (Column 13).

In the case of national econometric models, it is possible to compare the output of the National Accounts variables, such as GDP, and aggregate employment. The output is less comparable at the industry specific level because of differing industry definitions and levels of aggregation. More generally, comparability is limited below the standard Statistics Canada National Income Accounts variables.

At the regional level, comparisons can be made based on the standard Statistics Canada definitions of regional variables. A possible problem arises that MARV treats the Atlantic provinces as a group, whereas the remainder of the regional models define economic regions based on provincial boundaries. At the industry level, different industry definitions across the models may also limit comparability.

The comparability of output from different input-output models is dependent on the geographic, industrial and commodity levels of aggregation. In addition, there is also the issue of comparing the output of models which are founded on a different base year. The output from the Stats Can I-O models (and similarly for the economic base model), is not directly comparable with that of the dynamic econometric models.

The output of systems dynamics models may be comparable with that from an econometric model if they are defined at the same level of aggregation. Among the study models, however, the sub-provincial character of the systems dynamics models renders their output non-comparable with the provincial and national level econometric models.

Economic base models frequently use employment (person-years) as a unit of account. Consequently, their output is not directly or easily compared with that of the other models, which are defined in monetary terms (expenditure and income).

Migration

For some projects, whether the model can estimate migration patterns associated with project implementation may be an issue.

The economic base model is not specifically designed to measure migration effects, but the analyst can make assumptions about the amount of migration into or out of the project area. The exogenous migration information can be used to adjust the size of the employment multiplier to change. Migration impacts are not dealt with by input-output models.

The systems dynamics models can include a migration component if so desired. Generally, this involves only migration into and out of the project impact economy. The analyst must introduce exogenous assumptions about the size of the migrant component of the project labour force. In addition, the model may analyze general migration into and out of the region. Because of the sub-provincial scope of the systems dynamics models, inter-provincial migration is not modelled.

For econometric models, when it is involved, migration is analyzed at the inter-provincial level. For example, both TIM/RIM and MTFM/QPF have very detailed inter-provincial migration components, whereas FOCUS/PRISM does not deal with the issue. In general, only the econometric models with both national and regional components deal with the issue of inter-provincial migration.

NON-TECHNICAL CHARACTERISTICS

Non-technical characteristics include ease of user access, overall cost for using the model, and user-defined characteristics determined based on experience, such as credibility and usefulness. The summary characteristics presented in Table 2 are based on interviews with model builders and operators.

Table 2: Non-Technical Characteristics

Model (1)	Ease of User Access (2)	Credibility (3)
ECONOMETRIC MODELS		
NATIONAL ECONOMETRIC MODELS		
CANDIDE	- model can be used by project proponent when not being used by Economic Council - owner operated, batch job with turnaround time of 2 days to 2 weeks - reports written by model owner	- results are checked against intuition, but there is no standard of comparison
CHASE	- model run interactively by operator	- credibility checked by asking does the result make sense - checks for consistency by judging the results in the context of the current economy
NATIONAL - REGIONAL ECONOMETRIC MODELS		
Conference Board: - MTFM, QPF	- models run interactively - user generally wouldn't be able to interpret results without the aid the model operator	- credibility based on intuition and knowledge of the economy, and the model, however, accuracy of the reesults has not been assessed
DRI, MARV	- models are interactive, and available as personal computer products - better to let DRI run the impact model, though user could undertake it hands on - models produce reports, tables and graphs	- modeler monitors out for unrealistic results - there has been no follow-up to assess the accuracy of the results
FOCUS, PRISM	- user can run the model themselves but will have to know the model extremely well to carry this out - data collection is the key to turnaround time (1 day to run model) - user will require help from analyst to interpret output	- credibility checked by modelers intuition and knowledge of the economy
TIM, RIM	- operator does simulation and produces output, - report available if requested	- assessed by the model owner based on knowledge of the model and the economy
PROVINCIAL ECONOMETRIC MODELS		
B.C. Econometric	- owner runs simulation and produces report	- credibility based on comparsion with other regional models output, and operators general knowledge of the provincial economy
NSEM	- operators run the model and produce the report	- credibility checked by modelers intution and knowledge of the economy

.../2

Table 2: Non-Technical Characteristics (cont'd)

Model (1)	Ease of User Access (2)	Credibility (3)
Quebec EM	- operators run the model and produce the reports	- checked against output of other regional models, and based on general knowledge of provincial economy
INPUT-OUTPUT MODELS		
STATISTICS CANADA MODELS		
Stat Can I/O	- operator runs batch job with 1 week turnaround time - output provided on computer printouts or tapes	- judgement of operator, based on knowledge of production process, and general knowledge of the economy relative to that which existed during the base year
PROVINCIAL INPUT-OUTPUT MODELS		
Alberta I/O	- operator does simulation and produces report	- judgement of operator, based on knowledge of provincial economy
NS I/O	- operator does simulation and produces report	- credibility assessed by model owner based on knowledge of the economy
Quebec I/O	- operator runs batch jobs - model produces fully documented report	- not established, credibility based on assessment of model owner/operator
ECONOMIC BASE MODELS		
	- user built and operated	- judgement of operator, based on knowledge of the economy, and methodological approach
SYSTEMS DYNAMIC MODELS		
	- generally user built and operated	- judgement of operator, based on knowledge of the economy, and methodological approach

Ease of User Access

The ease of user access depends on such factors as whether the model is user-built and operated, whether the model can be run interactively by the user or only by the model owner/operator. The turnaround time for batch jobs and the format in which input data must be provided may also be important, particularly when the user may wish to compare the difference in impacts associated with different versions of the project under study.

The economic base model will almost always be a user-built model, designed to suit the specific characteristics of the local economy under study. The user has full control of the model as is the case with the systems dynamics model. Systems dynamics models are usually purpose built to analyze the impact of a project on a specific region. Their technical complexity will normally require the use of an expert to build and run the model. The user will still have complete control of and access to the model.

Input-output models, on the other hand, are generally too complex and costly to build on a project-specific basis. As well, building an I/O model is a time consuming effort. The result is that the user normally submits the project data to the operator of an existing model who runs the simulation and produces the results.

The complexity and cost of designing, building and operating the econometric models prevents the user from direct access. The operation of the model and interpretation of the results requires detailed technical knowledge of how the model works. Lacking this, most users will rely on the analysis and report produced by the model operator. However, users with repeated experience using a particular model can assume greater responsibility for analyzing the impact results. For some models, such as CANDIDE and MACE, the user is responsible for preparing the analysis of the model output, although the model operator will assist in interpreting the results.

Credibility

There is no absolute standard of comparison, or reference case, for assessing the credibility of model output from an impact assessment. Model operators argue that credibility can best be checked in terms of logic, consistency and intuitive knowledge about the economy. Hence, the main method of assessing credibility is to determine whether the model operator can explain the impact results of the model convincingly in terms of economic theory, knowledge of the economy and the model itself.

Summary

Four issues come to the forefront for assessing the effectiveness of an economic model to undertake impact assessment. The first issue is the *level of aggregation* of the model in relation to the size of the project under consideration. Specifically, economic models are available as national stand alone models, national-regional models, provincial models, and sub-provincial models. Econometric models are used at the national and national-regional levels, and also can be designed as stand-alone provincial models. Input-output models are used at the national and interregional levels, and also as stand-alone provincial models. Systems dynamics models can be designed at the provincial level, but generally are used to model the economic characteristics of sub-provincial economies. Similarly, the economic base model is used mainly at the sub-provincial level of aggregation.

The issue is whether the model is capable of dealing with project impacts which may be phased in over time (i.e., the *static and dynamic properties* of the model). Of the four models considered, only the econometric models and systems dynamics models are capable of dealing with phased impacts. The input-output and the economic base models are static models whose output has no time dimension. Placing the impacts in a time context would be the responsibility of the analyst.

The maximum *time span* of the model output is the third issue. For the input-output and economic base models, the answer has already been stated. That is, these models provide in effect single period snapshots of the economy. The time span of econometric models and systems dynamics models is determined by the model builder. For the models studied, the maximum time span ranges from 5 years to the 20-25 year range.

The final issue concerns the *level of detail and type of input* the models require, and the *level of detail of the associated output.* The economic base models and the systems dynamics models are the least demanding in terms of project data. For base models defined in employment terms, only project employment data in the local area are required. Systems dynamics models, like the study model examples, require the construction cost of the project, construction phasing, the labour component of construction and operations employment. If the user wished to expand the analysis beyond the employment related impacts, additional data requirements would emerge. The national econometric models all require project investment expenditure phased by year and broken down into domestic and import content. Generally, a further categorization into non-residential structures and machinery and equipment will be necessary. This breakdown may be requested on an industry specific basis. In the TIM/RIM case, expenditure by province at the 602-commodity level is highly desirable. Project output and input for the operating phase must either be provided or estimated by the model operated. If a national-regional combination model is used, the project input data must be further categorized by province of source. The econometric models do not require employment data but it is desirable if only for comparative purposes. The input-output models use expenditure and/or employment data. The expenditure data must be categorized in terms of industries specific to the model, e.g., 191 industries for Statistics Canada, 32 industries for the Nova Scotia Input-Output model. Province of source is desirable for the interregional input-output model. Generally, the input-output models are the most demanding for industry level information if the user is not satisfied with the use of historical average profiles.

The level of output detail, geographically and by industry, corresponds with the level of input detail. Nationally and provincially, the econometric models provide the richest variety of results. The input-output models can provide industry level output and gross domestic product by industry detail but they lack any dynamic impact capability. The systems dynamics and economic base models are the only models considered that deal with sub-provincial level impact assessment.

CHAPTER FOUR

MULTIPLIERS

The Concept

Economists and others have a long standing interest in measuring the total impact upon income, employment and output resulting from an exogenous change in expenditure. When it is properly understood and appropriately qualified, the multiplier is a useful technique for evaluating this relationship.

Keynes (1936) discussed the circular flow aspect of the multiplier and the principle remains the same today. In income expenditure terms, if a certain amount of income is injected into the economy, allowing for saving, consumer spending will rise by an amount less than the initial injection. The additional consumer spending becomes new income to other people. The latter, in turn, spend some of their additional income, and this process continues through several iterations. Keynes explained how, under some very strong simplifying assumptions, this circular flow spendin process can be summarized mathematically in a number now called the multiplier.

The discussion of the multiplier does not progress very much beyond this stage in most first-year university economics courses. Nevertheless, conceptually and empirically the multiplier is considerably more complex and subtle than is often appreciated. To place the multiplier concept in a proper impact analysis context, a number of general issues related to the interpretation of multipliers are discussed in the following section. Some of the properties of the multipliers associated with the study models are then outlined.

Multipliers are Model Dependent

In general, a multiplier represents the response of a dependent endogenous variable to a given change in a specific exogenous variable. This relationship can only be defined precisely in terms of an economic model. The model makes explicit the nature of the assumptions underlying the multiplier calculation. Seen in this context, it becomes evident that interpreting the multiplier relationship requires careful consideration of the specific model's characteristics.

Multiple Multiplier Values

There is a rather widespread view that a single multiplier exists. In discussing the impacts of a project, this is misleading to say the least. For any given project, estimates of the so-called multiplier effects can vary widely according to which economic model has been chosen to estimate the impacts. Furthermore, even for a given model, the estimated multiplier can be strongly influenced by the assumptions used in the analysis and the choice of variables to present the results.

Income, Employment or Output

In general terms, a multiplier is simply the ratio of the ultimate change in economic activity to the initial shock. A multiplier can be defined in terms of income, employment or output. The Keynesian multiplier referred to earlier is an example of an income multiplier. Although a project's impacts can be measured in income, employment or output, the estimated multipier values will change according to the variable chosen as a unit of account. For this and other reasons discussed below, there is little credence in drawing inferences about a project from the value of its associated multiplier.

Behavioural Assumptions

The estimated mutliplier value is related to the level of commodity and industry detail specified in the model. The greater the detail, the more carefully the various savings, tax and import leakages will be specified. For a given project, greater model detail may raise or lower the multiplier value. The actual effect depends on how the project's leakage characteristics match up with the leakage rates in the detailed model as opposed to the average leakage rates of a more highly aggregated model.

Another behavioural aspect affecting the multiplier in econometric models and possibly systems dynamics models is the cyclical response of the model to an exogenous investment shock. This response depends on the model's assumptions about the lags inherent in the economy's reaction to the new investment spending. Typically though, a build-up in income and employment will occur during and immediately following the period of investment spending. Activity will decline once investment spending stops and the economy begins to adjust to a normal relationship between the size of the capital stock and the level of output. It is possible for this adjustment process to carry the economy below the comparison base case levels because inventories and non-project investment spending are reduced and there are no offsetting spending stimuli permitted in the impact case. Although these adjustments can be regarded as natural patterns of economic adjustment, their impact may be accentuated in an impact analysis because the only difference between the base case and the impact case is the project expenditure.

Policy Assumptions

To conduct an impact analysis, the econometric models require the analyst to make assumptions regarding the government policy in force over the impact period. The details will vary from model to model, but in general, fiscal policy, monetary policy and exchange rate policy assumptions are necessary and the nature of the assumptions made will affect the impact results. For example, assuming relatively tight fiscal and monetary controls will dampen the estimated response to a given project shock. Or, for a project with a relatively high import content, one which earns foreign exchange or one which displaces imports, whether a fixed exchange rate, a flexible exchange rate or a type of 'dirty float' is assumed will lead to different impact results. A further complication can arise for energy projects expected to generate significant revenues for the federal and provincial governments. If these revenues are channeled into debt retirement, a relatively neutral assumption, they will contribute little or nothing to the impact results. On the other hand, if the project generated tax revenues are directed toward a specific spending program, they could add a signifcant incremental impact over the debt retirement assumption.

Constant Dollars vs Current Dollars

Multipliers can be computed in constant dollars (excluding any inflationary effects) or in current dollars (including inflationary effects). The constant dollar calculations can be made for any base year selected by the analyst, but the resulting multiplier value will vary according to the base year chosen. To see this, consider a model with a 1971 base year. Using its standard input and output variables, a multiplier for this model will be given in constant 1971 dollars. However, the analyst can express the multiplier in terms of constant dollars for another base year, say, for example, 1985 constant dollars. It can be shown that the difference between the two multipliers is equal to the ratio of the change in the price deflators for the numerator and the price deflators for the denominator. If, over the 1971 through 1985 period, the numerator price deflators increase more rapidly than those for the denominator, the $1985 multiplier will be greater than the $1971 multiplier. Conversely, the $1971 multiplier will exceed the $1985 multiplier if the denominator price deflators increase more rapidly than those for the numerator.

Another alternative is for the analyst to express the multiplier in current dollar or as-spent terms. The current dollar multiplier would be simply a translation of the constant dollar using the appropriate price deflators. Whether the current dollar multiplier exceeds or falls short of the constant dollar version depends once again on the relative rates of change for the numerator and denominator price deflators. Qualitatively, the impact information summarized in the two multipliers is identical, since one is a mathematical transformation of the other.

An important and evident implication of this discussion is the arbitrary character of the numerical value for a multiplier. The value can be changed by simply reporting the impact results in values differing from the model's base year, e.g., $1985 instead of $1971. Drawing meaningful conclusions about the validity or credibility of any impact results on the basis of the reported or implied numerical value for a multiplier is probably unwarranted. At the very least, the assumptions underlying the multiplier calculations need to be identified and their implications analyzed before drawing any conclusions.

Migration

Models with explicit inter-provinical migration flows may yield different multiplier estimates at the provincial level than those with no migration component. Inter-provincial migration flows affect numerous variables related to provincial income levels including the stock of households, the labour force, earned income and income from transfer payments. These effects may be amplified in any inter-provincial comparison if a fixed national population is assumed over the impact period, so that one province's gain in population must be counterbalanced by another's loss. Where inter-provincial migration is part of an impact scenario, its implications for the value of the multiplier will need to be assessed carefully. Where the model has no migration capability, this should be noted since some migration related impacts may be understated.

Employment Multipliers

The multiplier concept was first defined in income terms. For income-expenditure type models, an income multiplier can be readily derived following standard methodology as the ratio of income generated (measured in terms of gross domestic product) to the exogenous project investment expenditure. The equivalent employment multiplier needs to be carefully defined. The common practice is to use the ratio of total employment generated to the direct project employment (that is, the labour accounted for by the project wages and salaries). This is both misleading and incorrect. Consider an employment multiplier associated with the construction phase of a project. To be on the same footing as the income multiplier, the denominator (the exogenous change in employment attributable to the project) should include all the employment associated with the project investment expenditure, that is, direct project employment plus the labour employed to produce the goods and services inputs used to construct the project. Comparing total employment generated to just the direct project employment will yield an overestimate of the true employment ratio. However, since an estimate of the direct project employment is usually available and an estimate of the goods and servcies input employment can only be produced with much greater difficulty, the former is sometimes used in spite of the apparent difficulties cited.

National vs Regional Multipliers

Multipliers can be defined at the national or the regional level. Regional multipliers may refer to a provincial group, a single province or a sub-provincial area. As a general rule of thumb, a small economy will be more open to import leakages than a large economy. For example, a sub-provincial region is likely to produce less of the goods and services it consumes than a provincial economy, the provincial economy will likely be less self-sufficient than the national economy. Other things equal, then, the smaller the economy, the larger the import leakages in relative terms and the smaller the value of the income multiplier. Hence, the choice of the reference economy for the impact analysis can affect the multiplier values associated with a particular project impact analysis.

Comparative Static vs Dynamic Multipliers

A comparative static model compares the level of economic activity between different states of the economy. A multiplier derived from such a model indicates by how much an endogenous variable, for example, income, is expected to change per dollar increase of an exogenous variable, for example, investment expenditure, in moving from the initial to the final state of the economy. This type of multiplier is incapable of differentiating such impacts on an annual or other time period basis. Examples of this type of multiplier include those derived from the input-output models discussed in this study and from an economic base model.

Dynamic models, on the other hand, trace economic activity on an explicit time period basis, usually annually or quarterly. Because of this property, the econometric models, for example, can produce several types of multipliers themselves. (Their particular characteristics are outlined in the model specific characteristics discussion below.) A common property of these multipliers is that they are calculated for an explicit time period and the user must be careful to note this if they are to be interpreted correctly. In particular, comparisons of the multipliers from comparative static models with those from dynamic models are not likely to be meaningful.

Model Specific Characteristics

Econometric Multipliers

The dynamic properties of econometric models lead to a variety of possible multipliers. These include impact multipliers, delay multipliers, and cumulative multipliers, and an all-encompassing impact measure referred to as the ratio of cumulants.

Impact and Delay Multipliers

Impact multipliers measure the single time-period e.g. one year response of income, employment, or output to an exogenous change in an expenditure variable in the same year. Delay multipliers give an estimate of the delayed response of the endogenous variables in subsequent years to the initial exogenous change. The delay multiplier associated with a single initial shock will tend to zero in the long-run.

Both impact and delay multipliers refer to "one shot" or impulse exogenous changes. They answer the question, if an exogenous variable is raised by one unit in a period and then restored to its original level, what will happen to the current and future values of an endogenous variable?

Cumulative Multipliers

The cumulative multiplier addresses the question what will happen to the current and future values of an endogenous variable if an exogenous variable is raised by one unit in a period and then sustained at that level. Clearly, this multiplier refers to multiple time periods. Furthermore, while the delay multiplier tends to zero in the long-run, the cumulative multiplier will tend to increase in value as the time period covered is extended.

Ratio of Cumulants

This is an alternative dynamic measure of project impact, defined as the ratio of the cumulated increase in the endogenous variable, e.g. gross domestic product, to the sum of the project investment and the project value of production over the defined impact period. Obviously, the resulting value will change according to the length of the impact period. Also, as noted above, the ratio can be calculated in terms of constant or current dollars selected by the analyst and no particular significance can be attached to its numerical value since the ratio depends on the base year chosen for the calculation. Although the ratio has no stand-alone value, it may still be useful for comparing the overall impacts of different projects, or for comparing different versions of the same project.

Systems Dynamics Multipliers

In their standard formulation, systems dynamics models are designed to capture the feedback loops hypothesized to exist in the economy being modeled. In effect, the analyst builds multiplier relationships into the model through the assumptions made about the nature of the loops and the rate of change of variables, although the term multiplier is not part of the normal systems dynamics terminology. Still, for the purposes of this study, it is useful to retain the term because the output of a systems dynamics model can be analyzed using the same multiplier concepts as outlined for the econometric models. This is possible since, in an annual model for example, output is produced on a year to year basis for the model's variables. The analyst can thus calculate impact, delay and cumulative multipliers as well as the ratio of cumulants. It follows that the same care is required to interpret these multipliers for a systems dynamics model as for an econometric model.

Input-Output Multipliers

The comparative static nature of input-output models and their associated multipliers was noted above. To reiterate an important point, the multipliers represent the change in the level of an endogenous variable between the starting equilibrium and the final equilibrium associated with a unit change in an exogenous variable. It is conventional practice to compute industry level income, employment and output multipliers for an input-output model. Separate multipliers are defined according to the level of closure assumed in the model used for the impact analysis. The situation is summarized in the following table.

	Model is :		
	Open	Closed to Households	Closed to Government
Income	m_1	m_4	m_7
Employment	m_2	m_5	m_8
Output	m_3	m_6	m_9

Closure refers to the extent of recycling of expenditure and income through the model. An open model traces spending only through the inter-industry relationships. Closing the model to households introduces income recycling by including respending of income by housholds. Closing to the government level allows for government respending of its tax revenues. It is evident that increasing the level of closure increases the amount of income recycling and this in turn will yield a higher value for any multiplier estimate. For example, in the income row, multiplier m_4 will be larger than mulitplier m_1, and multiplier m_7 will be larger than multiplier m_4. The same relative relationship will also hold for the employment and output multipliers. Clearly, then, the version of the input-output model chosen for the impact analysis is important for it determines the relative size of the multipliers.

On the other hand, the relative numerical size of the multipliers for a particular version , for example, the income, employment and output multipliers m_4,m_5 and m_6 for the closed to households model, carries no significance. The underlying units of measurement differ in each case.

Certain qualifications should be noted concerning the use of multipliers. As noted, an open model traces the propagation of a demand shock through the model's inter-industry relationships. Strictly speaking, with an open model, there is no multiplier relationship as normally defined since there is no re-injection of expenditure. The so-called 'output' multiplier is in fact only a measure of the level of economic transactions occurring. It is not a value-added concept, since it measures total output values rather than just payments to primary factors of production such as labour and capital. Furthermore, the value of an output multiplier depends on the level of aggregation of the model. Thus, for example, a fully integrated industry will have a lower multiplier value than an industry purchasing a lot of its inputs from other industries, even for the same total impact on gross domestic product. The income and employment multipliers are derived from the output multipliers. Hence, they too depend on the level of aggregation. Moreover, the multiplier values are affected by the definition of direct and indirect impacts used by the models themselves.

In summary, when an open model is used, considering the qualifications noted, it is preferrable to focus on the total impact of a demand shock, rather than the ratio of the direct and indirect impacts (the so-called multipliers). The concerns arising from the level of aggregation and choice of definition must be considered when a closed model is used. But, at least some income is re-injected and it is possible to define meaningful multipliers.

Economic Base Multipliers

The economic base model is a comparative static model. The base model multiplier predicts the impact of an exogenous change in the economic base on the total economy. The model will yield either an employment or an income multiplier, depending on whether the model is defined in employment or income terms. It is possible to translate an employment multiplier into an equivalent income multiplier (Schwartz, 1982), but this adds no new information to the analysis since one multiplier is simply a transform of the other. The economic base model discussion in Chapter Two outlines short-run and long-run variations for the multiplier, according to the migration assumptions introduced by the analyst. Even with this refinement, the model possesses no dynamic properties, so the estimated impacts cannot be associated with particular time periods.

Summary

In sum, a multiplier is an empirical value which attempts to capture the total impact upon employment, income or output resulting from a change in exogenously defined expenditure. For impact analysis, the interpretation of multipliers is complicated by a number of factors. Multipliers are model dependent and can only be properly evaluated in the context of the model chosen for the impact analysis. Comparisons of multipliers derived from different models is neither straightforward nor easy. Furthermore, the size of the multiplier will depend on the behavioural assumptions embedded in the impact model and on the government policy assumptions adopted by the analyst for the impact analysis. The specific value of any multiplier reported will depend on the variable, income, employment or output, used to measure the impacts. For income multipliers, the choice of the base year for a constant dollar multiplier or reporting results in current dollars can influence apparent size of the multiplier, even though the real project impacts do not change.

All things considered, the conclusion is that using a multiplier as a summary descriptor for the economic impacts of a project is fraught with difficulty. Through experience, analysts and model operators can develop an intuitive sense of what is a reasonable range of multiplier values. However, there is no objective standard against which the multipliers for a particular impact analysis can be compared. Furthermore, even for a given model, on top of all the factors previously cited, the domestic versus import content of project expenditure will affect the size of the multiplier. Thus, the value of using multipliers to summarize project impacts within an SIA context is severely limited. Without a detailed analysis of the project expenditure, the nature of the impact model and the various assumptions on which the impact analysis rests, relying on multipliers to assess project impacts could be both misleading and incomplete.

CHAPTER FIVE

LARGE SCALE MODELS AND THE SIA DECISION-MAKING PROCESS

An Environmental Impact Statement (EIS) can be used in the selection of a preferred project from a number of alternatives, or in deciding whether a single project should be implemented. As part of an EIS, a socio-economic impact analysis (SIA) focusses specifically on the social and economic impacts associated with the study project or projects. Where significant socio-economic impacts are expected, the SIA can enhance the effectiveness of the overall EIS by subjecting the social and economic factors to intensive scrutiny.

The issues dealt with by the SIA fall into two broad categories: allocative effects and non-allocative effects. Allocative effects are concerned with the efficiency of resource use (i.e., which alternative makes the most effective use of resources). Non-allocative effects are those influencing the distribution of income (e.g,. equity considerations), employment and demography, socio-cultural impacts, regional balance, technological progress, market structure, the balance of payments, aggregate and industrial output, and inflation. The review of EIS guidelines presented earlier indicates that for most SIA's, non-allocative issues, ranging from micro-level impacts on individuals or small groups to the macro level impacts at the provincial, regional or national level, form the focus of attention. Large scale economic models constitute a method for evaluating some of these impacts.

The models considered in this study fall into four categories: econometric models, input-output models, systems dynamics models, and economic base models. (Admittedly, economic base models are not large scale models. They are included because it was felt they may be of some interest where local level impacts are a major concern.) The models are evaluated by applying criteria relevant to the uses made of non-allocative impact material in the SIA process. In this regard, two major areas of concern were identified:

- the magnitude and location of economic impacts; and,
- the distribution of project impacts geographically.

These criteria point to priority economic indicators such as the change in the level and the rate of growth of Gross Domestic Product, the change in growth of output in selected industries or sectors, changes in population, migration and housing demand, and changes in the level of employment, unemployment and the unemployment rate. The ability of the models to produce output on these variables at the national, the provincial/regional and the local level is an important consideration.

The effectiveness of the study models for SIA purposes is assessed according to a set of technical and non-technical model characteristics. Two technical characteristics are given special consideration, the models' data requirements and ability to isolate the magnitude and location of economic impacts at national, regional and local economic aggregations. Other factors assessed include the static and dynamic properties of the model and the policy assumptions necessary for conducting the impact assessment. The costs of conducting an impact assessment are addressed but specific conclusions are not drawn. This is because the factors affecting the cost of using a particular model vary to such an extent from model to model that comparisons are of little value. In most cases, the cost fluctuates sharply according to the amount of analysis and interpretation of the model's output the user requests from the model builder/operator.

The major findings of the study are summarized in Table 3. The following discussion outlines the important findings and conclusions as regards the choice of a model or models for conducting an SIA.

Data Requirements

Using any of the study economic models for the evaluation of project impacts requires project expenditure data, and as noted in Table 3, employment data for some models. The expenditure data are used to estimate the shock to the private investment sector of final demand. Each model has its own requirements for the level of detail at which project data must be introduced. The Statistics Canada Interregional Model and TIM-RIM are the most detailed. Both models prefer expenditure data for 191 industries, or preferably at the 602 commodity level, by province of source. The same is true for TIM/RIM. However, the Statistics Canada Input-Output models, TIM/RIM and the other national econometric models can use project investment expenditure disaggregated only in terms of Non-Residential Construction and Machinery and Equipment by province of source.

Project employment data are required by the CHASE and FOCUS models, by most of the provincial Econometric and Input-Output models, by the Systems Dynamics models and by the Economic Base model. The employment data must be specified in person-years except for the Statistics Canada Input-Output models and the Quebec Input-Output model. These models require wage bill information.

A Practical Consideration

The level of confidence attached to the project expenditure data must be considered in terms of the timing of the SIA in the project cycle. The project cycle can be divided into three phases:

- Planning
  - Preliminary
  - Detailed
- Construction
- Operation

The impact analysis is concerned with the effects of the Construction and Operation phases but the SIA itself is usually conducted during the Preliminary Planning period. This means that project expenditure estimates are normally available only with a very wide confidence interval, e.g. +/- 30-40%. The results of the impact analysis should be considered in this context. They are more likely to be indicative than definitive estimates of the project impacts.

Table 3: Summary of Key Model Characteristics

Level of Aggregation

Local	*Provincial*	*National*
Economic Base, System Dynamics	QPF, MARV, PRISM, RIM B.C. Econometric, NSEM, Quebec E.M., Alberta I/O, NS I/O, Quebec I/O, Stats Can I/O	CANDIDE 3.0, CHASE, MTFM, DRI, FOCUS, TIM, Stat Can I/O

Data Requirements

Expenditure Data	*Aggregate Data Only*	*Data by Industrial Sector (Preferred)*
	CHASE, FOCUS, NSEM, Quebec E.M.	CANDIDE 3.0, MTFM, QPF, DRI, MARV, PRISM, B.C. Econometric, TIM, RIM, and all I/O Models
Employment Data	*Required*	*Optional*
	Economic Base, Systems Dynamics, B.C. Econometric, CHASE, NSEM,	CANDIDE 3.0, MTFM, QPF, DRI, MARV, FOCUS, PRISM, TIM, RIM Quebec E.M., some NSIO Models

Economic Indicators

Gross Domestic Product

National	Provincial
- All National Econometric Models, Stats Can I/O	- CHASE, DRI/MARV, FOCUS/PRISM, MTFM/QPF, TIM, RIM, Stats Can Interregioanl I/O plus stand-alone Provincial Models

Change in Industry Output by Province

- CHASE, DRI/MARV, FOCUS/PRISM, MTFM/QPF, TIM/RIM, Stats Canada Interregional I/O, stand-alone Provincial Econometric and I/O Models
- Systems Dynamics Models - sub-provincial impact region for selected industries

Table 3: Summary of Key Model Characteristics (cont'd)

Changes in Population, Migration and Housing Demand

- Provincial population, housing, CHASE, DRI/MARV, MTFM/QPF, TIM/RIM
- Provincial Econometric Models: British Columbia, Quebec, Nova Scotia
- Interprovincial Migration: MTFM/QPF, TIM/RIM
- Sub-provincial impact area population, migration and housing - Systems Dynamics Models

Changes in Provincial Regional Employment and Unemployment

Provincial

- CHASE, DRI/MARV, FOCUS/PRISM, MTFM/QPF, TIM/RIM

Sub-Provincial

- Systems Dynamics Models

Dynamics

Dynamic Models

- All Econometric Models, Systems Dynamics Models Base Models

Comparative Statis Models

- All Input-Output Models and Economic

Policy Assumptions

Not Required

- Economic Base Models
- Input-Output Models, but closing model to government implicitly assumes the fiscal policy of the model's base year

Required

- All Econometric Models need fiscal policy, monetary policies and exchange rate assumptions
- Systems Dynamics Models may require assumptions about the actions of municipal government

Government Revenue

National Econometric Models

Direct and Indirect Taxes

CANDIDE 3.0, MTFM, DRI (but a separate energy model is available)

Direct and Indirect Taxes Plus Separate Revenue

TIM, CHASE, FOCUS, MACE

Table 3: Summary of Key Model Characteristics (cont'd)

Input-Output Model

Statistics Canada I/O (National)

- Models currently estimate only revenues arising from indirect taxes

Provincial Models

- Provincial level information at a relatively aggregated level

Systems Dynamics

- No ability to estimate tax revenue impacts at the provincial or national levels
- Municipal taxation effects are normally estimated

Economic Base

- No capability to provide information on taxation in either the energy or non-energy sectors

Source: Gardner Pinfold Consulting Economists Limited

Magnitude and Location of Economic Impacts

The size of a project in relation to the size of the economy in which it is located is an important determinant of the choice of an impact analysis model. Where a project is large relative to the national economy, a national level model such as CANDIDE may be suitable for the analysis. Where a project is large relative to its surrounding provincial economy, but not large in a national context, the national-provincial models (e.g. CHASE, DRI/MARV, FOCUS/PRISM, MTFM/QPF, TIM/RIM) will provide both national level and provincial impact estimates. The provincial level stand-alone models (Alberta, British Columbia, Quebec and Nova Scotia) provide alternative tools for impact analysis in those provinces.

The Input-Output models studied can be used to assess the magnitude and location of an investment shock at both national (Statistics Canada) and provincial levels (Statistics Canada, Alberta, British Columbia, Quebec and Nova Scotia) where the time patterns of the impacts is not an issue. Systems dynamics models and economic base models are effective in assessing the project impacts mainly at the sub-provincial level, though provincial models might be feasible in some circumstances. The system dynamics or economic base models would have to be purpose built for the analysis in most cases.

Geographic Distribution of Impacts

Large scale projects such as a tar sands development or an offshore oil field development will generate impacts in several provinces. A measure of the inter-provincial distribution of impacts may be desired in the SIA. If so, this will entail the use of one of the national/provincial Econometric models (CHASE, DRI/MARV, FOCUS/PRISM, MTFM/QPF, TIM/RIM) and/or the Statistics Canada Inter-regional Input-Output model. For projects in the Atlantic Provinces, the current version of the MARV treats the four provinces as group, so separate provincial impact estimates would not be possible with this model.

Economic Indicators

According to past SIA studies, the priority economic indicators for SIA purposes cover income-expenditure effects, output effects, and employment effects. The most general economic indicator is the change in the rate of growth of Gross Domestic Product. Regional or provincial estimates of the impact on GDP are important, although national level estimates would be of interest for very large projects. As shown in Table 3, all the national econometric models, and the Statistics Canada National I-O model, will generate results on national GDP, on most other aggregate National Accounts variables and on other variables of interest such as employment and unemployment.

The national-regional model combinations will produce estimates for provincial GDP. These models will be of particular interest where interprovincial comparisons of GDP impact are desired. Where the impact zone is confined within provincial boundaries, the stand-alone provincial models can be used to estimate the impact of project development on provincial GDP. However, some national-provincial models (e.g., TIM/RIM, MTFM/QPF) are beginning to develop the capability of running their provincial models on a stand alone basis. These models may be an alternative for provincial level economic impact analysis in the future.

The second key economic indicator is the change in industry output by province. All of the study econometric and input output models, except CANDIDE, can estimate the changes in industry output by province, but at varying levels of industrial disaggregation. Where the user is interested in this aspect of the economic impacts, a review of the industry detail carried by each model would be required to select the appropriate model. Since both of the systems dynamics models reviewed pertained to sub-provincial regions, they do not yield provincial level information. Depending on the selection of industries included in such a model, the user could obtain desirable impact information at the sub-provincial level. In this situation, note that the systems dynamics model is likely to be purpose built for a particular impact analysis. This offers the user the opportunity to specify a set of industries for inclusion in the model (assuming of course the requisite data are available for model building purposes).

In an SIA, the interest in project-induced changes in population, migration and housing demand is frequently focussed at the sub-provincial level and sometimes at the provincial level. Only the systems dynamics models attempt to estimate sub-provincial level project impacts on population, migration, and housing. Special components are built into the models for this purpose. At the provincial level, population and housing demand impacts can be estimated by the national econometric models with associated regional/provincial models and by the stand-alone provincial econometric models in British Columbia, Quebec and Nova Scotia. Estimates of project-related inter-provincial migration effects are available from the MTFM/QPF and TIM/RIM combinations.

Changes in the provincial level of employment and unemployment and the provincial unemployment rate are estimated by all of the national/regional Econometric models and by the provincial stand-alone econometric models. The systems dynamics models estimate employment impacts for their sub-provincial reference region. If appropriate labour force participation rate information is built in, the models will also estimate the impact on the sub-provincial region unemployment rate.

Analytical Considerations

Static versus Dynamic Impact Assessment

The guidelines directing the SIA process do not offer clear guidance on the use of economic models. For example, there is no formal SIA guideline indicating whether or not the main concern is with the magnitude of impacts or the time profile of the impacts. Given the generally extended construction and operating phases of large scale projects , 20 to 25 years for a project such as the Hibernia oil development, the assessment of a time profile of impacts on key economic indicators is a reasonable requirement. If so, the use of static (timeless) input-output models or the economic base model is generally precluded.[1] Only the econometric models and the systems dynamics models, with their dynamic features, are capable of generating an impact profile over time, expressed in annual or other time units.

Policy Assumptions

If a national or a national-provincial econometric model is used for an impact analysis, assumptions are required for fiscal policy, monetary policy and exchange rate policy over the impact time period. Normally such assumptions will be established for the base case economic forecast and remain unchanged in the impact analysis. Frequently the model builder/operator will already have established the policy environment as part of regular forecasting activity and the impact analysis will adopt these assumptions. Sometimes however, especially for energy projects, special assumptions may be required. A pertinent question at this point is: *Should the formation of policy assumptions be left to the project proponent, or should the SIA panel specify its own policy assumptions?* In the Canadian scene the conventional practice has been for the proponent to specify the policy assumptions. In principle there seems to be no reason why the SIA panel could not draft guidelines covering policy assumptions. Even in the absence of doing so, the SIA panel needs a full understanding of the implications of the assumptions used for the impact analysis results.

Systems dynamics models require policy assumptions normally only at the sub-provincial level. These assumptions relate to the provision of infrastructure or other services for the region or municipality. Neither input-output models nor economic base models require policy assumptions.

Base Case Definition

This issue is similar to the policy assumption issue. A base case or reference case is required for an impact analysis using an econometric model or a systems dynamics model. Impacts are measured relative the base case. The question is, should the SIA panel establish guidelines for the base case? This would include forecasts for the model's exogenous variables as well as the policy assumptions discussed previously. Here, too, the conventional practice has been for the proponent to define the base case. Whether or not the SIA panel should adopt a more assertive role in defining the base requires a review of the objectives and procedures to be used in conducting an SIA. This is a matter that extends beyond the scope of this study.

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1 In some Input-Output models, the operator can generate a time profile, although this will not be expressed in annual or other time units.

National/Regional/Provincial Consistency

Consistency in the generation of impact estimates at the national, regional and provincial level may be desirable. This can be best attained by using a model or linked models that produce results at each level of aggregation. Of the models studied, CHASE, DRI/MARV, FOCUS/PRISM, MTFM/QPF, TIM/RIM and the Statistics Canada National and Inter-regional models are the only ones to satisfy this requirement.

Indirect versus Induced Impacts

Indirect impacts refer to income and employment effects arising from inter-industry purchases of goods and services, while induced impacts include the effects caused by consumer spending of incomes earned from direct project employment and from indirect employment. In some cases, an SIA may wish to distinguish between the two types of impacts. If so, this will affect the choice of impact model. Econometric models and systems dynamics models merge both effects into a single impact estimate. If the user wishes to isolate the indirect impacts, then an input-output model must be used as they are the only ones to differentiate the indirect and induced impacts.

Project Scale

Whether or not a large scale economic model is appropriate for an SIA clearly depends on the scale of the project under analysis. For a tar sands development or an offshore oil field like Hibernia, a national or a national-provincial model would be useful for analyzing the national and provincial economic impacts. For a smaller development, such as a small offshore gas field or a modification or extension of an existing project, the main concerns are likely to be to assess and to understand the impacts on one or more sub-provincial impact regions. The large scale econometric and input-output models are less useful for this task. A provincial stand-alone econometric or input-output model may shed some light on the scale of provincial impacts. However, for a sub-provincial region, if a modeling approach is desirable, a systems dynamics model is the most directly relevant. As the illustrative models discussed in the study showed, these models can be designed and built, data permitting, to simulate the impacts at the regional level. In this situation, the analyst should be well acquainted with the structure and performance of the local economy in order to ensure a sensible interpretation of the impact results in the regional context.

Negative Impacts/Mitigative Measures

A major concern of SIA is evaluating possible negative impacts from a project, particularly as they affect the immediately surrounding local area, and the formulation of appropriate mitigative measures. Except for the systems dynamics and economic base models, the study models can only identify project impacts at the national level and the provincial level. Thus, for identifying negative impacts (or indeed any impacts) on sub-provincial impact areas, the large scale models are of little direct use although they may help to isolate impacts at the provincial or industry level. An economic base model can generate aggregate employment and/or income impacts for the local area but nothing more. A systems dynamics model like, for example, the Regional Simulation Model, can provide more detail on the local impacts in terms of variables such as output changes for selected industries, employment, housing, population and municipal services. The model will also estimate the timing of the impacts.

For large scale projects, the large scale models can be used to assess the effectiveness of mitigative measures. For example, the effect of policy changes affecting the sourcing of goods and services used by the project or employment recruitment could be tested using the models. Traditionally, however, this has not been part of an SIA .

A Standard Methodology

Finally, the issue arises whether or not a standard economic impact assessment methodology can be prescribed. The answer is clearly no. First of all, the projects subject to analysis are not uniform. They differ, for example, in size and impact characteristics. Different methodologies may be required to handle these variations. In the second place, as the review of SIA requirements revealed, there is no standard set of impact assessment requirements applied to all projects. The EIS/SIA guidelines are normally drafted taking into account the special characteristics of both the proposed project and the main impact region. In part, this situation stems from an underlying lack of agreement on the questions to be addressed in the EIS/SIA process.

According to its research prospectus, the review of Social Impact Assessment commissioned by the Canadian Environmental Assessment Research Council (CEARC 1985) should shed some light on both a generally agreed set of questions and the appropriate methodology to produce answers. Hopefully, the CEARC research will clarify the *institutional arrangements* such as the guidelines for SIA, the roles and the responsibilities of the parties to social impact assessment and possibly the use of a more focussed approach in SIA. A particularly important issue is the general model underlying the overall approach to SIA. Whether SIA should be based on a *technical/planning model* or a *political/community development model* is the question which needs resolution. The economic models discussed in this study are mainly useful for the technical/planning model approach where the non-allocative economic impacts of a project are a major concern.

APPENDIX A

DETAILED DESCRIPTION OF STUDY MODEL CHARACTERISTICS

CANDIDE 3.0 Model
CHASE Econometrics Model
Conference Board Model
Data Resources Model
FOCUS and PRISM Econometric Models
Informetrica Macroeconomic and Regional Models
Statistics Canada Input-Output Models

THE CANDIDE 3.0 MODEL

Description

The CANDIDE model is the second largest of the econometric study models, containing 2,490 equations and requiring the input of 1,046 exogenous variables (Economic Council of Canada, 1985). The size of the model is a function of the high level of industry and commodity disaggregation.

CANDIDE is a medium term model founded upon Keynesian economic theory, which generates both macroeconomic and industry level output. The overall level of economic activity is determined by the interaction of aggregate supply and demand functions.

Main Uses

The principal uses of the CANDIDE 3.0 model are to produce medium and long-term forecasts of the national economy, and to assess the impact of introducing new fiscal and monetary policy. CANDIDE can also be used to assess the impact of large scale projects.

Sectoral Components and Linkages

CANDIDE 3.0 is a national annual model with sub-components in its final demand component. The composition of consumption is disaggregated to identify 40 different levels, while private investment is evaluated for 38 different industries. The remaining sub-components of final demand are government expenditure, the balance of trade, (i.e. exports and imports), and residential construction.

Industry output is determined for 48 different industries, and aggregate output is not constrained by the supply side in the long-run. The specification of the production function for each industry determines the corresponding demand for labour. The demand for labour then enters the labour and demographics component to determine unemployment residually.

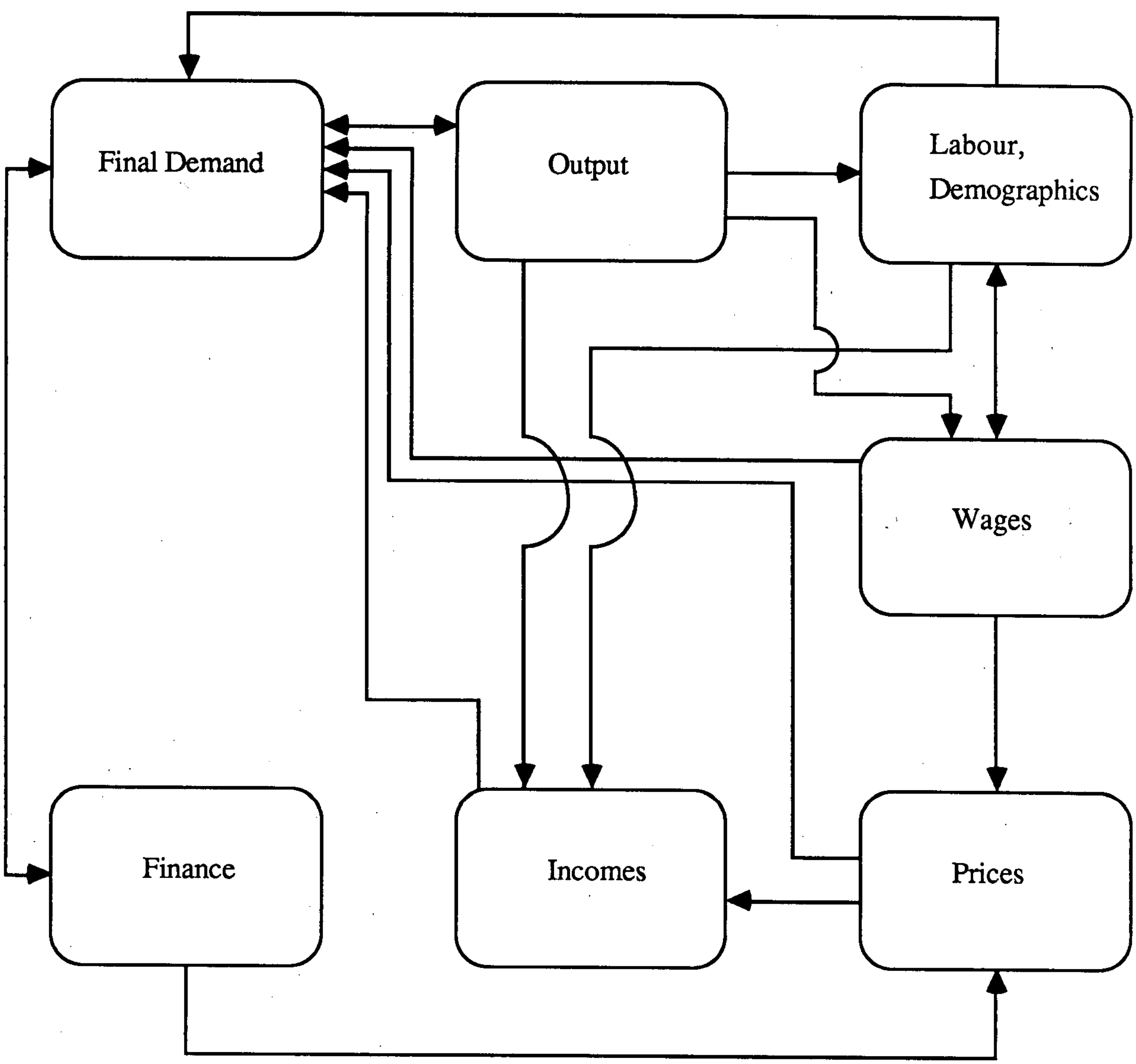
The supply of labour is determined in the demographics sub-component of the labour block using participation rate equations. The explanatory variables of the participation rate equations differ for each of the eight age-sex cohorts. Common explanatory variables include the current unemployment rate, the after-tax real wage, the number of dependents, education, pension benefits, and the availability of UIC.

CANDIDE incorporates considerable detail in evaluating prices and wages. Wages are modelled at the industry specific level, based on a Phillips curve specification which uses an approximation of inflation, and endogenously defined labour force characteristics. Domestic prices are modelled by commodity, and are derived from value added functions which are assessed primarily using the cost mark-up principle. Import prices are defined exogenously, and subsequently final demand prices are determined as a weighted average of both domestic prices and import prices.

The monetary sector is divided into six components including government debt, assets held by the non-financial public, earning assets of chartered banks, the mortgage market, the term structure of interest and the exchange rate, and the balance of payments. The major linkages of the monetary sector to the real sector run through the impact of changes in the money supply on interest rates, prices, wages, and ultimately final demand. Money has an impact on prices through its effect on the expected rate of inflation in the wage equation.

CANDIDE 3.0 does not contain a detailed energy sector. The structure and main sectoral linkages in the CANDIDE model are shown in Figure A-1.

Figure A-1: A Schematic Diagram of the CANDIDE Model



Prepared by Gardner Pinfold Consulting Economists Limited.

THE CHASE ECONOMETRICS MODEL

Description

The CHASE model is currently composed of slightly over 900 equations with about 1,200 variables. The model design is based on the RDX family of models, whose modular framework allows tailored simulations to be done.

Main Uses

The CHASE model is used to produce short and long-run forecasts, in addition to assessing the impact of changes in fiscal and monetary policy, and alternative scenario simulations. The model does not have a formal impact routine, but can be altered to accommodate impact assessment. A benefit of the modular structure of CHASE is that the impact of a particular demand shock on a particular sector can be examined by designating other important variables as exogenous.

Sectoral Components and Linkages

The CHASE model is founded upon Keynesian theory, and as such is demand driven in the short-run. However, there is no requirement that aggregate demand and supply be equilibrated in the long-run.

There are six sub-components which comprise final demand: consumption, housing, government expenditure, private investment, exports, and imports. Consumption is disaggregated to identify 9 different categories, while private investment is evaluated for non-energy investment in business non-residential construction, and machinery and equipment. Energy investment is treated as exogenous.

Although the CHASE model is capable of accepting input data which is disaggregated by industry, it will simply sum industry output to shock the model's single production function. The key output variable is real private business output, which is defined as real GNE minus capital consumption allowances. Principal explanatory variables defining aggregate output include labour force characteristics, i.e. industrial employment, which is dependent on the marginal productivity of labour, and stock variables.

There is no formal demographics block in the CHASE model. The model uses Statistics Canada population projections as input to the participation rate equations. Participation rate equations are derived for six age-sex cohorts, and the specification of the equations implies no on-going discouraged or additional worker effects.

The wage rate is not defined using a Phillips curve specification, but rather is related to changes in GDP and changes in the gap between the actual and natural rates of unemployment. The natural rate of unemployment is determined endogenously for one specific age cohort (that between 19 and 24 years), and uses real per capita unemployment insurance benefits as the principal explanatory variable.

Domestic prices are determined using the cost mark-up principle, and import prices are determined either stochastically or exogenously. Costs included in price determination are average weekly wages, the price of energy, excise taxes, the manufacturers sales tax, retail sales taxes, import prices and an assessment of factor productivity.

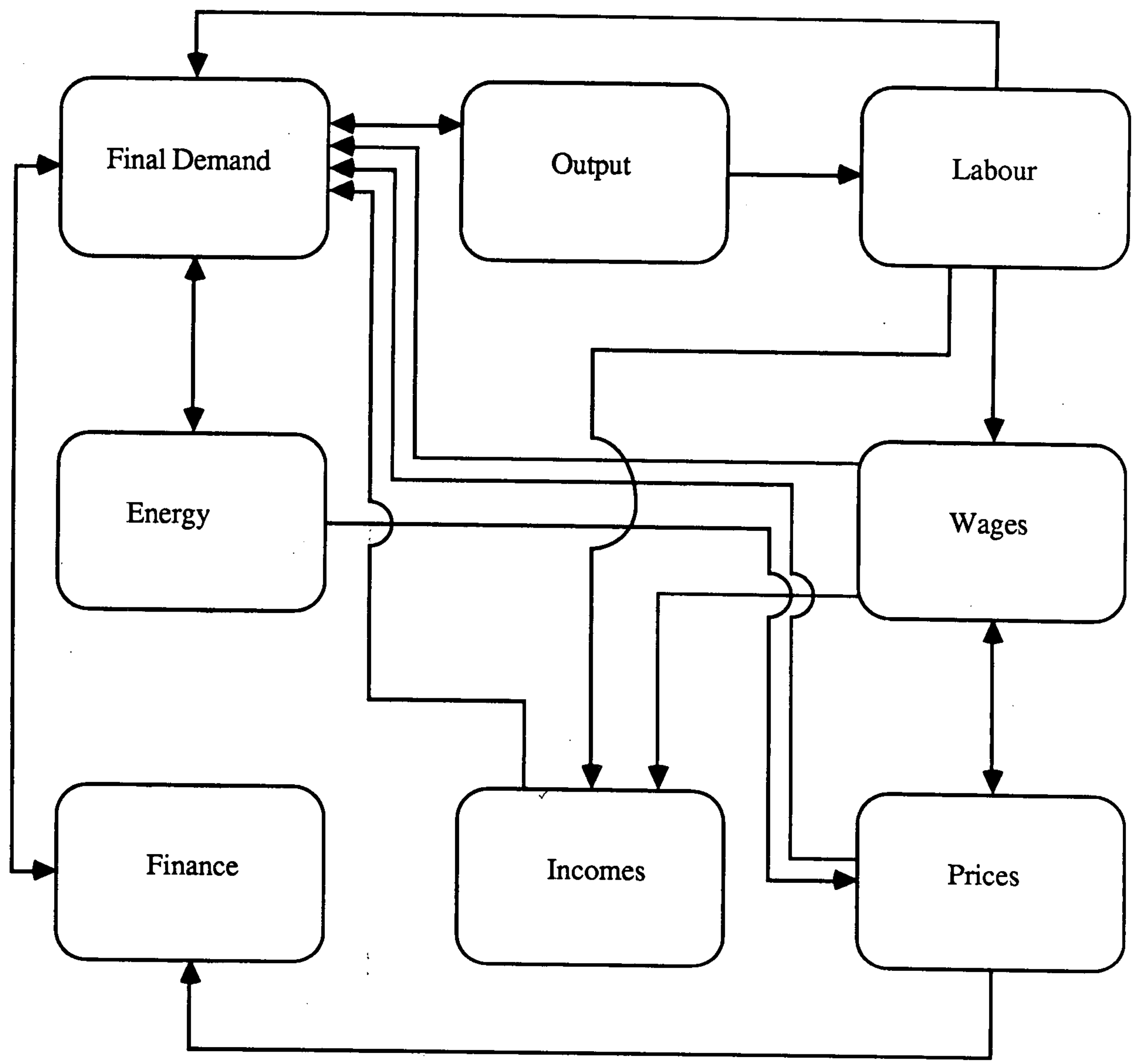
The model contains a detailed energy sector which incorporates the policies of current energy agreements. Equations are designed to evaluate the production, consumption and revenues from oil and gas, and also other energy sources, and can be used for forecasting or impact assessment. For the purposes of this study the modularity of the CHASE model allows for the impact of new energy project on energy demand and supply to be assessed in isolation.

The financial sector provides estimates of monetary aggregates and a variety of interest rates. The exchange rate is determined endogenously primarily as a function of changes in the short-term interest rate, and the balance of trade. These variables are in turn linked into the investment component of final demand. Figure A-2 illustrates the general schematic of the CHASE econometrics national macroeconometric model.

CHASE has developed a regional model which is strictly top-down. Currently, they are trying to build in bottom-up capabilities.

The regional model disaggregates national GDP by industry for 32 industries. In addition, national labour force and demographic characteristics are disaggregated to the provincial level, as is personal disposable income. Subsequently, provincial GDP values are calculated, and their sum is forced to equal the national value.

Figure A-2: A Schematic Diagram of the CHASE Model



Prepared by Gardner Pinfold Consulting Economists Limited.

THE CONFERENCE BOARD MODELS

Description

The Conference Board currently operates and maintains a national quarterly macroeconometric model of the Canadian economy, MTFM, and a Quarterly Provincial Forecasting Model.

The Medium-Term Forecasting Model (MTFM) is a large scale econometric model of the Canadian economy developed and maintained by the National Forecasting Group. The MTFM replaced the AERIC model in December 1981. As a result of increased demand for economic forecasting for regional planning purposes, the Conference Board formed its regional model. The original version of the Quarterly Provincial Forecasting and Simulation Model was developed in 1975 and 1976. Since that time the model has continually been evolving, and has produced forecasts on a regular quarterly basis for all ten provinces.

Main Uses

Unlike the AERIC model, which was used primarily for short-term forecasting, MTFM is designed for forecasting and simulation over the short to medium-term. The Quarterly Provincial Forecasting model (QPF) is used primarily for producing short-term forecasts (one or two years), although it is also used for medium-term forecasts (up to five years) and for impact analysis.

Sectoral Components and Linkages

The MTFM model is based on the neoclassical synthesis. As a result, output is largely expenditure-determined, but there are supply-side feedbacks through sector capacity measures that influence prices, imports and exports, and in turn, output.

MTFM emphasizes factors important for forecasting the medium-term prospects for the economy. These factors include a detailed consideration of population and its age structure and a disaggregated modelling of investment expenditures. The government sector is also treated in detail.

The model has 850 endogenous variables and 800 exogenous variables. Approximately 350 of the endogenous variables form a large single simultaneous block in the model reflecting the interdependence of the model's different sectors.

MTFM disaggregates industry output into 40 industries. These include agriculture, primary manufacturing, construction, commercial services, and public administration.

In the labour component, employment equations directly determine the demand for labour by industry. Labour supply is derived as a function of the population and the hours worked (which is determined using a reduced form equation of labour demand and labour supply).

The wage equation is a reduced form equation based on both the demand and supply of labour. Industry prices are modelled as a mark-up over cost, and incomes are derived stochastically.

The key variables determined in the financial component are the short-term interest rate for Treasury bills and the exchange rate. The important explanatory variables determining the exchange rate are the basic money balance (i.e., current account plus long term flows) and the change in the Canada-U.S. interest rate differential. Figure A-3 illustrates the flow in the MTFM model.

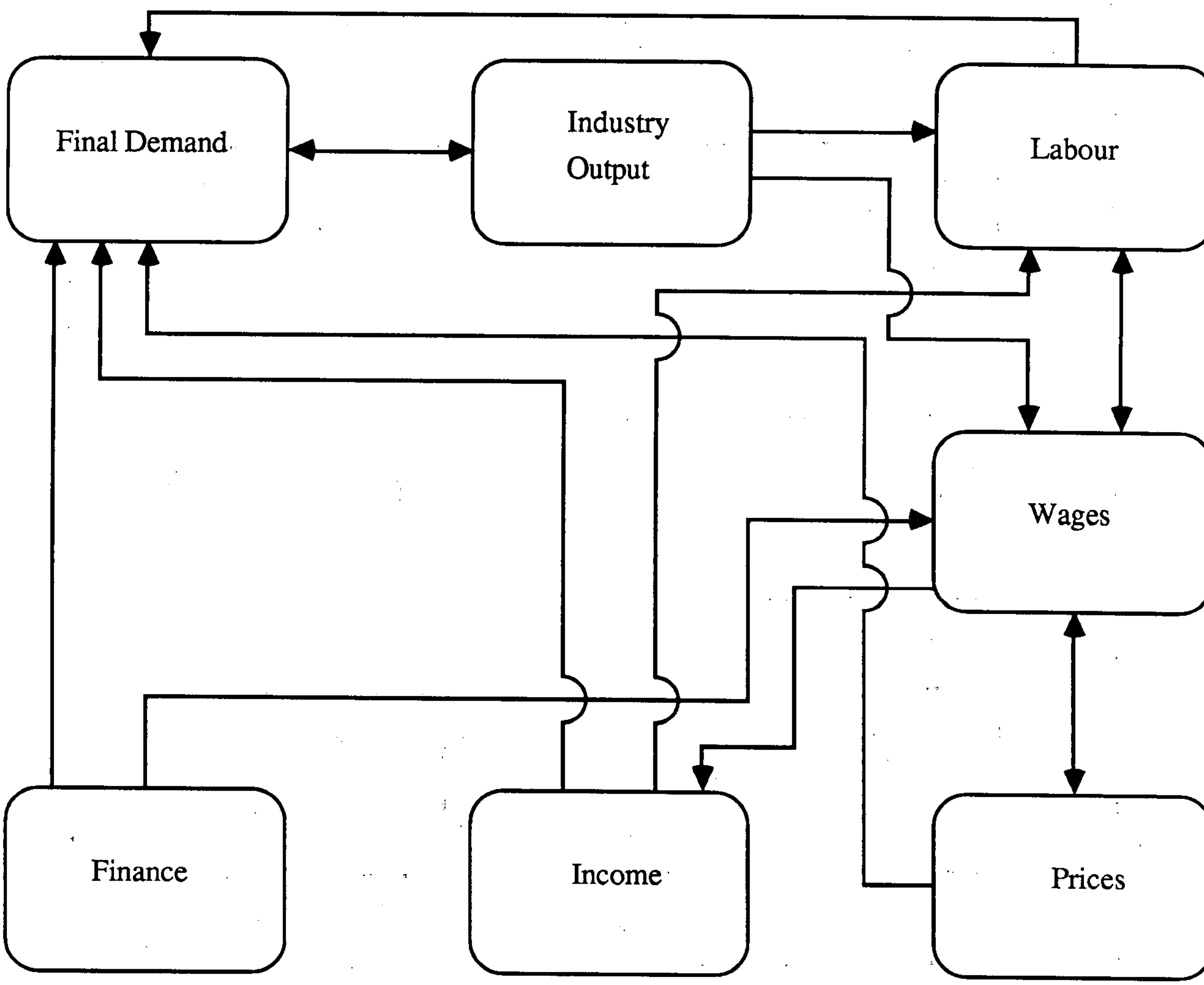
The Quarterly Provincial Forecasting (QPF) model is a top-down model with some bottom-up characteristics. The national totals are not simply allocated among the various regions on the basis of pre-determined shares. Provincial output, employment, income and expenditure, are determined by their counterpart national variables and by developments in the province concerned and other provinces. A notable feature of the model is that the summed values of provincial variables need not agree with the corresponding national total. The model does, however, have the capacity to impose such an agreement.

In the labour market block, provincial population forecasts are determined exogenously. Work is currently being done on modelling interprovincial migration and other components of provincial population change.

Figure A-4 illustrates the flow within the provincial forecasting model. The direction of the arrows indicates the order in which the model's equations are solved in the absence of feedback mechanisms. The presence of feedback links leads to the requirement that a large portion of the model be solved simultaneously. Provincial GDP feeds into the employment equations, employment feeds into the personal income equations, and personal income feeds back into the provincial GDP equations.

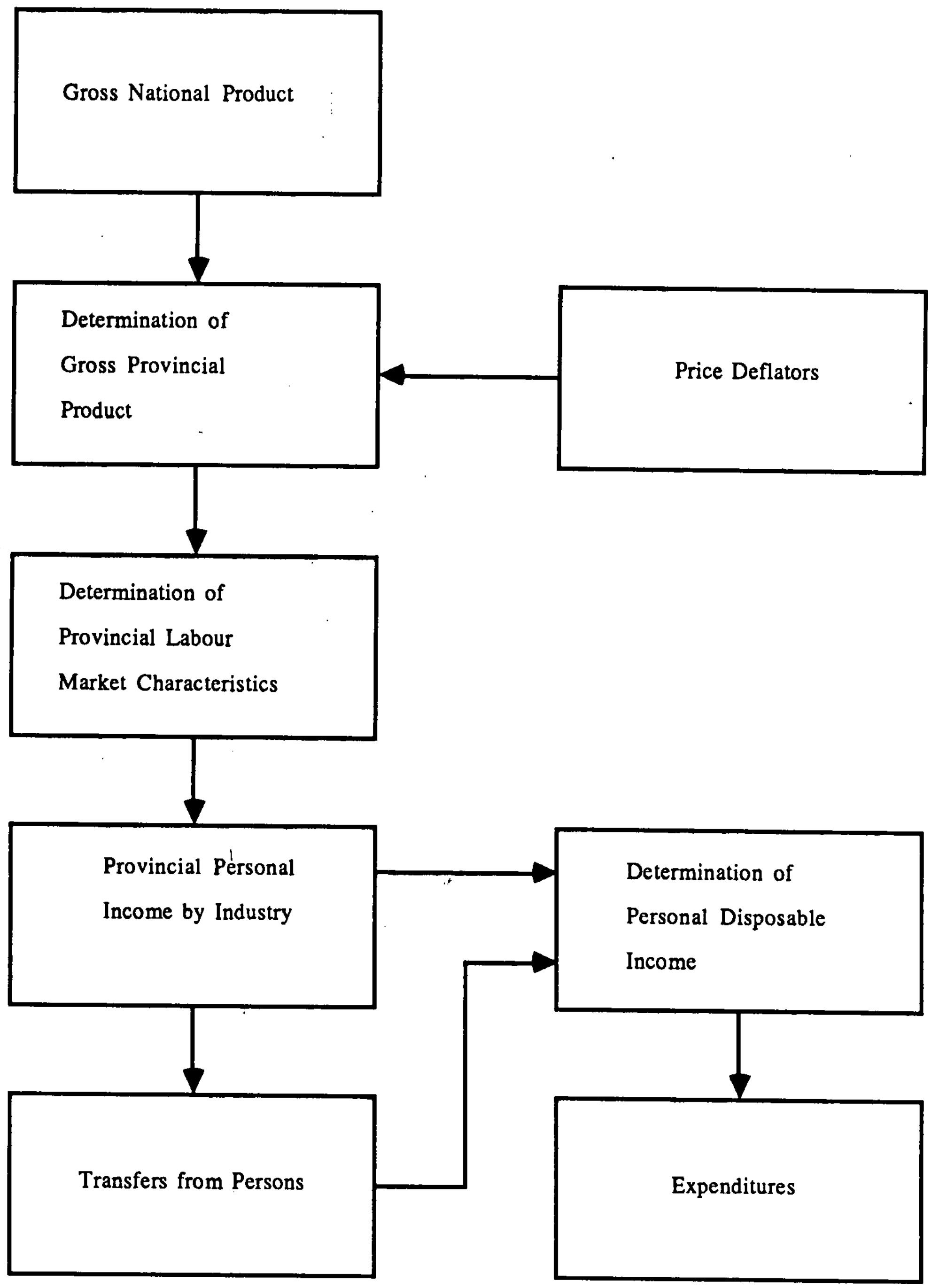
In addition to intra-provincial feedback links, there are also links between the GDP and income of different provinces. As a result, simultaneous solutions are also defined for measures of output, employment and income in many provinces. This is a unique feature of the QPF model differentiating it from a simple top-down model.

Figure A-3: A Schematic of the MTFM Model



Prepared by Gardner Pinfold Consulting Economists Limited.

Figure A-4: Block Structure of the QPF Model



Prepared by Gardner Pinfold Consulting Economists Limited.

Source: Conference Board of Canada

THE DATA RESOURCES MODEL

Description

The Data Resources of Canada (DRI) model is a simultaneous quarterly econometric model of the Canadian economy. The latest version of the model was developed in 1983. It contains 816 variables and 551 equations, of which 208 are identities and the remainder are behavioural/technical relationships. In addition, Data Resources has developed a small national annual model which is about one-quarter the size of the quarterly version.

The DRI macro model is basically a Keynesian model, though output is constrained in the long run by the economy's productive capacity. The bulk of the data used for equation estimation are obtained from the Statistics Canada data base, CANSIM. The estimation interval reflects the availability of data and currently begins in the early 1960's.

Data Resources has recently developed a Canadian regional model called MARV, the acronym for Model, A Regional Variety. The original version of the model was developed as a component of the DRI Canadian Energy Service in order to forecast energy demands by region in Canada. The regional model is now a separate entity available to study regional economic activity in Canada.

Main Uses

The principal design uses of the DRI model are forecasting and policy analysis. The model is used to prepare short-term quarterly forecasts on a monthly basis, medium-term (10 to 12 year) forecasts on a quarterly basis, and long-term (25 year) forecasts twice a year. Typical applications include adjusting international economic assumptions, fiscal and monetary policy analysis, industry analysis, and addressing stategic planning issues. The results generated by the DRI macro model are used to feed the regional model, designed primarily for regional forecasting.

Sectoral Components and Linkages

The DRI Macroeconomic Model

The format of the DRI model is similar to the other econometric models examined in this study. In keeping with its Keynesian foundations, the model is demand driven: the National Accounts measures of final demand are derived initially and then fed into the industry output block, wage and price block, and the incomes block. Interest rates and money and banking are dealt with in the financial block. The exchange rate and the balance of payments are handled in a separate block.

Of particular interest for this study are the labour and industry output components. Labour force behaviour, as indicated by total employment, the aggregate unemployment rate, the total labour force, participation rates, unit labour costs and an index of manufacturing employment, is modelled within the income expenditure, employment and potential GNP block. The unemployment rate equation is modelled on an Okun's law specification as a relationship between unemployment, actual GNP, and full employment GNP. Alternatively, labour force characteristics can be specified exogenously.

The industry output block is disaggregated into 33 industrial categories of Real Gross Domestic Product. The main output concept in the DRI model is real GNP. Potential output is defined as full employment GNP which is generated by a production function which estimates output as a function of labour, capital, and an energy input. The difference between actual and potential output is an indicator of capacity utilization and is the primary channel through which supply and demand imbalances impact on prices. A resulting feature of the model is that the industry output block runs recursively with the rest of the model. There is no feedback mechanism through which industry output impacts upon the rest of the model.

The monetary sector is relatively highly disaggregated and includes a detailed balance sheet of the assets and liabilities of banks and trust companies. Estimates are also made for the M1, M2, and M3 money supply indicators. The key interest rate in the model is the rate on 90 day finance company paper. Monetary policy in the DRI model affects the real sector indirectly via interest rates and the exchange rate in the conventional manner. The structure of the DRI model is illustrated in Figure A-5.

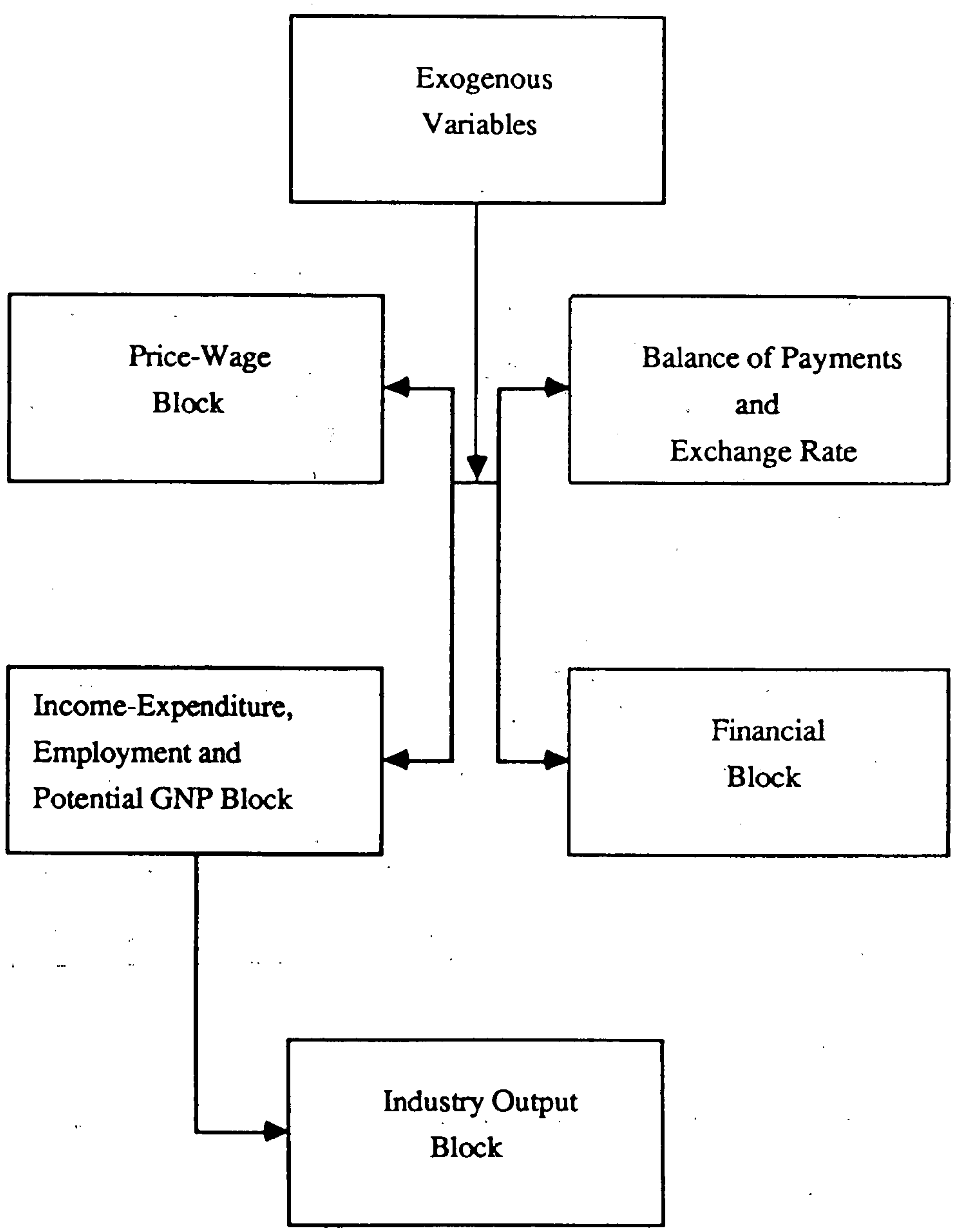
The MARV Regional Model

The regional model combines both top-down and bottom-up characteristics, and is driven by industry detail as opposed to the DRI model which is founded on the income-expenditure concept. The model contains seven regions defined by provincial boundaries west of New Brunswick. The Atlantic provinces are grouped together to form a separate region. The structure and main components of MARV are shown in Figure A-6.

The characteristics of the labour and output blocks are of particular interest for this study. In the output block, two inputs are supplied by the DRI national model, Real Domestic Product by Industry, and National Retail Sales. In addition, the regional demographics and income blocks provide values for the regional population and disposable income variables, and housing starts. The generated result is Real Domestic Product by industry on a regional basis.

The output block, the largest component of the regional model, contains 26 equations for each of the seven regions. The block can be disaggregated into 14 goods producing sectors, and four service sectors. The goods producing industries of each region are summed to give a total goods production, and similarly, the service industries are summed to yield total regional service output. These aggregates are summed to get the

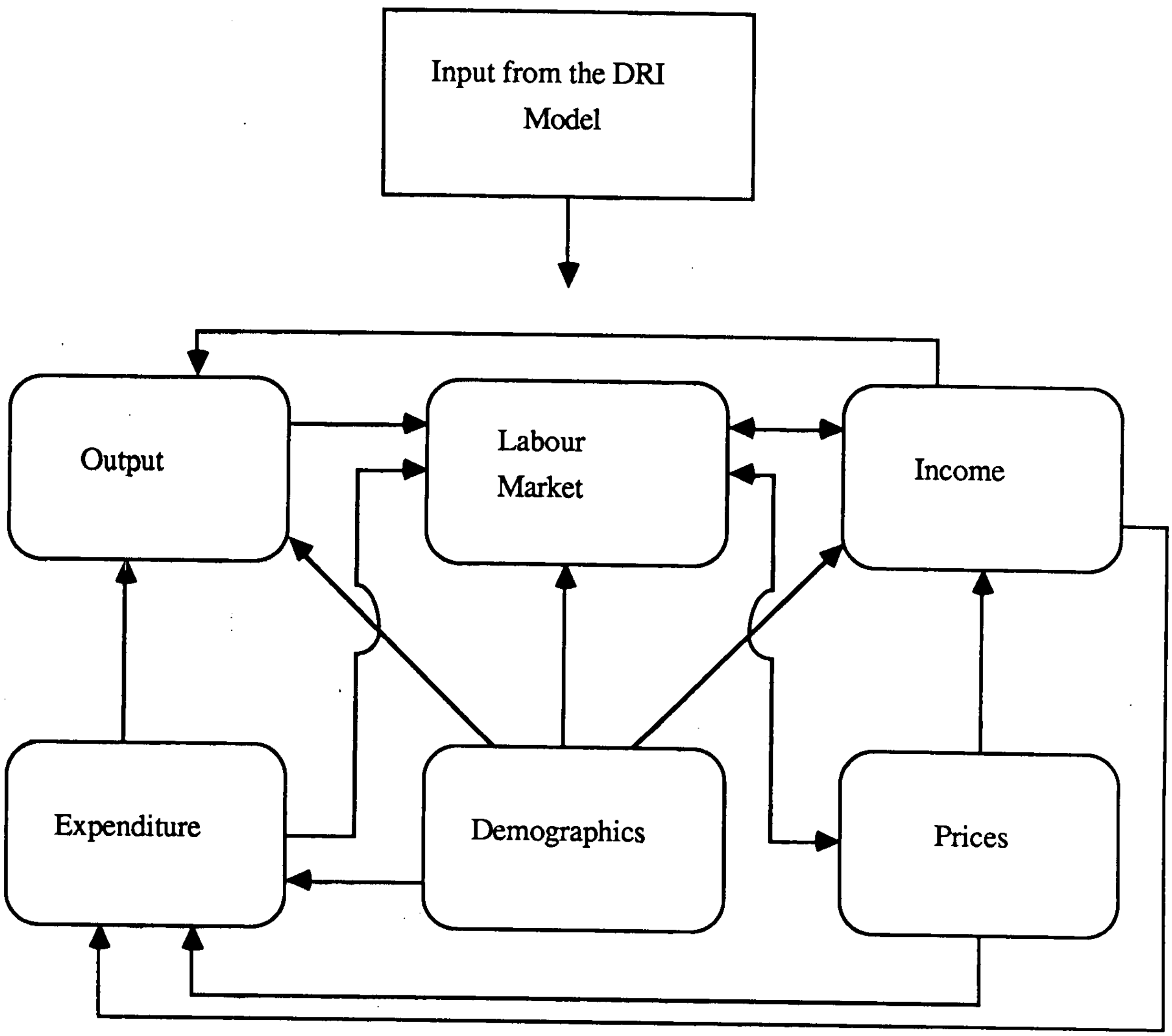
Figure A-5: Structure of the Data Resources Inc. Model



Prepared by Gardner Pinfold Consulting Economists Limited.

Source : Data Resources of Canada

Figure A-6: Structure of the MARV Regional Model



Prepared by Gardner Pinfold Consulting Economists Ltd.
Source: Data Resources of Canada

total RDP for each region, which is in turn used to drive various employment equations in the labour market block.

Two identities define the labour force and the unemployment rate. The participation rate equation treats changes in regional participation as proportional to national changes.

The employment rate is defined using a behavioural equation where employment is derived as a function of regional RDP and the real wage rate. A correcting equation is used to impose consistency between the regional and national forecasts. The unemployment rate calculation is based on derived employment and labour force levels.

In the demographics block, consistency is imposed between the sum of the regional projections and the underlying macro forecast. The outputs of the demographic block are the number of births, deaths, net migration, total population, and population 15 years and older for each region.

THE FOCUS AND PRISM ECONOMETRIC MODELS

Description

The FOCUS and PRISM models were developed and are maintained by the Institute for Policy Analysis, at the University of Toronto. The FOCUS macroeconomic model is the University of Toronto's second generation answer to the Quarterly Forecasting Model developed during the early 1970's. The name FOCUS is an acronym for forecasting and user simulation model. FOCUS is designed for policy analysis and trend projection over the medium and long-term.

PRISM is an acronym for Provincial-Industrial Satellite Model. The roots of PRISM lie in the 'Industry Ontario' model constructed for two studies done for the Ontario Economic Council. The first version of PRISM was released to the public in April, 1981. The current version of the model PRISM83D, was released in April, 1983.

Main Uses

The FOCUS model is designed to carry out medium and long-term forecasting, as well as policy analysis and simulation exercises. For impact analysis, the annual macroeconomic variables from FOCUS are fed into the PRISM regional model to induce the first impact shock. PRISM in combination with FOCUS perform as an instrument for policy analysis around a given base case. Three types of policy analysis are possible:

- the analysis of national policies, with no special provincial implications;
- sector-specific policy analysis; and,
- province-specific policy analysis.

Sectoral Components and Linkages

The FOCUS Model

FOCUS is a large-scale macroeconomic model, consisting of 300 behavioural equations and identities. The basic assumptions of the model are based on standard Keynesian economic theory. FOCUS is demand-driven in the short-run, with supply side constraints coming into play in the long-run.

The real block is characterized by the standard National Accounts variables for determining final demand - consumption, investment, government spending, and the balance of trade - and concurrent sectors determining industry output, wages and prices. The principal output variable in FOCUS is real private domestic product.

Total population is divided into three age cohorts, and the corresponding labour demand and supply characteristics are derived for each cohort. The size of the labour force is determined using participation rate equations. The state of the labour market feeds back to affect final demand via the incomes sector. In turn, income levels exert a strong impact on prices and final demand, and ultimately the demand for labour.

FOCUS has one key wage equation which determines the average annual wages and salaries per employee in the private sector. These are expressed as a function of the CPI, the price of final sales, expectations about the change in the CPI, and the difference between the natural rate of unemployment and the actual rate. The key price in FOCUS is the implicit deflator for privately produced GNP.

The monetary block of the FOCUS model is not highly disaggregated. The main financial variables modelled are the money supply (the M1 and M2 indicators) and interest rates. Figure A-7 illustrates the basic structure of FOCUS.

The PRISM Model

The national sectoral detail in PRISM consists of real value-added, employment hours and domestic-product deflators for 22 industries, plus government. Industrial detail is developed by PRISM from the real final demands allowing for intermediate production generated by FOCUS, which allows for intermediate production. Sectoral detail from PRISM is forced to add to the national aggregates derived in FOCUS. The breakout of sectoral demand is explicitly "top-down" in PRISM.

The provincial detail in PRISM depends upon provincial output shares of the different industrial sectors. Provincial real and nominal gross domestic products are obtained by applying these shares to national industrial outputs and summing across sectors. Employment by province is also derived from summing sectoral shares, adjusted for gross differences in provincial labour productivity (determined exogenously to the model). The model also breaks the nominal provincial GDP's into provincial income components.

To sum up, the PRISM model assimilates the aggregate (national) macroeconomic variables from FOCUS, and then allocates final demands at the industrial sectoral level. Subsequently, PRISM sums across sectors to get provincial GDP and employment variables. Figure A-8 illustrates the disaggregation which occurs in the PRISM model.

Figure A-7: The Structure of FOCUS

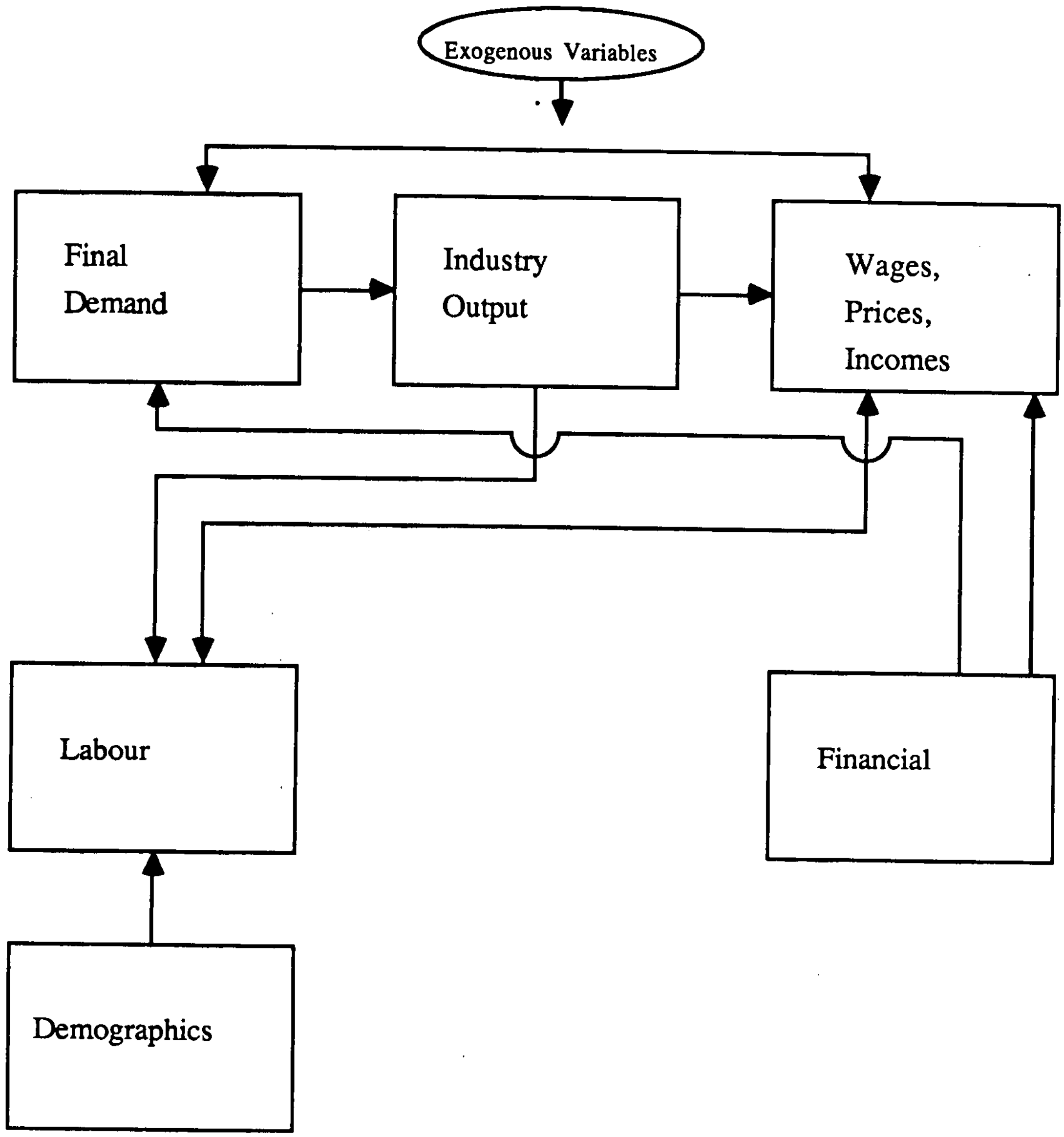


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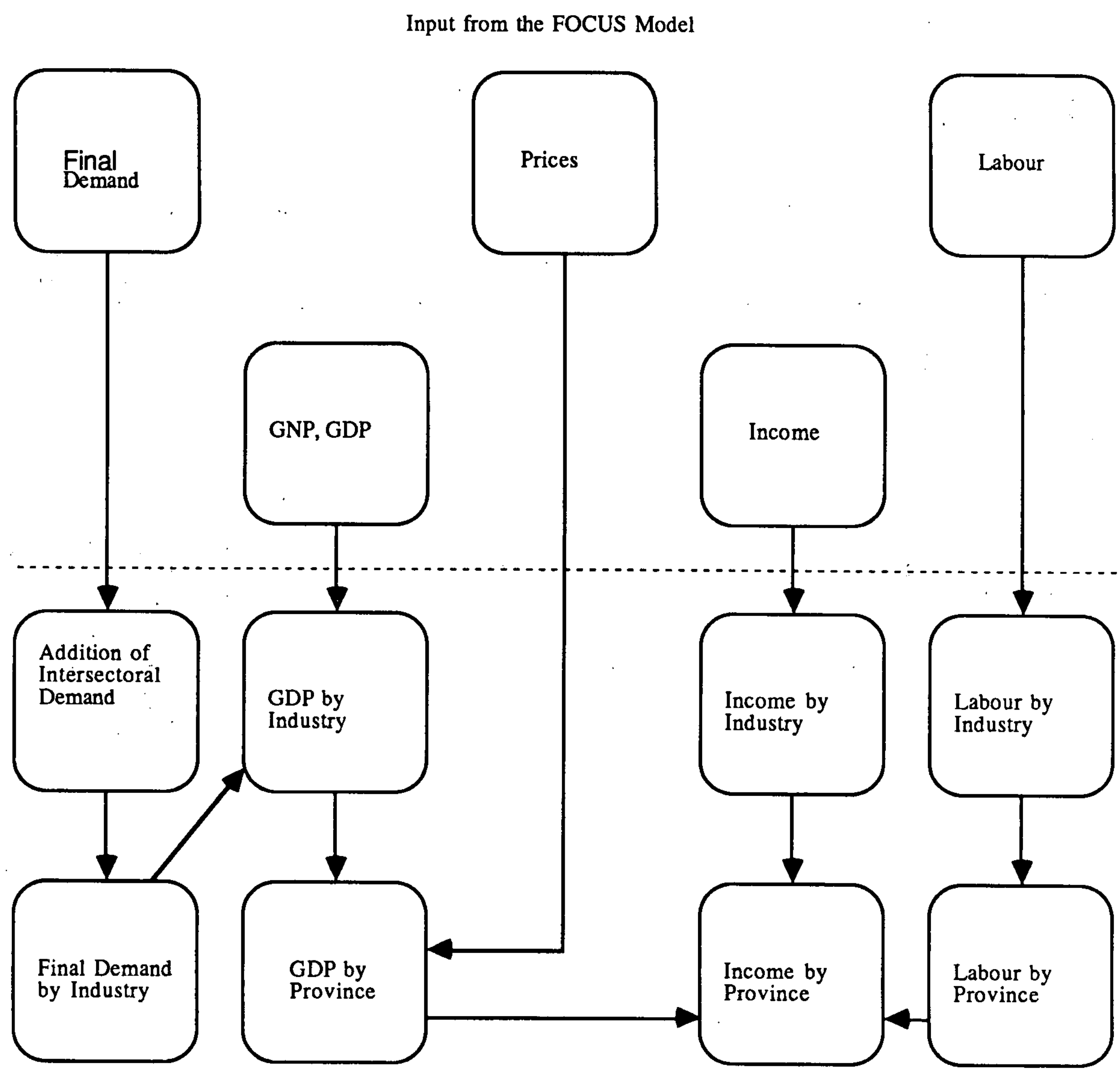
Figure A-8: The Structure of PRISM



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THE INFORMETRICA MACROECONOMIC AND REGIONAL MODELS

Description

The Informetrica Model (TIM) is a lineal descendant of the CANDIDE family of models developed between 1977 and 1979. Currently TIM is a large annual simultaneous equation econometric model, containing about 4000 equations which produce estimates for most National Accounts Variables.

Informetrica's Regional Industrial Model (RIM) is used recursively with TIM. The major goal of RIM is to provide long-term regional forecasts and impact statements consistent with the national view of the economy provided by TIM. RIM shares out national goods production across the provinces in a conventional top-down fashion. With goods production given, RIM then determines endogenously the level of retail trade, services and so on for each provincial economy.

Main Uses

The TIM-RIM combination of models permit the user to do short, medium, and long-term forecasting, impact analysis and policy analysis, at both the national and regional levels. The Regional Industrial Model is closely integrated with TIM, the Provincial Construction Forecast Service, and the Major Projects File. (The Major Projects File is a compendium of all large planned construction projects, particularly those in the energy and resource sectors). RIM utilizes the disaggregated projections of industry activity, employment, labour supply, demographics, and industry value-added prices at the national level for regional forecasting and impact analysis.

Sectoral Components and Linkages

The Informetrica Model (TIM)

The Informetrica model is founded upon Keynesian economic theory, and the equations utilize the standard variables of the system of National Accounts. The driving force behind the model is the final demand block which consists of consumption, investment, government expenditures, exports and imports.

Fifty categories of consumer expenditure are defined in terms of personal income, final demand prices, and demographic aggregates. The key explanatory variables and linkages defining investment are industry output, industry incomes in the form of GDP, and final demand prices.

The external economy is dealt with exogenously. For exports, the chief linkage to the rest of the model is through industry prices. The magnitude of imports on the other hand is determined by comparing domestic prices with the exogenously defined foreign price, and also by the ability of foreign imports to satisfy domestic needs.

TIM has highly developed industry output and labour market components. The function of the industry output component is to generate Gross Domestic Product at Factor Cost, or Real Domestic Product. There are 73 categories of industrial output used in the determination of imports, exports, inventories, business investment, and employment. A major linkage runs from the Industry Output component to determine Factor Returns, and then to the price component, to determine the corresponding prices of industrial output.

In the labour block, employment by industry is derived and used to determine labour income. The labour component also defines the demand for and supply of labour, utilizing a population sub-model.

The wage per worker is modelled in TIM for 17 industries. In the aggregate, the rate of inflation influences wages with a lag. After three years, although wages in some sectors such as retail trade will have increased by less than the full amount of inflation, in the aggregate wages will fully reflect inflation.

Consumption prices are primarily determined as weighted combinations of domestic prices and foreign prices. Relative prices play an important role in determining economic activity in TIM/RIM. There is a direct linkage between the final demand price block and the income block.

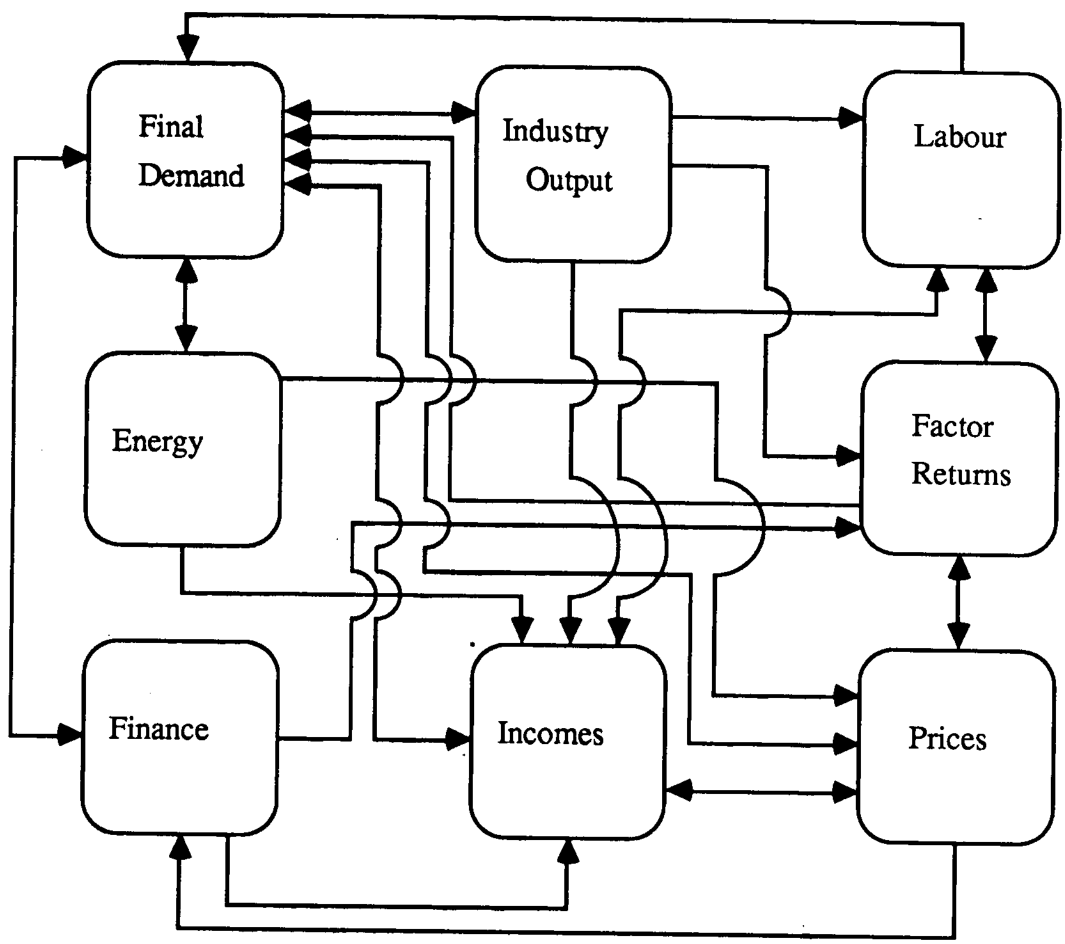
In the income block, the components of GDP are disaggregated as the sum of factor incomes including labour income, return to capital, capital consumption allowance and income from unincorporated business. The National Accounts definitions of incomes are also modelled.

The Energy Sub-Model is based on the premise that income and tax flows associated with the energy sector are based on existing government policy with respect to energy pricing and the acquisition of resource rents, and exogenous assumptions about the world oil price and Canadian production. The sub-model serves three purposes:

- to balance exports, demand and production assumptions is assured;
- to assign correctly the disposition and impact of economic rents and tax flows; and,
- to achieve consistency between the administered prices of oil and gas factor incomes.

The heart of the financial block is the determination of interest rates. In addition, the financial sector determines the flow of funds on the international capital markets, and also the exchange rate. The money supply is completely endogenous but does not influence the price system or any other part of the model. Thus, the financial sector provides linkages between monetary aggregates, financial stocks, government debt and interest rates. Figure A-9 illustrates the sectoral structure of TIM.

Figure A-9 : The Informetrica Model - Sectoral Structure



Prepared by Gardner Pinfold Consulting Economists Ltd.
Source: Informetrica Limited.

The Regional Industrial Model (RIM)

The macroeconomic output generated by TIM is fed into RIM to enable forecasting and simulation at the regional/or provincial level.

RIM forecasts GDP for sixty industries, and employment for seventeen industries. Estimates are provided by province for labour supply, labour income and corporate profits, after the construction forecasts from the Provincial Construction Forecast System and additional demand generated by projects from the Major Project File are incorporated into the regional model. (The results of the Provincial Construction Forecast System are dependent upon the exogenous input from the Major Projects File.) RIM itself has five major components to determine RDP, GDP, employment, labour force characteristics and income characteristics at the provincial level.

The key element of RIM is the determination of provincial activity according to the provincial shares of 60 goods-producing industries. In general the shares of the primary and manufacturing industries are treated as exogenous. On the other hand, the shares of manufacturing industries are adjusted in the forecast period to reflect known shifts derived from the Major Projects File. The construction sector is estimated as a function of construction investment from the Provincial Construction Forecast Service. The remaining industrial sectors are estimated endogenously as functions of total provincial GDP.

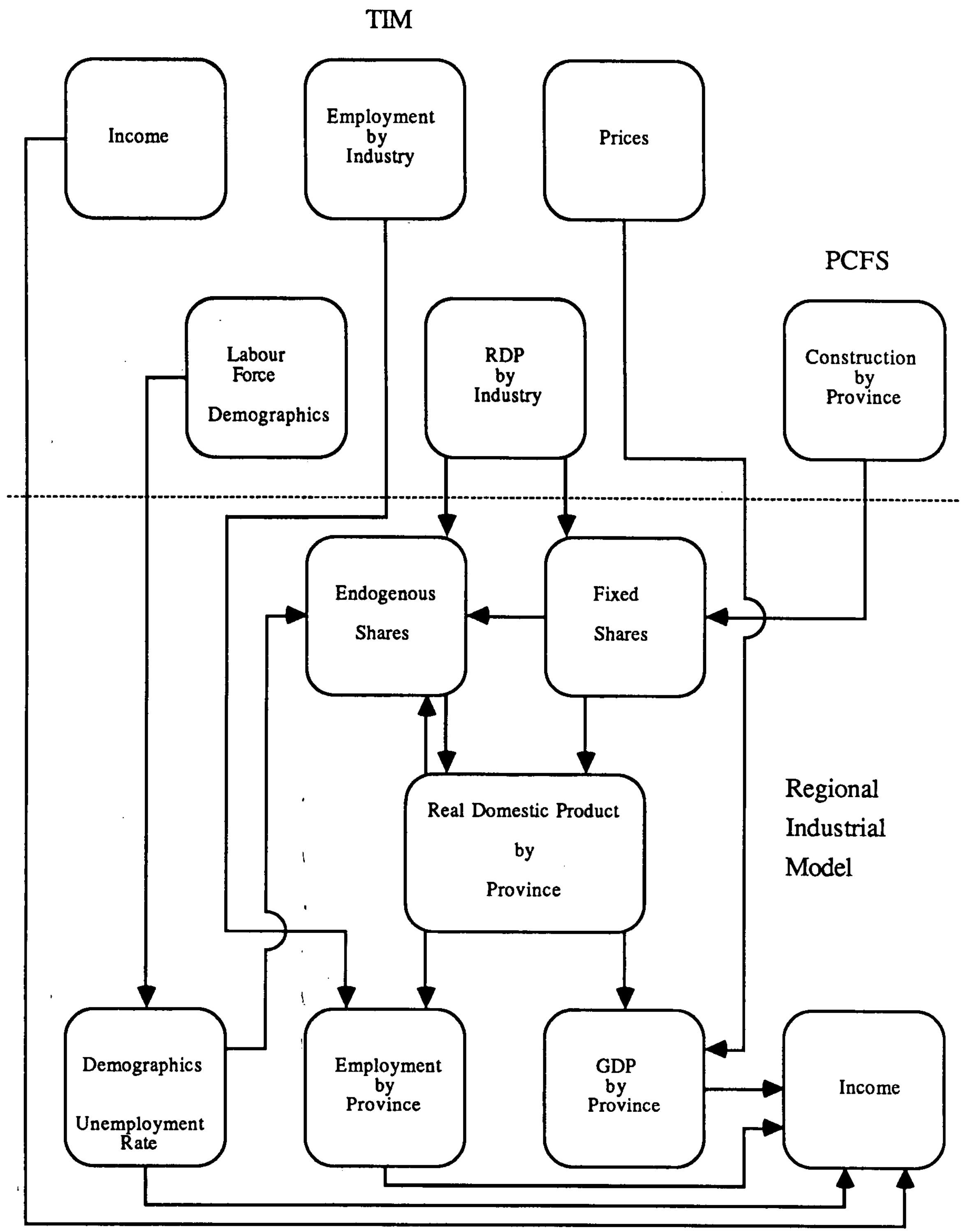
The model estimates labour demand share equations for only 17 industries. Each industry employment share is related to the corresponding share of GDP. Employment, or labour share, is related to the value of output through production functions, and labour productivity is determined exogenously.

In the demographic block, RIM forecasts the regional share of total households as a function of the regional share of employment. The result is that each provincial labour force is obtained using a participation rate equation whose principal explanatory variable is the real labour income per member of the labour force for the region in the previous year. The unemployment rate is determined residually.

Provincial labour income is explained using national unit labour costs derived from TIM. Provincial estimates are derived using a weighting scheme to reflect the related unit labour costs of the manufacturing sub-industries, and unincorporated income is allocated in a similar fashion.

Total provincial income in RIM is defined at factor cost using the sum of the provincial constant dollar GDP industry measures and the appropriate national deflator. Corporate profits are estimated on a domestic basis. In other words, in RIM total provincial domestic profits are estimated as a function of national profits, and net foreign income flows to the provinces. Figure A-10 illustrates the structure of the Regional Industrial Model.

Figure A-10: Structure of the Regional Industrial Model



Prepared by Gardner Pinfold Consulting Economists Limited.
Source: Informetrica Ltd.

STATISTICS CANADA INPUT-OUTPUT MODELS

Description

The Statistics Canada Input-Output models are a direct descendent of the Leontief model. The interregional model was developed by the Structural Analysis Division of Statistics Canada, subsequent to the completion of the national input-output model. The national model traces the transmission of demand throughout the Canadian economy. In the interregional model, the transmission of demand is traced through an economy that is provincially and industrially disaggregated.

The models embody the theory of the more traditional models illustrated in the previous section. The major difference arises from the development and use of a commodity by industry accounting framework. In this framework, the one-to-one correspondance between industries and commodities developed by Leontief is abandoned. Instead, each industry is allowed to produce more than one commodity, and each commodity may be produced in more than one industry.

Main Uses

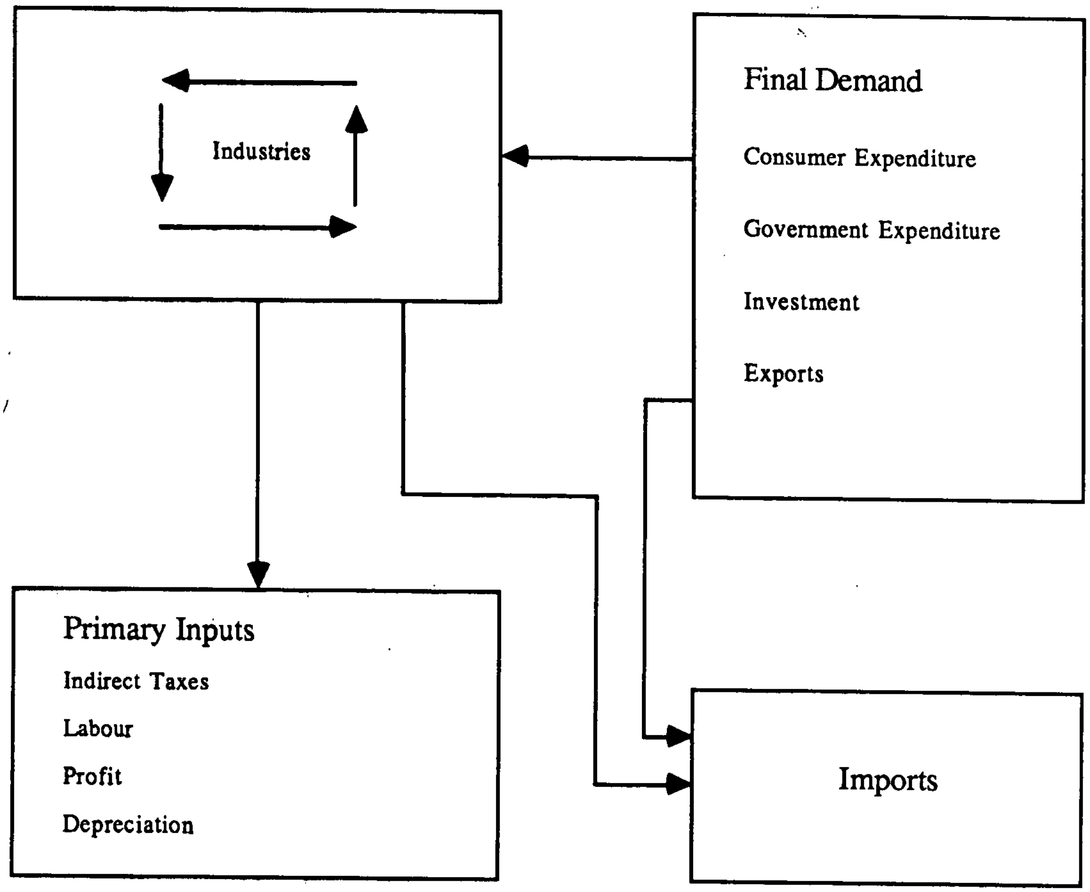
Both the national and interregional models can be used for impact analysis, structural simulation, and as a final demand converter. However, the models are used mainly for impact analysis.

Sectoral Components and Linkages

The interregional or 'interprovincial' model is composed of the same main sectoral components and design as the national model, though the former incorporates interprovincial trade relationships. Currently, both *open* and *closed* versions of the Statistics Canada output determination models (illustrated in Figures A-11 and A-12) are operational. The latter is *closed* with respect to the household sector. Figure A-12 illustrates this effectively by differentiating consumer expenditure from final demand and showing the feedback from the income payments to the household sector block to consumer expenditure. Effectively, in the *open* model, incomes generated in the production process are respent, whereas in the *closed* model they feedback to the household sector and are spent on goods and services and leakages (savings, and imports) until the model converges to an equilibrium value.

The monetary side is excluded from the input-output system. However, government related leakages (indirect taxes) and injections (government expenditure, transfer payments) are included.

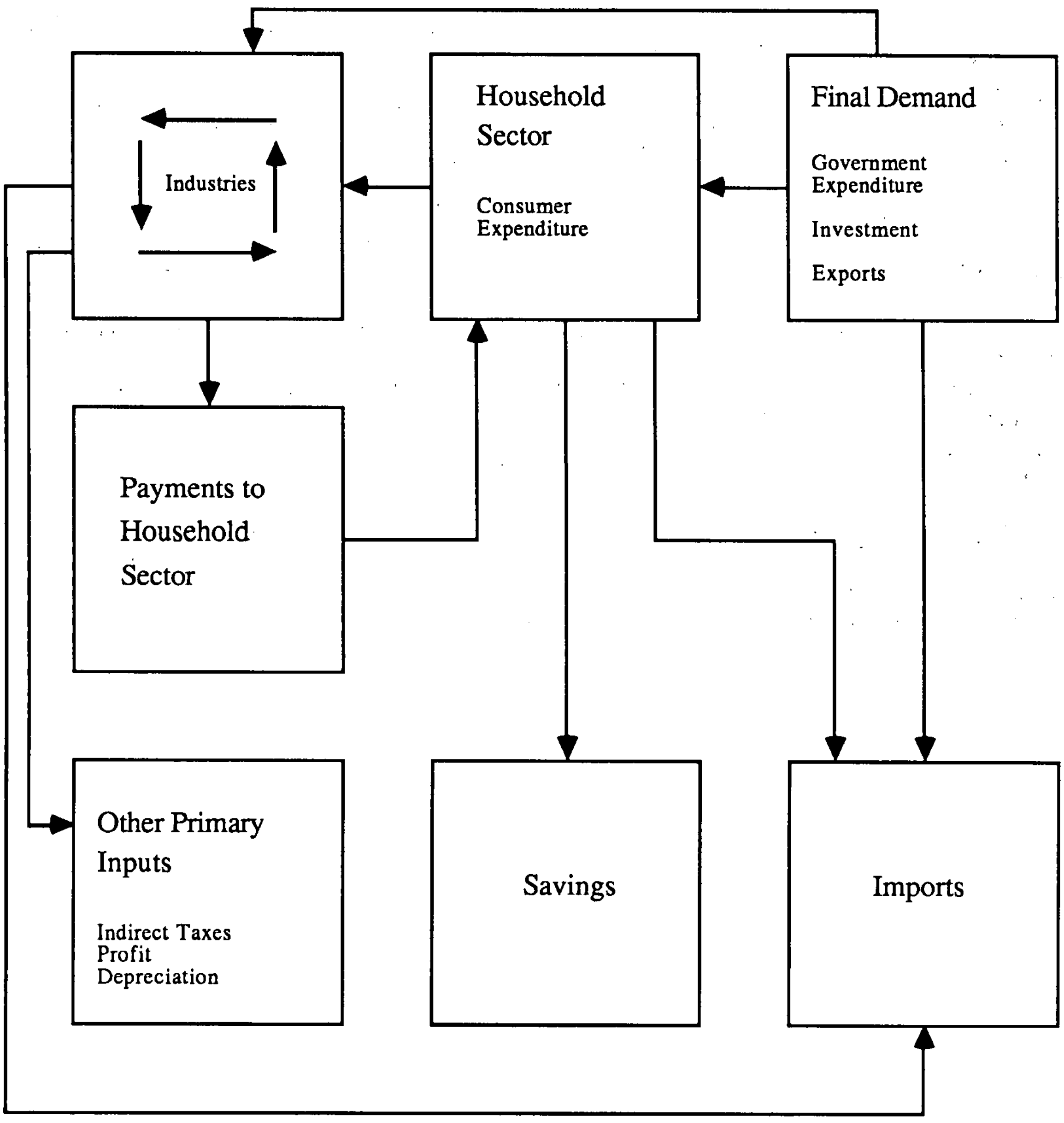
Figure A-11: Schematic Diagram of the Statistics Canada Open Input-Output Model



Prepared by Gardner Pinfold Consulting Economists Limited.

Source: Statistics Canada.

Figure A-12: Schematic Diagram of the Statistics Canada Closed Input-Output Model



Prepared by Gardner Pinfold Consulting Economists Limited.

Source : Statistics Canada

Each industry supplying intermediate goods to the producer of a final good must acquire imports, labour, and other factors of production to accommodate for changes in demand. For the interregional model, provincial interdependence is accomplished by adding a set of interprovincial trade relationships to the market share and input relationships used in the national model. Within this context, the models can be used to examine the impact of a large investment project, the impact of changing demand for an industry output, or the impact of producing additional products.

The national model produces results at one of three standard levels of aggregation by commodity - 602 commodities, 100 commodities, or 49 commodities. Similarly, there are three levels of aggregation at the industry level - 191 industries, 43 industries, or 16 industries. Results can be obtained in both commodity and industry space by defining user-specific classifications in terms of the 602 commodities and/or 191 industries.

The output produced by the model includes Domestic Final Demand and Total Domestic Ouput, the components of value added in each industry, and Gross Domestic Product at Factor Cost by Industry.

In the interregional model an extension of the national input-output accounting framework is used. It distinguishes 191 industries which produce and/or utilize 602 commodities. Eleven regions are represented: the ten provinces and the two territories combined to form the eleventh region. As a consequence, the accounting framework is completed by a set of interprovincial trade tables consisting of one table for each commodity.

The interregional model traces the effects of a demand shock throughout the Canadian economy that is provincially as well as industrially disaggregated. It takes into account interdependence among provinces as well as among industries. In all other respects, the interprovincial model is similar to the national model.

GLOSSARY

Accelerator Principle	The hypothesis that the level of investment varies directly with the rate of change of output.
Actual GNP	A measure of the total flow of goods and services produced by the economy over a specified period of time, including income accruing to domestic residents arising from investment abroad less income earned in the domestic market accruing to foreigners abroad.
Behavioral Equation	An equation based on an assumption about the way in which individual economic agents behave, and most especially about their motives, and the way in which they respond to differences between expected and actual outcomes.
Comparative Static Model	A model which begins by examining the current state of equilibrium of the economy as portrayed by the model. Subsequently, one of the underlying determinants of this equilibrium is changed, and the new equilibrium position examined. The new equilibrium position is then compared to the previous one, and from this the effects of the change are deduced.
Constant Dollars	Current dollar values are converted to constant dollar values using the Consumer Price Index or other index, to allow for the interpretation of real time trends in the variables being examined, (i.e., net of inflation).
Constant Returns To Scale	The notion that any increase (decrease) in output is the result of an exactly equal proportion increase (decrease) in all inputs.
Current Dollars	The current value of the economic variable being examined.
Demand Shock	A change in the magnitude of the components of final demand, introduce exogenously by the model user.
Dynamic Model	A model which attempts to capture the movement of economic systems through time. Relationships are explicitly time-dependent and contain variables whose values may change over time.
Economies of Scale	These exist when expansion of the scale of production capacity of a firm or industry causes total

	production costs to increase less than proportionately with output.
Endogenous	A variable whose value is to be determined by forces operating within the model under consideration.
Equilibrium	A state in which forces making for change in opposing directions are perfectly in balance, so that there is no tendency to change.
Exogenous	A variable which, although playing an important part in the model, is determined by forces outside the model and is unexplained by it.
Exogenous Change	A change in an economic variable, determined by forces outside the model.
Functional Form (Functional Specification)	The mathematical form used to empirically estimate an economic hypothesis, or relationship.
Full Employment GNP	The GNP that could be produced if full employment were maintained.
General Equilibrium Model	A model designed to allow for the analysis of an interdependent set of markets or sectors, with full regard for spillouts and feedbacks.
Intermediate Goods	All goods and services which are used as inputs into a further stage of production.
Keynesian Economic Theory	Predominantly, the notion that because of problems of wage rigidity, and insensitivity of investment to the rate of investment, positive economic change can be brought about by increased spending, (i.e. fiscal policy, namely government expenditure, is the key to economic growth and stability).
Lagged Variables	Variables which derive from a previous time period, and which are used to explain current economic behaviour.
Model	A technical method for simulating, studying, and trying to empirically verify economic theory.
Multiplier	A measure of the effect on total national income of a unit change in some component of aggregate demand.
Multiplier Effects	The overall effect of an increase in investment as captured by the multiplier value.
M1	A narrow definition of money - currency outside banks plus demand deposits.

M2	A broader definition of money than M1 - currency plus privately held Canadian dollar deposits in chartered banks.
National Accounts	The presentation of the national income and expenditure accounts in a form showing the transactions during a given period between the different sectors of the economy.
Okun's Law	The close negative relationship between the rate of unemployment and the ratio of actual GNP to full employment GNP.
Phillips Curve	A curve depicting the hypothesized relationship between the percentage change in money wages and the level of unemployment.
Production Function	A mathematical relationship between the quantity of output of a good and the quantities of inputs required to make it.
Purchasing Power Parity Theory	A theory which states that the exchange rate between one currency and another is in equilibrium when their domestic purchasing power at that rate of exchange are equivalent.
Scale Economies	(See economies of scale)
Stochastic	Probabilistic or random. A variable is called a stochastic variable if it is capable of taking one of a number of alternative values each with a stated probability.
Stock Adjustment Model	A model which hypothesizes about optimal stock adjustment, or the optimal rate of change in inventories.
Statistical Bias	Bias in a statistically estimated parameter which results from differences in the assumptions upon which the statistical method is grounded, and the way in which the method is used.
Simultaneous Econometric Equations	A block of inter-related statistically estimated equations which are solved simultaneously.

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