OPTIMAL DISTRIBUTION PATTERNS OF REGIONAL ECONOMIC ACTIVITY

THE REGIONAL DISTRIBUTION PATTERN OF ECONOMIC ACTIVITY IN CANADA: A LINEAR PROGRAMMING EXERCISE.

BY

RASHID AZIZ

A Thesis

Submitted to the School of Graduate Studies

in Partial Fulfillment of the Requirements

of the Degree

Doctor of Philosophy

McMaster University

1980.

TO THE MEMORY OF MY GRANDPARENTS

AND TO A FAMILY LIKE NO OTHER

DOCTOR OF PHILOSOPHY (1980)
(Economics)

McMASTER UNIVERSITY
Hamilton, Ontario.

TITLE: The Regional Distribution Pattern of Economic Activity in Canada: A Linear Programming Exercise.

AUTHOR: Rashid Aziz, M.Sc. (University of Islamabad)
M.A. (McMaster University)

SUPERVISOR: Professor A. A. Kubursi

NUMBER OF PAGES: xi, 253

ABSTRACT

Resource allocation across regions in an economy has been analysed by many authors, both from the efficiency and equity viewpoints. In general, these aspects are assumed to be conflicting - the attainment of higher growth rates and income levels in accordance with efficient resource allocation normally discrimminates against the relatively less well off sections of society. The literature concentrates largely on the allocation of resources across sectors, irrespective of geographic considerations, so that the decision to invest in a region seldom incorporates the area's absorptive capacity. The regional imbalance that results is shown just as clearly by the lack of high technology industry in some areas as it is by the (potential) congestion and overcrowding that characterises other regions. This study focuses on the relationship between the regional allocation of income generating activities and the total income generated for the nation.

The growth potential of any area is defined by the availability of all essential facilities - service and repair facilities, transport and energy supplies being only a part of the picture. Factor supplies and the supply of credit, alongwith the high degree of interaction between regions and sectors also complement the picture. The low income potential

of the peripheral areas of any nation is the result of a lack of these ancilliary facilities. However, once these bottlenecks are removed, the outlying areas normally depict higher growth rates than the core regions.

In this study, a linear programming model is developed linking the commodity, factor and asset markets of a nation, both across sectors and across regions. Thus, the commodity market of any region is related to the commodity, asset and factor markets of all regions. National absorptive capacity is now defined in terms of the potentials of all areas of the nation. The application of this model to Canada results in a set of optimal regional patterns of economic activity. Growth in any area is now encouraged only if the regional economy is not operating close to some capacity limitation, and if a full complement of goods and services, factors and assets is available.

The results obtained justify these expectations because the model depicts a pattern of resource allocation that stresses areas where all facilities for growth are present. Thus, further investment in the traditional center - Quebec and Ontario - is restricted, some critical thresholds regarding absorptive capacity having been hit. However, the regions where a full complement of services and asset supplies is not available - the Atlantic provinces - are not

the alternatives. The relative ordering favours the modern manufacturing and service sectors in Alberta and British Columbia.

The model does suggest the existence of a tradeoff between national income and regional balance, since the imposition of regional balance constraints reduces the value of national consumption. However, even when regional equity constraints are imposed, the model suggests that more national income can be generated through reallocation of economic activity than was generated by the historical pattern of allocation.

ACKNOWLEDGEMENTS

I wish to express my sincere gratitude and appreciation to the members of my supervisory committee - Professors Atif Kubursi (Chairman), Dave Butterfield and Stuart Mestelman - for their help and guidance, and the thoroughness with which they supervised every stage of the work. I am especially indebted to both Professors Butterfield and Kubursi for the pains they took to improve the quality of the work. The study would surely not have been possible without their stimulating comments and suggestions. The time and resources the two of them have devoted to various phases of the study exceeds any of my expectations.

I am also indebted to Karen Scott for her assistance with various stages of the computer work.

I would also like to acknowledge the contribution of a number of people who helped make my stay in Hamilton more enjoyable. Most notable among these are the entire Malik family and all my colleagues at McMaster.

Finally, I wish to thank all the members of my family for their support and patience throughout the work. The completion of this work is as much a credit to them as it is to me.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1: INTRODUCTION.

1.1 The need for this study

Among the few "truisms" in economics is the acknowledgement that resource supplies are not infinite, in fact these are not sufficient to fulfill all the ends a society wants to attain. While in some societies, or sections of a society, this scarcity implies that subsistence is threatened, in other cases this lack of a command over sufficient resources is entirely relative to the ends to be attained. As a result of the rather insatiable nature of man, human wants seem to grow with the means to satisfy them, so that once a society has attained some essentials of life, the quest for a better standard of living leads to a larger (and better) flow of goods and services being defined as necessities. This scarcity of resources takes on varied forms in different nations. In some nations, hunger and poverty, are the main concerns, so that all efforts are directed towards production of these basic necessities - enlarging the size of the economic pie. Other nations are not faced with this urgent problem, so that, having attained a certain supply and distribution of most of these essentials, such nations devote their efforts more to avoiding waste and inefficiency in resource use, with an emphasis on avoiding inflation and unemployment.

This strict segregation along national frontiers does not truly characterise the world, however, as these twin facets of life exist simultaneously in both types of countries. Thus in the relatively rich nations, poverty and hunger are suffered by the residents of city slum areas, by residents of traditional resource providing regions whose mineral wealth has been depleted to a point of no return, or by residents of areas that are relatively far from the centers of activity, so that the basic amenities of life cannot be easily provided. Similarly, this dichotomy is revealed in poor nations by the existence of very diverse standards of living between most urban areas and the rural areas or by the shantytowns and slums that exist on the outskirts of major cities. This duality cannot be truly predicted by a simple application of economic theory because the latter would imply that factors should move from areas (and occupations) of low factor income to areas where factor rewards are high, and thus create a tendency towards equality by raising income levels in the former and reducing them in the latter. The fact that the economy seems to settle into a "high level" equilibrium depicted by the urban areas (with their high income levels and faster growth rates of income) and a "low level" equilibrium depicted by rural areas and other depressed regions implies that regional problems may not be studied fruitfully by simply applying special

assumptions to established economic paradigms. As a result, the discipline of Regional Economics has emerged in response to the problems of these diverse types of areas within a nation, problems that in most cases imply that discretionary action has to be taken to correct interregional imbalances. This study is an attempt to look into the existence of these regional income inequalities in Canada and to investigate how the pattern of resource allocation can be made more desireable. To this end, Section 1.2 below lists in brief some of the issues raised in connection with the allocation of scarce resources inside a nation, while Section 1.3 describes the methodology followed by this study and how the work is organised in various chapters.

1.2 Some Issues in Resource Allocation for Growth

Given that resource supplies are limited, and that different resources are effective in relaxing different constraints in varying degrees, the problem of resource allocation in a growth context has to be looked at from three distinct angles. First, there is the issue of "consistency" versus "optimality". In a consistency framework, the aim is solely to find a feasible solution - i.e. to avoid violating any supply limitations that define the amount available of each commodity and resource. While in this case a resource can be allocated to any activity as long as total demand does

not exceed total supply, in a system based on an optimality criterion the emphasis is on allocating resources to their best uses. Thus while there are problems in defining objectively what constitutes the "right direction" to follow, once this objective is defined, overall resource use will become more efficient than before because the marginal unit of a resource used yields the same marginal addition to the objective function in all uses.

Second, resource allocation can be examined in a partial or a general equilibrium framework. In the former, as attention is limited to one section or sector of the economy, it is possible to study in depth what changes in particular variables can lead to the highest growth rate of income. However, in this preoccupation with a single section, it is often forgotten that the economy is an interlocking system of many economic actions. As a result, movements in one market are bound to influence all the important magnitudes in other markets, and hence it is not appropriate to take the outcome in the latter as being given exogenously for the former. Since the use of any resource in one activity implies a reduction in the amounts available for other activities, it may be better to study the system as a whole, to analyse the productivity or utility of scarce resources or goods in all markets simultaneously. This interdependence is the focus of a general equilibrium system that has as its components many

markets and also makes explicit the specific links between all markets and/or facets of the economy.

Finally, especially in the context of regional economies, there is the question of what ensures the fastest growth of income in any region. The analyst has to investigate whether a higher level of income and/or consumption can be provided to any region by the existing distribution of productive facilities, coupled with an income reallocation scheme, or, alternatively, by a redistribution of productive facilities. If the first alternative is the most suitable, there is no real need to induce industry and jobs to move to the regions, but there is a need to reallocate income. However, if the second alternative is desireable, there should be concrete efforts to move jobs into the poorer regions.

1.3 The Methodology and Organisation of this Study

This study is designed to analyse the spatial pattern of economic activity in Canada by use of a linear programming (LP) model. The structure of this model is a general equilibrium description of the economy, and from its LP nature it is an optimisation model. The results that emerge are based on allocating resources to those activities where their productivity is the highest. However, the LP is subject

to a series of constraints that are designed to cover the consistency problem so that the available supply of any asset, commodity or resource is at least as great as all the demands that may arise. These constraints include a description of the equilibrium conditions in the markets for goods, factors and assets. This multi-dimensional emphasis helps to discover what are the most significant constraints on growth of income levels in any region. As the constraints embody not only descriptions of each market but also contain links between these three facets of the economy, the course of the optimisation is determined by all possible (direct, indirect and induced) impacts of any action. This exercise is used to determine whether jobs should be moved into any area or whether income should be redistributed between areas via transfers and other income subisdies.

In Chapter 2 a fairly extensive survey of the literature on regional economics is presented. The coverage in the first half of the chapter is on the existence of regional income disparities in a variety of nations, some causes of this phenomenon, and some reasons why a free market system may not be adequate to cure these distortions in the economy. The major tools a regional policy maker can use are discussed in the second half, while some of the technical details are presented in the appendices. Thus Appendix I is devoted to showing how some studies are based on single

region Input-Output (I-O) tables while others are extensive enough to warrant a Multi-Region Input-Output (MRIO) table. In Appendices II and III the construction of a MRIO table and the main proxies used by research workers in deriving a set of trade coefficients from regularly published statistics are described.

Chapter 3 documents the existence of interregional income differences across Canada. The picture is compared in terms of income levels, consumption per head, employment rates and in terms of availability of various services across regions. Similarly the prospects of future growth are analysed in a discussion of investment spending per region. A fairly extensive evaluation of past government policies aimed at reducing these disparities is presented, along with the observation that these actions seem to lack a uniform direction, any kind of optimality criterion or a general equilibrium basis.

In Chapter 4 the economic model is described, in terms of the constraints imposed on the optimisation and the objective function used. The model relies on a link between the goods and asset markets in the financial constraints via the trade balance. Further conditions include a description of income levels and a government budget constraint. Regional or national trade balance constraints are also imposed and

the impact of a series of assumptions about factor mobility is observed.

The results of various runs of the model are presented in Chapters 5 and 6, with the main sets of experiments described being those related to a change in the specification of trade balance constraints and factor mobility assumptions. While Chapter 5 is related to overall consumption levels when factor supplies and demands for goods are altered, in Chapter 6 the model is forced to equate the level of per capita income across all regions. These runs are termed the "equity" version of the model and can be compared to the results of the "efficiency" solutions of the earlier chapter.

Some of the results obtained from the exercises are of interest because they provide a new insight into the problem of interregional income inequality in Canada. It is observed that in many cases, the optimal solution is to produce a high level of output in the two provinces of Alberta and British Columbia, while the rest of the country is supplied outputs via trade flows. When factor mobility is free or relatively unhindered, there is a large transfer of these resources to the western provinces, and the output level of these two regions rises by a factor of almost twenty. Generally, the four western provinces are not too

constrained by trade deficits, while in case of Ontario, Quebec and the Atlantic provinces, the trade deficit reaches above 25% of income levels. In other cases the results show that the most binding constraint on various regional economies is the financial constraint defined below (see Chapter 4.2). There are many runs in which relaxing this constraint by one unit raises the objective function by three times as much as is possible by producing an extra unit of output. If per capita income in all regions is forced to equality, all regions are constrained by the extent of income growth in the poorest region, which in the year 1966 is Prince Edward Island. The economies of all other regions operate with a significant slack in these runs.

A general summary of the study is presented in Chapter 7. Some special assumptions and how these affect data values and the specifications of various constraints is complemented by a brief discussion of how the theory behind the model used for this thesis is an addition to other works currently seen in regional economics. This discussion is substantiated by the results of various experiments discussed earlier. Finally, some avenues for further research are outlined.

CHAPTER 2: AN OVERVIEW OF REGIONAL ECONOMICS.

2.1 Introduction

This chapter presents a general survey of the literature on regional plan and policy making, even though there are references to the Canadian context. The discussion includes various issues that arise in regional economics, and the need for a regionalised perspective in overall economic thinking. Some tools of analysis and estimation methods are also briefly discussed. Thus Section 2.2 analyses what regional issues are important in economics. A brief discussion of the historical emergence of interregional inequalities in living standards is followed bu an analysis of the ways regional plans and policies have been used. It is noted that stability, not growth, and the need to thoroughly evaluate existing policies and plans dominate the reasoning behind regional plans and models. Sections 2.3 and 2.4 discuss some techniques of analysis and choice and the estimation methods available to the regional model builder. The coverage on Input Output (I-O) as a technique for analysis of both single and multi-region systems is extensive because these tables emphasise the sectoral make up of each region, and this is the most important factor differentiating one region from another. National economies typically display some element of balanced sectoral growth in comparison with

which regions rely too heavily on one or a few sectors. This discussion also brings out the case for an optimisation framework as opposed to simple econometric estimation.

Some past works in the field of regional forecasting and impact analysis are surveyed next. It is noted that both econometric models and optimisation techniques can be used to replicate the basic structure of the economy or to find out the effects on each region of changes in exogenous conditions. The Appendices to this chapter cover some of the technical details related to I-O studies. Appendix I is devoted to a discussion of when and where single region I-O models are used and why a multi-regional framework seems more appropriate elsewhere. Appendices II and III cover the data requirements and some of the approximations used to derive interregional trade coefficients in constructing Multi-Region Input-Output (MRIO) tables respectively.

2.2 Some Issues in Regional Analysis

This section is based on the need for "Regional Analysis" i. e. the reasoning behind why economic issues and problems can and should be looked at from a regional point of view. The main regional issue focussed on in this study relates to interregional equity - how inequalities arise and the various ways these can be removed. Other issues briefly

mentioned in this section include the need to make optimal use of government funds, and hence relate to the need for efficiency tests of various policy measures. Traditionally, regional issues have been studied by adding special assumptions to international trade theory and applying it to the smaller scale of regions within a nation. However, international trade theory is not by itself adequate to capture all the linkages between regions, and this results in the need for specific theories of regional economic (and other) interaction. As an example one can cite the assumption of free factor mobility inside a nation used in international trade models, a natural corollary of which is factor price equalisation within national frontiers. In real life this equality is not seen to be achieved, and some areas in a country find their poverty aggravated by a flight of capital and (scarce) skilled labour while there is quick growth in the already rich regions because of economies of scale and agglomeration. The unequal income levels that emerge from these diverse growth rates and potentials are important in discussions of interregional equity. Similarly there is no formal counterpart in international trade theory of the issues that arise because the sum of all important regional variables (output, employment, income, consumption and the like) has to equal known national totals.

In the recent past, however, debate has shifted from

the need for specific theories of regional and interregional economic behaviour to the idea that a regional disaggregation of national plans and policies is a part of the quest for greater detail and accuracy in the construction of national economic models.[1] Thus the issues analysed in great detail relate to the emeregence of disparities in living standards across regions, the need for stabilisation (balanced growth across regions of a nation as opposed to growth for its own sake), and the need for efficiency tests of various national and local policies. In addition, the need to model a regional economy arises because of the utility of forecasts of regional (in addition to national) values of important variables, especially for central and local governments and businesses.

2.2.1 From Growth to Stability

In the 1960's there was an overwhelming emphasis in economic theory on growth and development, from analysis of how best to ensure high levels of income and/or high growth rates to detailed evaluations of why and how these prescriptions were sucessful in some instances and not in others. However, the literature seemed to ignore the issue of stabilisation - e. g. questions regarding what constituted the optimal rates of growth for an economy given its supplies of factors, its level of technology and know how, and its

current and future supplies of non-renewable resources (especially the latter). Similarly, there was little or no analysis of the bottlenecks to unchecked growth implied by the existing transport and service network and by the ability of some areas to absorb a larger population. An optimal growth rate need not be one that enables the highest level of income or consumption to be attained, but rather, given the issues raised here, may be one that the economy can sustain over long periods of time. A significant first step towards such an optimum involves utilisation of all the national space as opposed to concentrated growth in a few regions.

It is well known that industrial growth tends to concentrate in small areas of a nation because (among other factors) manufaturing industries are linked to each other through intermediate input purchases and supplies. An I-O table is a thorough documentation of these "forward and backward" linkages among industries through which various manufacturing enterprises reinforce each other - both by creating demands for the products of others and by providing inputs at cheap rates.[2] Economies of scale and economies of investment in repair, service and transport facilities reinforce these effect. The literature on Growth Poles and Centers[3] contains numerous examples regarding how these economies can be significant, and how manufacturing enterprises can obtain these economies by locating in the

pole regions. As a direct result of these "polaristaion" forces, the outlying regions of a nation are drained of their most productive labour and capital resources by the attraction of better living conditions in the central cities - a feature Myrdal refers to as Backwash Effects.[4]

Evidence on the extent of concentrated growth across various areas of a nation can be obtained from many sources.[5] The fact that the average standard of living is higher in the central cities as opposed to the outlying areas (what Friedman refers to as Core regions as opposed to Resource Frontier and Downward Transitional areas[6]) can be seen very easily in the case of Canada. Traditionally, the areas around the Great Lakes, especially in Southern Ontario and Quebec have been the core regions in Canada, enjoying not only high rates of growth and employment, but also being the recipients of a large influx of population, particularly from the Atlantic Provinces. In recent years, with the emergence of energy as a crucial determinant of economic viability, the oil rich province of Alberta has replaced the eastern provinces as the dynamic growth center, but other areas, especially the Atlantic region lag far behind in terms of levels of economic welfare. These regional disparities are also observed in most other nations, notable among them being the large concentration of industry around London, Paris and in the North-Eastern states and the Great Lakes region of the

U. S. The forces that lead to this concentration are an extension of the ideas of Center and Periphery used by Prebisch in the international context.[7]

Such disparities in industrial growth and income levels are not only unfair from an equity point of view but are also not effiecient. Although the equity arguments have strong non-economic overtones, there are very rational economic reasons for considering them too. When some areas of a nation are lagging behind others in terms of employment rates and income levels, the marginal return to a unit of labour is not being equalised in all uses across all regions. This means that there is a potential for improving overall output by reallocating resources from activities and areas where the rate of return is low to points where the rate is high.

Again, such high rates of growth (that are attained through excessive concentration in some areas) are only sustainable for small periods of time, after which the central or core regions become excessively congested and polluted. Without an appropriate analysis of how to distribute the development effort over the entire land mass of the country, it is not possible to attain any stability in growth rates because the growth points cease to grow. These limits to growth are also complemented by the bottlenecks

imposed by existing transport routes and facilities. Ultimately the rates of return in the core regions become very low, which as shown above is not compatible with efficient resource allocation. It is true that when one core area has has been developed to its maximum potential, economic activity tends to converge on a new pole (Alberta in the Canadian context may be a parallel to Atlanta and other areas in the "Sun Belt" in the U. S.). However, the pattern of growth still reflects concentration in some metropolitan area(s) rather than a balance across space. The same problems of pollution and congestion are likely to slow down the pace of growth in the new pole region before too long, unless there is a better utilisation of all the national space and of existing transport facilities and a development of better ones for the future.

2.2.2 Efficiency Tests of Policies

Regional models are needed to translate the effects of any movements at the national level into values of variables regarding regional income and activity. There are various kinds of (central and local) government actions that have an important regional bearing. In terms of impact and incidence, some policies could be considered as having differential revenue implications while the expenditure aspect of other actions differs across regions. Thus at one

extreme are all those plans and policies whose emphasis is on expenditure in particular regions and not in others. The most obvious of such programs are those directed at some cities - or poor sections therein - by way of direct income aid. As there are bound to be leakages from each region's income stream through imports, taxes and savings, and the extent of these leakages differs from region to region, the total effect of the injection is conditioned by the regional environment. A similar injection into the income streams of two regions will yield different multipliers because the magnitude of withdrawals, especially through imports, is not uniform. At the other extreme are policies whose revenue source is specific regions and not others. Notable among such policies are the various regulatory clauses and requirements imposed to prevent excessive growth and congestion in some areas. While the aim of the policy here is not primarily to tax any investment in the area but to discourage growth and congestion, the policies affect any region by the size of the withdrawal from a particular region's income stream. In between these extremes are policies that outwardly appear to be neutral but whose impact may be highly discrimminatory, and as a result needs to be investigated. As an example, say a 5% investment tax credit is imposed on all areas of a nation. A priori this policy may discrimminate against the urban areas of the nation if business firms realise greater cost savings by locating in the rural areas, even though a

uniform credit is available in all regions. Similarly, as costs of living, wages and transport costs and patterns evolve over time, the pattern of investment is not expected to remain invariant so that while at one time a policy has a certain regional incentive effect, a decade or so later, the same policy may result in quite the opposite regional incentive effect.

From these simple observations it is clear that a variety of policies have very different regional impacts. This is seen to hold true of such seemingly "pure" regional policies as a direct transfer to the residents of a certain region. The main reason why such a partial look is misleading is because of the very open nature of regional systems. As the boundaries of regions can hardly ever be enforced as entry points for merchandise, there is far greater trade across regions than across national frontiers. This can be coupled with the very high interdependence between financial institutions across regions within a single nation. The multiplier effects of an injection for any region are thus seen to be very different from the impact of similar injections into the national economy. It is difficult to construct national models that convey all this information about the regional impact of any plan or policy without making the model excessively large. In addition, most of the information obtained by linking all the regional economies to

a national model is likely to be of little value to individual researchers who are only interested in the implications of changes in the national economy for one particular region. Thus it may be advisable to construct regional models that can transfer the effect of movements in national variables to various regional economies.

An aggregative view of the economy may also not show the true regional picture because not all goods are national. The market for a large fraction of all goods and services produced and consumed indeed is the entire nation. However, for a significant fraction the market is more localised (especially in case of goods and services for which transport costs per unit of sales revenue may become prohibitive beyond a very small market). Demand, supply and prices for such commodities, which may even include unskilled labour, are not determined at the national level. Hence a policy applied uniformally across all regions of a nation may affect some markets in some regions more than others. As a result, it is again essential to take a regional perspective to get a full picture of the impact of the policy. This approach is the cornerstone of the theory behind Courbis' work on the REGINA model of the French economy (Courbis 1972, 1975, 1979). To this can be added the fact that the nation is indeed the sum of its component regions but all regions are not alike. Thus by treating just the nation, and by not differentiating among

regions, one is likely to overlook some very important characteristics of the national economy - e. g. the impact, say, of New York City's financial crisis on the national money markets in the U. S. economy.

In addition to these two reasons as to why national models cannot adequately reflect regional economic conditions, it is noted that values or forecasts of regional variables are of increasing interest by themselves, especially for regional representatives in the central government and for central and local businesses. The fact that regional interests are strongly pitted against each other in most central governments is well known. To enhance any claims for additional funds to their regions, politicians in both local and central governments are relying increasingly on comprehensive and accurate forecasts of the effects of alternative policies on specific regions. Central government policies with regards to location of military bases, taxes, expenditure and international trade appear to have differential effects, impacting on certain areas more significantly than on others. The recent emergence of energy as a focal point of economic issues has made the question of who gains and loses from energy prices and availabilities a significant one. The answer can be crucial in determining the long run competitiveness of any area relative to others. Business firms are likewise affected by the regional impact

of all government actions, since the decision to invest in any area depends on the availability of labour resources, power and service facilities and local demand conditions. All of these decisions are analysed using comprehensive models of regional economies - with a view not only to providing isolated forecasts of regional systems and variables but also to determining the possible consequences of various plans and actions. Whether or not the resulting information increases the efficiency of central government policies depends on how the data is put to use, but a regional perspective is quite clearly needed to gather the information that could be used to make an optimal use of central government resources and funds.

2.3 Available Techniques

In this section various techniques of analysis and choice are surveyed, with special emphasis on regional model building (both of an economy wide and I-O nature). While separate discussion of these techniques may seem to imply that the use of the methods is mutually exclusive, in reality these methods can be used jointly. For example, regional multipliers are derived from the equations of an economy wide or I-O model, Cost Benefit Analysis could be used to make choices between alternative government expenditure patterns as part of any regional model etc. However, the techniques

described either represent a partial equilibrium analysis (Cost Minimisation, Goal Achievement Matrices etc.) or lack optimality criteria that may lead to the selection of the best from among a host of alternatives.

2.3.1 Procedural and Analytical Techniques

This section is devoted to the actual techniques at the disposal of a regional policy maker. The major demarcation line drawn here is between techniques that can be used in making choices between different projects - Procedural or Choice techniques - and those that help analyse the current workings of the economic system - Analytical techniques. In the discussion that follows the first three techniques are Procedural techniques, while the latter three, i.e., Economic Forecasting, Regional Multiplier Analysis and Regional (economy wide and interindustry) Model Building, are classified as Analytical techniques.

(i) Cost Minimisation - Cost Effectiveness: The idea here is to lay more emphasis on the material costs in achieving the same goal as between different projects. The partial nature of the techniques that judge one project superior to another solely on the basis of cost is seen clearly because there is no regard for any indirect benefits the project may be generating. A major improvement in this

direction is seen with the introduction of the Planning, Programming Budgetary System (PPBS) developed mainly to help make choices in public expenditure, by making a more systematic use of current information. Under PPBS there is detailed use of

a) information on current resource use and on how effective current programs are in meeting outlined objectives;

b) information on a detailed definition of the objectives, and of alternative ways of meeting these objectives;

c) a review of plans and programs with every new situation and new evaluations of current plans, including ways to relate the consequences of current decisions to future needs.

In this manner PPBS makes better use of the current level of data availability, and it can be adapted to working with quantitative and qualitative data.

(ii) Goal Achievement Matrices: Also classified under these techniques are various methods labelled as "Checklist of Criteria", in both of these cases the emphasis being on formulating a list of goals that are to be achieved, in a descending order of importance. A weighted average of goals achieved therefore defines the best technique from among

those available. These methods can only incorporate costs of projects as movements away from some goals, but there are ways of allowing for the differential incidence of various plans on various groups in society via the weighting process. The success of this technique depends on a correct choice of weights and an unbiased formulation of the goals to be achieved.

(iii) Cost Benefit Analysis: Since there exist a number of excellent surveys of the literature on Cost Benefit Analysis (CBA),[8] the coverage here will focus only on its value as a tool for regional analysis. By its definition CBA attempts to discount all costs and benefits of a project to the present, and the planner can then recommend the scheme that maximises net benefits. In CBA an allowance is very easily made for non-market costs and benefits and choices can be made among projects with diverse life spans, as well as among cases where many constraints have to be kept in mind. Regional planners can use CBA by incorporating constraints on the projects' operation that are not felt at the national level and can also allow for regional variations in price levels in their choice among projects. Finally, CBA has its maximum utility for projects that have only a limited impact, and such small projects are the ones regional planners will normally be the most interested in. An extension of CBA is the method of a Planning Balance Sheet (PBS) under which the

community can be divided into a set of homogenous groups and then advantages and disadvantages can be measured as the benefits and losses to particular groups. Again the technique of PBS can be adjusted to allow for the effect of non-measurable variables. Clearly when the policy maker has an idea of the magnitude of non-measurables involved, a better choice among alternatives can be made.

(iv) Economic (and other) Forecasting: In the real world economic forecasts range all the way from educated guesses to estimates derived by the use of sophisticated models. Since each forecast depends on a host of assumptions, before making any predictions it may be best to prepare a set of forecasts based on a set of possible values of various parameters. Examples of useful forecasts are those of the present and future levels of population and labour force. In planning for the future levels of demand for housing, education, welfare and other services, population forecasts could provide a very useful outside indicator of what the plan has to accomplish in the future. Although many forecasts are subsumed in model building (and this will be discussed in great detail later on) the technique has a utility all its own at the level of regions because the scale here may not be large enough to justify a full scale model. Forecasts can be made both via questionaires and by simple extrapolation of past trends, and there are advantages and

disadvantages to both. While in one case there is no use of new information that may actually change the trend in the future, in the other one is relying on the validity of the responders' reply to the questions, and there may be quite a few reasons why the latter may not give full or accurate information. The task of forecasting is made no easier by there being substantial margins of error in forecasts, and only a process of continuous monitoring and adjustment will make possible a correct estimate in any case. However, forecasting has a useful role whenever the scale of operation is not too large, because there is a large saving in resources used by not building a full scale model.

(v) Regional Multiplier Analysis: Regional multipliers perform at the level of the region the function a national multiplier performs for the whole economy - to assess the overall consequences of any change in expenditure. For every dollar injected into the income stream there are income effects for all sectors - called the "direct effects" of the injection. But the process of income creation continues as a fraction of this increase is re-injected into the flow of income at each round. The multiplier is the sum of these direct, indirect and "induced income effects" over a large number of rounds. When applied to regional analysis, the analysis reveals some special features of regional systems whereby imports and savings are not the only

expenditure leakages from the income stream (these effects being contained in the value of the multiplier). There are also leakages from the regional economy because even the monetary savings in the banking system flow out to the better developed financial markets of the central cities. A low value for the multiplier will reveal among other things that there are many leakages of income and, thus, that any required level of income change is harder to attain (requires a larger injection) than would be the case with a high value for the multiplier. Due to this feature regional multiplier analysis is biased in favour of the richer regions because these depict larger multipliers and so any degree of national income change will be easier to attain if the already rich region is given a preference. Regional multiplier analysis can again be used in a fashion parallel to the national level because the effects of various policies can be studied. For example, it is possible to know whether or not a monetary stimulus will do more for the regional economy than a fiscal stimulus. Following Richardson[9] it is seen that regional multipliers can be derived both for the conventional income models and for the "export base" model. The latter splits regional income into a service income and a base (or basic) income, where the latter could be represented as the exogenous income component. Regional income then emerges from these models as a multiple of basic income.

(vi) Model Building: Since economic models of regional systems are now far more frequent than they were a decade ago, these are treated in greater detail in the next section and in the appendices to this chapter. The review here is limited to the utility of economic models, both of the economy wide and inter-industry nature, for the analysis of problems specific to regional systems. When a region's economy is modeled along the lines of a national economic model, the regional planners can use the model for all manner of impact analysis, prediction and forecasting and for simulation of performance over a period of time in response to various shocks. Regional models can be used to highlight the special character of a region's economy, to analyse relations and dependencies that are not crucial to the nation or to other regions. These models are broken down on the lines mentioned above, i.e. economy wide and inter-industry models, as well as being broken down into systems for single regions or multi-regional systems. A single region system can be built to analyse the economy of the region in question in great detail, and the peculiarities of the regional economy can be easily spelled out. But this kind of system does not contain sufficient avenues to incorporate the high degree of dependence that a region may have on some other region or on the national system. In building a multi-regional system some of the novelty of the region's structure has to be glossed over due to the need for standardisation of variable

definitions and data values, but the interrelations between various spatial components of the nation are completely spelled out. Both categories of models thus have their own sphere of influence and their own advantages and shortcomings.

2.3.2 Regional Economy Wide and Interindustry Models

As stated earlier, economic model building of regional systems uses both the economy wide approach and the I-O methodology; again there are models of both types for single and multi-regional systems. In the detailed discussion to follow, economy wide exercises shall be discussed first, followed by the interindustry approaches.

(i) Economy Wide Models: These models of regional systems essentially parallel national models, with a set of relations among variables prescribed as behavioural equations or as identities or balance equations. The general equations are similar to those used nationally except for cases where the lack of regional data may force the analyst to use proxy variables. Thus demand for labour may be determined by profit maximising behaviour while labour supply may be derived from the labour-liesure tradeoff. Similarly while consumption spending should ideally be treated as a function of regional income, the lack of data on the latter forces some

researchers to use regional output as a proxy for income. Such regional models can be attached to some already existing national model, which then permits the researcher to trace the impact of any shock in the national economy through the entire system (especially the smaller spatial sub-divisions). The normal approach to linking these regional models to national ones is to make some equations in the former depend upon variables and values taken from the latter as

$$F(y_t, y_{t-1}, \cdot \cdot y_{t-s}, {}_r x_t, {}_n x_t, k_t) = e_t \quad ;$$

where F is a general vector of functions;

y_t is a vector of regional dependent variables at time t ;

${}_r x_t$ is a vector of regional independent variables, time t ;

${}_n x_t$ is a vector of national independent variables, time t ;

k_t is a vector of parameters at time t ;

and e_t is a vector of disturbance terms.

National variables are treated as being given exogenously for the regional system, and the impact of changes in any

national variables is transmitted via the relevant relations to the regional system. This approach to regional model building whereby the national model is the main focus and regional models are built primarily as attachments to it is referred to by Klein and Glickman[10] as "Top-Down" Modelling.

While such Top Down models are very useful for single region studies as they can be built around the particular economic structure of the region, giving special importance to any variables, sectors and relations that are significant for the regional economy, their most obvious weakness is this recursive nature - i.e. their ability to incorporate the dependence of the region on the national economy but not to be able to allow for the reverse channel of dependence. This is taken care of by going "Bottoms Up" - or by starting from a set of regional models and combining these to get to the national economy. The relations used to combine regional models include overall national (balance) equations which define the nation as the sum of its component regions, trade balance equations that dictate that the net regional trade surplus or deficit over all regions be zero, etc. The national value of any variable now emerges as the sum or average of regional magnitudes. In many ways Bottoms Up removes the shortcomings of Top Down models, mainly by way of removing the recursive element of the latter and by providing an avenue for analysing spatial frictions. But the

problems with such models are quite a few, ranging from the data problems of estimating inter- and intraregional trade to consistency problems that may emerge when the total of regional values of a variable does not add up to the known national total. Again some of the charm of regional analysis is lost in the need for a standardised definition of sectors and variables because now the model cannot be built to adequately reflect the peculiarities of each region's economy.

Whether it be for a single region or for a set of regions, in these models the regional economy will be divided into a number of blocks, each block related to one sub-system of the economy. Thus there may be a set of equations defining the input mix of (one or more) production sectors, a set of factor demand and supply equations, some equations depicting how wages, prices and income are determined, and how each category of spending (the sum of which is regional aggregate demand) is related to other variables in the system. These can be complemented by equations for the foreign and inter-regional trade sectors, some equations regarding the regions' demographic make up, and some relationships for the financial side of the economy. There may be equations about relations peculiar to this economy in one particular block, or such regional oddities may be contained in equations within one or more of the regular blocks. It is to be

expected that equations within one block will be a lot more simultaneous than are relationships between blocks. In fact each block will contain only one or two variables that are connected by any relationships to variables in other blocks, e.g. factor input ratios may be the only link between the output and the factor demand-supply blocks.

(ii) Single Region Input-Output Models: In terms of the time and the quantity of resources spent in developing and refining its theoretical structure, as well as in terms of empirical analysis, the most important tool of regional analysis is the I-O table. The literature on regional models contains numerous studies where this table has been used either in isolation for the analysis of the region's production structure, or in conjunction with other equations for a full description of the region's economy. This very great devotion of effort to I-O analysis may be seen by some with surprise given the rather pessimistic views expressed by Tiebout[11] about these models and their usefulness for regional analysis about two decades back. While it is true to say that Prof. Tiebout's comments were directed more towards the actual I-O models in use at the time than towards I-O analysis of regional systems in general, and that those old models are only distant relatives of the versions now in vogue, the number of current day studies placing an almost exclusive reliance on this table is still surprising. When

I-O tables are used for regional analysis, the first order of business is to get the table itself, i.e. to obtain a set of I-O coefficients that can reflect the interindustry purchases of the region. The most common approximation in this regard stems from assuming that the production structure of each sector is uniform across the nation, so that the set of coefficients used at the national level also correctly depict the interindustry structure of the region. This approximation does not, however, do away with the fact that a region's coefficients may be affected by the scale of operation of the industry or sector in the region,[12] and also may differ from national values because of variations in regional product mix. These factors are the more important ones among many that lead Tiebout to conclude[13] that this uniformity of I-O coefficients is not expected to be borne out in real life. Similarly, Tiebout was concerned about the fact that as regional economies grow, input coefficients may change quite rapidly, the actual magnitude of the change being known only when an estimate is available of the rate of diffusion and adoption of new technology. These problems associated with the use of proxy values to represent regional I-O coefficients are almost over because current day researchers frequently have access to one or more tables for most regions of western countries, Japan and some underdeveloped nations that are built up from primary survey data and thus serve as adequate proxies for the production structure of the region.

(iii) Multi-Region Input-Output Models: The fact that regional economies are often treated as small open economies was mentioned earlier. In reality this degree of openness of most regional economies is so great that even the amount of trade in intermediate inputs is substantial enough to warrant separate consideration, and should not be subsumed under imports for final use. A MRIO table is an attempt at disaggregating input supply and demand across space, and thus it shows a full listing of all possible sources and destinations of production and trade flows in a nation. Hence if a typical element of a standard I-O table is X_{ij} showing the amount of sector i's output used by sector j as an input, the typical element of a MRIO table is ${}_{rk}X_{ij}$ representing the amount of sector i's output produced in region r shipped to and used as an intermediate input by sector j in region k. As is clear now not only are technical conditions depicted by the value ${}_{rk}X_{ij}$ (or the coefficient given by ${}_{rk}a_{ij} = {}_{rk}X_{ij}/{}_{k}X_{j}$) but the numbers also show the fraction of each commodity demanded that is purchased from each region. This coefficient is thus derived from two rather diverse forces - i.e. the technical production side, and the trade structure, the latter incorporating spatial frictions in the form of transport costs and available transport routes and the like. Not only is it unreasonable to represent these diverse factors by a single term, but also when a change is observed

in the magnitude of the overall coefficient it is not sure whether the change was due to changes in technical relations or to a change in the trade pattern between the relevant regions. It may thus be advisable to split up this coefficient into two components that jointly convey all the above information but individually refer to only one of these facets. Thus the coefficient $_{rk}a_{ij}$ could be said to be a product of a number expressing each sector's demand for each other sector's output for use as an input regardless of the region of origin (the technical coefficient) and a second number that splits up this demand into demands from various regions including the home region (the trade coefficient). The sum of these trade coefficients over all supplying regions and sectors should be unity to fully exhaust the sources of supply of intermediate inputs to this sector.Thus

$$rk^{a}ij = rk^{t}ij \cdot r^{a}ij$$

In this form the assumption of constant overall coefficients boils down to assuming unchanged trading patterns because the second assumption - viz. constant technical coefficients - is taken for granted at the national level. There are many reasons to be wary of this assumption of unchanged trading patterns; the latter are expected to change with the ongoing process of improvements in transport routes, changes in fares and freight rates and other trade facilities. Finally there

is hardly any nation whose data collection techniques are advanced enough to tabulate the sources and destinations of all trade flows geographically, and so this ideal trade coefficient is not easy to derive. Most often, some assumptions are made to derive workable equivalents for these trade coefficients from regularly tabulated data, and these approximations are discussed in Appendix III.

2.4 The Methodologies Conventionally Used

This study distinguishes between the methodologies that require no Optimality criteria and those that do. In the analysis of regional systems, the significant economic relations and interdependencies can be represented by a system of equations. Depending upon the degree of detail that regional data is available in, the best description of the economy may involve an aggregated (economy wide) or a disaggregated (I-O) specification. Econometric estimates of parameter values can be derived if time series data is available; if not, a one period survey can be undertaken to derive parameter (I-O coefficient) values. Once it is known how integrated the full model is, any one of a multitude of full model is, any one of a multitude of methods can be used to estimate the parameters of a simultaneous system of equations (Two and Three Stage Least Squares, Instrumental Variables etc.). If the system is Recursive (or

Block-Recursive) the estimation problem is made correspondingly simpler. Once an estimate is available of all parameters, it is possible to simulate the performance of the economy using the model over time. Values of exogenous variables and parameters at time t are used to get estimates of the endogenous variables at time t. These are then treated as given exogenously for time period t+1, and with values of parameters and the purely exogenous variables can be used to get estimates of the endogenous variables at time t+1. In this manner the system can be run for a number of years to generate "simulated" values of variables. When these are compared to the actual values of those variables over time, an idea can be obtained of the model's ability to replicate the real world.

Furthermore, the time path of one or more exogenously given variable can be altered to investigate the response of the system to these changes. The values of one or more parameters can also be changed and the experiments repeated, to see how sensitive the results are to these estimated parameter values. Models by Glickman, Crow and others (see Glickman 1977, Crow 1973) are some of the examples of these econometrically estimated models. In varying degrees of detail, these models are able to duplicate the past performance of the economy and to provide projections for the future. However, this leads to one of the limitations of

these models. Once a policy controlled variable or parameter is altered, the model provides estimates of all variables "in response to" these changes. While the forces that motivate the change are clearly observed, the economy described by the model is not moving "towards" any goal or objective. Thus, for example, if a high rate of growth is built into the equations, the model will yield high rates of growth; but if stagnation is built into the model, the results obtained from any simulation will show the impact of any changes dying out over a long enough period of time and the economy settling to its secular path. This lack of direction stems from the fact that the model is not designed to achieve any objective or target, but only to simulate possible courses of action. While it is true that the information obtained from various simulations can be of immense value, it is felt here that the ultimate aim of economic activity is to find the best uses of scarce resources. This idea of "an optimum" will be discussed in some detail below.

Another factor that can hinder the development and use of regional models of an econometric nature is the lack of data over a significant time period. While estimates for any particular set of variables for one or two years can be always obtained through surveys over the region concerned, long enough time series may not be easy to obtain. Unless the data collection apparatus is adequate, the best estimates

that could be derived for many a region in most nations would have to be based on a very short time series - a factor that results in fairly low degrees of freedom.

Some of these limitations of the estimation technique can be removed by using a Linear Programming (LP) formulation.[14] In LP, the economic relations are again defined by a system of equations, but these are now used as constraints within which an Objective Function (OF) is maximised. It is true that the choice of any OF represents the policy maker's value judgement about what it is worthwhile to maximise, a fairly objective choice can be made by using national income, output or employment as the OF. Now when the LP optimistion is performed, the performance of the economy is not duplicated, but rather the economy is moulded in the direction of (the variables in) the OF. Hence if the OF can be seen as what is desireable, a LP exercise yields a combination of activities that make the best use of available resources - maximise the OF. The impact of various changes in variables or parameters (policy impacts) can be seen by repeating the optimisation with these changes in the constraints and noting the movements in the OF and the reallocations of activities this entails. Thus by providing a direction to move the economy towards, LP removes one of the limitations of purely econometric estimates. The economy is now no longer just moving along (almost by inertia), but is

being propelled in a given direction.

Similarly, in the case of limited time series observations, an econometric model cannot provide too many guidelines about how the economy will react in the future. Estimates of parameters based on limited (or even negative) degrees of freedom cannot really be used for simulations or projections. However, with a LP at least some idea can be obtained of the future trends of variables from various shadow prices. As these shadow prices represent the effect on the OF of an additional unit of any activity, they can be taken to show the direction the system will take in the future. Activities with higher shadow prices than others will be preferred when a larger amount of resources is available (in the future). Thus a LP framework can at times be used to derive estimates of possible courses of action that are better indicators of the future than can be obtained by simple econometric estimation. However, it shoud be cautioned that the LP framework is not without its own shortcomings, not the least of which is related to providing an economic rationale and interpretation for the mathematical manipulations that are made as part of the optimisation. A somewhat detailed discussion of the limitations of LP is presented in Chapter 7 (Section 7.2 below), but it may be useful to mention here that many additional assumptions and refinements in the overall data and computational base are

needed before the results derived below can be used for any actual policy predictions.

The discussion here has tended to segregate models in which parameters are estimated from models using an optimisation (LP) framework. In reality the parameters used in say a LP study can be those obtained by econometric estimation. Similarly, while the actual use ofoptimisation models for simulation is rare, this does not mean that these models cannot be so used. In terms of actual application and estimation, though, it is seen that econometric techniques are used to estimate parameters and simulate performance whenever time series data is available, while LP optimisation is used whenever this is not the case.

2.5 Regional Models: A Brief Review

In this section some actual applications of regional models are discussed. The need to be brief prevents a discussion of some very significant theoretical works in this field, and also precludes a discussion of some very relevant potential uses of regional models. In general, the coverage is only of models that concentrate on the commodity demand-supply nexus, with only passing mention of the studies dealing with special applications. Various exercises involving econometric models are discussed first, with

applications of optimising models being analysed later.

2.5.1 Forecasting and Impact Analysis Using Regional Econometric Models

As discussed above, regional models are used to simulate the past performance of the economy, or to derive forecasts for the future based on plausible values of exogenous variables and estimated values of all parameters. The more sophisticated regional models are able to capture all the major swings in economic activity in their relevant regions, as evidenced by the results quoted in Glickman's study of the Philadelphia region (Glickman 1977) or Crow's study of the North-Eastern states (Crow 1973). The margin of forecast error between the actual values and simulated figures is small, even though the simulated results do extend the peak and trough periods into the following year or two because of the distributed lag nature of the investment function used in these studies. Similarly, Crow notes that the simulated values miss some sharp turning points (representing, for example, years in which there is a sudden change in the level of economic activity). As these sharp turns are normally caused by special events, a bad harvest in a particular year causing a sudden drop in agricultural output for instance, the impact of these special events can be accounted for by the use of dummy variables.

The use of I-O models for forecasting includes the early works of Moses and Tiebout (Moses 1955, Tiebout 1968) and Zuker's work on the multi-regional model for the Canadian economy (Zuker 1977). Because of the degree of detail contained in the I-O table, such models can provide possible courses of action for the smaller sectoral subdivisions too, thus helping bring out the leading sectors of the region's economy as opposed to sectors that do not have too much growth potential. Again, while the models can simultaneously duplicate past performance, their ability to forecast the future is conditioned by the assumed constancy of input and/or trade coefficients.[15]

In general, much more attention has been paid to the use of regional models for impact analysis - whether it be for the effects of a reduction in overall government spending (military spending, say) or of expenditures in any one region, or for investigating the effect of changes in energy prices and rates or of transport routes and rates.[16] Again Glickman's study can be quoted as an example (Glickman 1977) - the author conducts numerous experiments ranging from a simulated cut in arms spending to changes in government transfer payments to persons, and changes in oil prices and supplies, noting the effects of each change on the economy of the region. The MRIO model by Polenske (Polenske 1970a, 1972)

has been used extensively to investigate the consequences of changes in commodity freight rates and shipments. Due to the very comprehensiveness of the I-O data in this study, the model is able to capture all the first and latter round multiplier effects of such changes. In general it is observed that aggregated models such as Glickman's can only capture the first round multiplier effect of a change (say a reduction) in exogenous spending. As a MRIO model allows for the reverse effects also, a cut in spending in one region, by depressing the economy of this region also reduces imports from other regions, and as a result those regions import a smaller amount from the first region. In total there are thus far larger leakages from the income stream than the original reduction in spending and so the multiplier effect of any change is smaller than is suggested by (single region) aggregative models.[17]

2.5.2 Programming Models and Regional Economies

The use of LP models for long run simulation and forecasting is fairly rare, due primarily to the fact that a dynamic LP system requires large amounts of computer memory space. Just adding on a time dimension to the sectoral disaggregation seen in an I-O table increases the computational burden quite substantially; with an added regional dimension the size of the problem increases

geometrically and can become extremely large for even the most elementary of models. Some simple applications of LP to regional economies include Golladay and Sandoval (1972), Ochs (1969), Paelinck and Nijikamp (1975), Rahman (1963), Scott (1971) and Mennes, Tinbergen and Waardenburg (MNT 1969) among others. Rahman's model is a dynamic programming model used to determine the optimal allocation of investments between two regions that differ in savings ratios and in capital/output ratios (a similar investigation using different techniques is also discussed by Paelinck and Nijikamp). However, the results derived (that a maximal rate of growth is attained by investing in the region with the higher savings ratios) are dependent on the assumed capital coefficients and the assumption that these ratios remain constant over time. Although MTW do not provide an empirical test of their theoretical model, the overall structure most closely resembles that of the REGINA model for the French economy (Courbis op. cit.) because these authors also distinguish between various categories of goods. Thus, while maximising income or output, the model accounts for the presence of local, national and international goods, and simultaneously minimises total transport costs. The aim of the model is to derive an optimal location structure for all investments, resulting possibly in a dispersed pattern for local goods and concentrated development of manufacturing industry for national and international goods. A series of impact effects

for a regional economy are derived by Golladay and Sandoval, ranging from the effects of changes in government spending to variations in the export demand for the product the region is a significant producer of. The results derived in such optimisation exercises should be interpreted not just as the response of the regional economy to the externally generated shocks but as the optimal regional adjustments to the implied changes.[18]

The LP formulation is used in this thesis in preference to an econometric estimation for the following reasons. There is only now an adequate data base for econometric estimation of the parameters of regional economic systems in Canada. Even the series available are for consumption, income, investment and other aggregates. As the sectoral distribution of activity varies so widely across regions in Canada going from an almost exclusive reliance on agriculture and mining in the Prairie regions to a huge dependence on manufacturing in Ontario and Quebec, a somewhat detailed sectoral study was felt to be necessary. Data on capital stock and labour force per sector per region was again not available for any length of time and had to be derived. The MRIO table (Zuker 1976) was available for only one period, and thus econometric estimates were not feasible.

Again the issues to be tackled in this thesis include

the issue of equity versus economic efficiency, the question of moving jobs to people versus people to the jobs, and the ideas related to moving physical investment across regions as opposed to moving only financial capital via transfers to the relevant regions. In each of these questions it was felt that an optimality framework was essential. For example, only via optimisation is it possible to determine whether a certain per capita income can best be attained across all regions by moving industry or by migration of factors (what Richardson calls "People" prosperity as opposed to "Place" prosperity - Richardson 1978 p189-192). When say national income is maximised subject to mobile factors and a fairly flexible upper bound on sectoral output, the results show which action or combination of actions (moving jobs - sectoral growth, or moving people - migration) maximises income. Similarly if a certain magnitude of income growth in the poorer regions of the nation can be better accomplished by providing financial transfers as opposed to physical investment, then the best strategy to follow would not involve any industrial reallocation. If this were the case, the optimisation solution would feature a binding financial constraint with a high shadow price. For these reasons the model that is used in this study is a one period LP optimisation in which national income (the sum of regional income) is maximised subject to various constraints derived from various relations in the system.

2.6 A Summing Up

This chapter is devoted to a detailed survey of the literature on regional models and issues in regional policy making, going from a discussion of what regional issues are important in economics to how they are and can be tackled. A fairly brief survey of some regional models is complemented by the format that this thesis uses (the model being described in detail in Chapter 4 below). The debate focuses on various techniques at the disposal of regional policy makers, and also touches on how these tools of analysis can be used to answer relevant policy questions.

It is to be noted that the model used in this study is an extension of traditional work on regional analysis in two main directions. First, the exercise here uses a LP framework that adds a dimension of "optimality" to the results. The results can thus be looked at as being the best available within a set of bounds on the regional economy defined by resource availabilities and trade opportunities etc. Second, the model discussed and used below allows for a wider variety of constraints and equations describing the economic system of the nation and each region than is seen in most of the earlier works. The most important of these new equations refers to the financial structure of each region

and the financial links between various regions.

The extent of the regional problem in Canada is surveyed in the next chapter. It is noted that the poorer regions of the country depict low levels of income, low employment levels and a lack of most services that may be thought of as being essential for life. Similarly, the growth rates of income in these regions (as depicted by the rates of investment per capita) are well below the Canadian average. Various policies pursued by the various levels of government are also mentioned, with the discussion also attempting an evaluation of these poilicy measures. It is found that these traditional policy prescriptions have a lot of room for improvement. The model and some applications of it are discussed in the following three chaptes. Most of the results discussed compare versions where the economy is free to maximise income (or consumption) with versions in which this optimisation is to be performed while simultaneously equating the level of per capita incomes in all provinces. The various experiments cover a host of assumptions about factor mobility across sectors and across regions, and also are designed to investigate the impact of various specifications of the trade balance constraint on regional income levels.

The final chapter is devoted to a discussion of the various limitations of the study, going from limitations of

the model and the optimisation framework used to some shortcomings of the data values derived here. The major limitation is seen to be the assumption of a steady state equilibrium, an assumption that considerably simplifies the form of one of the crucial equations, but the results can now only be seen as showing the picture before and after all adjustments have been made, not showing the process of adjustment in between.

Footnotes.
(to Chapter 2.)

1. Apart from bein first discussed by Klien, L. R. in "The Specification of Regional Econometric Models," Regional Science Association Papers and Proceedings, Vol. 27, No. 2, 1969, this idea lies behind the articles by Adams and Glickman, Lyall and Crow in Adams, F. G. and N. J. Glickman ed. Modelling the Multiregional Economic System, Lexington Books, D.C. Heath and Co., Lexington, Mass., 1980. (Chapters i, 2, 3, of the book).

2. Aside from the works of Hirschman and Myrdal on the transmission of growth impulses, these issues are discussed in Chap. 5 of the US Dept. of Commerce publication (1955) and the UNIDO Seminar (1968) esp. the article by C. Michalopoulos, "Interindustry relations, external economies and regional economic expansion".

3. Although the original ideas of Growth Poles and Centers are in the works of Perroux (1961, 1964) and Boudeville (1968) the literature is now considerable expanded. Among the various ways to define a Growth Pole, one is quoted from Hansen "Criteria for a Growth Center Policy", p102-116 of Kuklinski 1972.

> "A growth pole is an urban center of economic activity which can achieve self sustaining growth to the point that growth is diffused outward into the pole region and eventually beyond into the less developed regions of the nation".

4. See Myrdal and Hirschman op. cit.

5. e.g. Morgan and Alden (1974) p59-61 show some figures on the extreme localisation of industry in the Great Lakes region and on the Eastern Seaboard in case of America and Canada, and elsewhere quote similar data for other nations.

6. See Friedman (1966) especially p67-98.

7. The work of Prebisch is a landmark in the theoretical literature that attempts to show how external trade has not been the "engine of growth" it was once touted to be for the poorer nations, but has in fact been responsible for the creation of a world center (Europe, North America and Japan) and a periphery (mainly South and East Asia, Africa and Latin America) with the latter continually facing deteriorating terms of trade. While in the

international context this means mainly the accruing of all the (material) gains from trade to the center, in case of regions inside a nation it also results in a migration of most of the younger, energetic and skilled population from the periphery to the core (the quick growing and dynamic center).

8. The list of articles and books on the subject ranges from the early work of Prest and Turvey (1965) to the OECD Manual - Little and Mirrlees (1974) - to some more traditional works, e.g. Mishan, E.J. Cost Benefit Analysis, Allen and Unwin, 1971. In terms of case studies while an equally exhaustive list can be drawn up, perhaps the most comprehensive is that of the Roskill Commission on the Third London Airport - Thompson (1970) - also analysed in detail in a special issue of the Journal of the Regional Studies Association, Vol 5, No. 3, 1971.

9. See Richardson (1978) p84-92 for a simple derivation of export base multipliers and how these parallel the conventional income multipliers derived from the Keynesian expenditure equations.

10. In separate and in joint papers, Klein and Glickman have spelled out the basic features, essential requirements and the advantages of single region economy wide models. For these theoretical firsts in the field see Klein "The specification of regional econometric models", Vol. 23, No. 2, 1969 and Glickman "Son of 'The specification of regional econometric models'" Vol. 32, p155-77, 1974, both published in Regional Science Association Papers and Proceedings, in addition to Klein and Glickman (1977) where these terms are first used.

11. See Tiebout (1957).

12. Variations in the I-O coefficients can be caused by variations in scale of operation in the following ways:

    i) A region using a commodity as an input may import it when demand is small enough not to justify setting up a production factility, but at a higher scale of operation another region may be locally producing the commodity; I-O coefficients for these two regions will differ widely merely because of scale differences;

    ii) A region producing mainly raw materials may end up exporting most of its output if the scale of operation is small, but at a higher level of operation the region may end up processing a lot more of its production and export

semi-finished or finished goods;

iii) At or around the threshold size of a new plant a region with smaller scales of operation will be using techniques geared to small markets while a region with a larger market may use more mechanised and large scale production methods, thereby causing I-O coefficients to change.

These factors are brought out in a good survey of the literature by Miernyk (1972).

13. The doubts about the use of these coefficients for regional analysis are brought out in the following words from Tiebout (1957)

> "Regional coefficients have still another serious pitfall. They not only specify the amount of needed input per unit of output, but they also specify the regional source ... trade patterns are assumed to be stable ... there is no logical reason to expect trading patterns to exhibit stability .. " p144.

14. Although the term "Linear Programming" is used in what follows, it should be taken as a proxy for all models that incorporate an optimality framework.

15. Some other works that can be referred to include Carter and Ireri (1970), Riefler and Tiebout (1970), all of which are based on the assumption of constant ratios of inputs to output. Although now I-O coefficients are available on a yearly basis for Canada, the same kind of detail is not available for any (set of) regions. See also the articles by Milne, Adams and Glickman, Ballard, Glickman and Gustley, Dresch, and Harris and Nadji - Chapters 11, 12, 13, 14 of Adams and Glickman op. cit. for some other applications of economiy wide and I-O models of regional systems.

16. These shocks (like the exogenous change in military spending) may not be directed primarily at the region. However, their effects filter down in varying degrees to all regions, and regional models can account for the effects of these actions on the regional economy.

17. This feature whereby MRIO models are able to capture not only the entire feedback effect, but also are seen to stress the most significant linkage between regions (interregional trade) is the reason why such models are the most commonly used in regional analysis.

18. See Ochs, J. "An Application of Linear Programming to Urban Spatial Organisation" Journal of Regional Science, No. 9, p451-59, 1969; O'Sullivan, P. "Linear Programming as a Forecasting Device for Interregional Freight Flows in Great Britain" Regional and Urban Economics, Vol. 1, p383-96, 1972; Paelinck, J. H. and P. Nijikamp, Operational Theory and Method in Regional Economics, Farnborough, Saxon House, 1975; Rahman, M. A. "Regional Allocation of Investment," Quarterly Journal of Economics, No. 77, p26-39, 1963, among others.

Appendices to Chapter 2.

APPENDIX I: Some Issues in Regional I-O Analysis.

In this appendix some caveats to the above text are discussed, to help bring out the diverse nature and manifold emphasis currently seen in regional economics. To begin with it is noted that the main tool for regional analysis is the input-output table. This predominance of I-O studies is in some ways a direct reflection of the nature of regional economies. As seen earlier, these are essentially treated as small open economies, the extent of "openness" though being such that the boundaries of regions can never be enforced as strictly as can national frontiers. To the extent that financial intermediaries too depict a branch structure inside a nation (i.e. a single organisation has branch offices in all regions rather than each region having its own financial organisations) the financial assets of a region will also normally flow to the better developed financial markets in the country. The monetary sector of the region's economy is thus not isolated from outside effects, just as the commodity sector cannot be isolated from external trade effects. While there are some avenues for differential local government action, federal governments cannot be discrimminatory between regions. Hence a policy maker loses most of the policy tools (tariff and exchange rate barriers being impossible to impose intranationally and fiscal and monetary policies not being fully operational) that are indispensable to the conduct of a

growth or stabilisation strategy. Hence about the only avenue by which planners and policy makers can hope to manipulate the economic structure of a region is via the production structure. Here the I-O model with its emphasis on and detailed analysis of the production system of the economy becomes a very useful tool for regional analysis. There are, however, studies (Fishkind 1977) relating to the differential impact of, e.g., monetary policy across regions and so it would be wrong to conclude that the production structure is the only avenue, though it is the most obvious and by far most successful, by which regional economies can be directed.

Second, there seems to be a strict segregation between I-O and economy wide models; in reality this segregation holds more for single region studies than for multi-region cases. In most single region exercises (e.g. Adams, Brookings and Glickman 1975, Crow 1973, Glickman 1977, Lee, Moore and Lewis 1973, Moore and Patterson 1955, and Tiebout 1969 among others) the size of the project is limited - although the Glickman model comprises of over 200 equations - and the emphasis is limited to analysing some impacts of externally imposed changes and simulation work. However, when the project is undertaken at a multi-region level, it normally involves some support from the national planning apparatus, or of some other government agency, and then the main aim is to comprehensively model the national economy.

With this in mind the exercise often takes on a scale where it becomes feasible to conduct exhaustive surveys on trade flows, movements of factors, balance of trade conditions and the like. Thus the model will normally encompass not just the production structure via the I-O table but also all or most of the other constraints and relationships seen as relevant to the economy. As an example there is a large increase in cost in going from a single region system (for which trade flows can be taken as exogenously given) to a multi-region system (for which trade flows are surely endogenous influences), and it does not cost too much more to incorporate other economic relations in the model. Examples fo such combinations of I-O and economy wide models can be quoted from the series of papers by Courbis for the French economy (Courbis 1972, 1975, 1979) to Funck and Rembold's German economy model (1975). The series of papers by Morrison (Morrison 1973) also combine I-O and economy wide relations for the economy of the region. In most of these large models the I-O structure is needed to derive the supplies of output it is necessary to produce to satisfy a given level of final demand, given the intermediate requirements. Factor constraints and overall trade balance equations help determine national output and its allocation across regions, from which regional incomes and employment rates can be derived. The model by van Duijn (1972) is a very simple and well explained illustration of the workings of a multi-region

economy using a set of plausible parameters to trace the impact of a number of exogenous changes.

APPENDIX II: The Construction of a MRIO Table.

Multi Regional Input-output (MRIO) is a technique by which interindustry and interregional linkages can be identified, essentially by a disaggregation of the standard Leontief system derived for a national economy (Leontief 1951). A MRIO table is a full representation of available data on production and trade, but its utility goes beyond that as the technical coefficients matrix can be used for studies of a linear programming nature (as is attempted in the model described below), while the inverse matrix can be used in all manner of impact analysis and to study regional growth paths. The fact that a MRIO table allows for more than just a first round income injection due to trade means that the overall income multiplier, due to exports for instance, is expected to be higher in case this detailed table is used than may be the case with a single region table. This question of differential multipliers has been investigated theoretically and empirically by Garnick (1970), Greytak (1970), Hartwick (1971) and Miller (1966, 1969) among others, and while no conclusive statement can be made, the general picture that emerges is one of an underrepresentation of the value of the multiplier by single region tables. In some instances the magnitude of this underestimate is almost negligible but in others it may be substantial.

Following the discussion of the text (Section 2.6 above) the construction of a MRIO table is divided into 3 parts. The first element of data needed for the table concerns the interindustry structure of each region's economy, i.e. the matrix of coefficients depicting the supply of a sector's output for intermediate use in all sectors along a row and the use by any sector of output from all others along a column. The second data element needed are the columns and rows depicting respectively the use of each sector's output for final demand and the use by each sector of primary factor inputs. As of the moment these two matrices depicting the demand side of a regional economy need not be distinguished by region of origin of the relevant product.

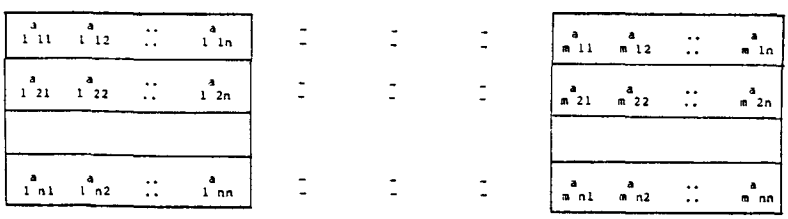
For a system of m regions, n sectors and p categories of final demand and primary inputs, there will be m matrices of order (n x n) in the first set and 2m matrices of order (n x p) and (p x n) in the second set. These matrices are then arrayed in blocks of the appropriate dimension along the major diagonal of a larger matrix as shown in the diagrams in Figure 2. Here Fig. 2a and 2b represent the alternative ways of treating final demand values. If the trade pattern is invariant between intermediate and final imports, the final demand vectors are to be multiplied by the same trade coefficients as the intermediate use values, and so the final

demand columns can be listed alongside each region's interindustry coefficients (Fig. 2a). But if the trade pattern is not constant between these two categories of uses, only the I-O coefficients should be arrayed along the major diagonal, the final demand values being placed separately in a set of columns, the order of this matrix now being (mn x p), as shown in Fig. 2b.

The third, and in many ways the most crucial data matrix is that of trade coefficients, the values of which split up each sector's demand for each intermediate input by region of origin. The sum of trade coefficients over all supplying regions is unity. In case of the general Isard formulation (see Appendix III below) this matrix is dense everywhere, but in case of the Chenery-Moses model this (mn x mn) matrix is composed of m^2 matrices of order (n x n) each of which has non-zero elements on the diagonal and zeros elsewhere, shown respecitvely in Fig. 3a and 3b. The product of these two matrices yields the MRIO table as

$$\underline{A} = T'.A = ({}_{rk}t_{ij})({}_{k}a_{ij}) = ({}_{rk}a_{ij})$$

Figure 1. Regional Input-Output Tables.



REGION 1. REGION M.

Figure 2. Regional Interindustry and Final Demand Coefficients.

Figure 2a.

Input-Output Coeffts Reg. 1	Final Demand Region 1.	o o ..		o o	-	-
o o	o o	Input-Output Coeffts Reg. 2	Final Demand Region 2.	o o	-	-
o o			o o	Input-Output Coeffts Reg. m	Final Demand Region m.	-	-
o o			o o			-	-
o o			o o			-	-
o o			o o			-	-

Figure 2b.

Input-Output Coeffts Reg. 1	o o o		o o o	Final Demand Region 1.
	Input-Output Coeffts Reg. 2	o o	o o	Final Demand Region 2.
o o	o o		Input-Output Coeffts Reg. m	Final Demand Region m.
o o	o o			
o o	o o			

Figure 3. Trade Coefficient Matrices.

Figure 3a.

Isard Coefficients.

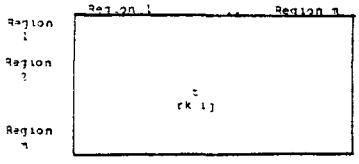
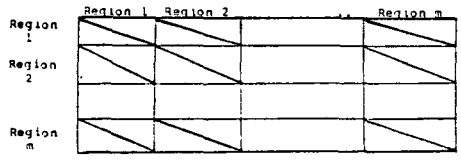


Figure 3b.

Chenery-Moses Coefficients.



There are three basic versions of the trade coefficient model and since two of these are derived from specifications of the I-O table, these are discussed here. The section relies mainly on notation used by Polenske (1971a). Apart from the other symbols defined below the term "d" is used to mean "a change in" rather than its more conventional meaning - of a derivative. In all that follows, m is the number of regions, n of commodity sectors.

dX = (mn x 1) column vector of the change in output of each sector in each region;

dY = (mn x 1) column vector of changes in final demand for sector i in region r regardless of where the output is produced;

A = a block diagonal matrix (mn x mn) of m square matrices each (n x n) of I-O coefficients along the diagonal, describing each region's input structure;

T,S = (mn x mn) block matrices of (n x n) square matrices the element $_{rk}t_i$ relating outflow of sector i from region r to total production in r and the element $_{rk}s_i$ relating inflow of i to production of i in region k;

D = a (mn x mn) matrix of elements $_{rk}d_i$ relating the

fraction of i exported from r to k per unit output of i in r. Thus the sum of $_{rk}d_i$ over all receiving regions yields (Total destinations/Total output) and hence equals unity.

C = a (mn x mn) matrix of $_{rk}c_i$ relating to the fraction of i imported into k from r. The sum of these coefficients over all supplying regions must be unity.

Also let

$_{ro}X_i$ = total output of commodity i in region r;

$_{oo}X_i$ = total national output of commodity i;

$_{ok}X_i$ = total demand for commodity i in region k (final plus intermediate);

$_{rk}q_i$ = a trade parameter incorporating distance, transport costs and other spatial frictions in transporting goods from region r to k.

Then

Table 2.1 Summary Comparisons of MRIO Models.

MODEL.	TRADE COEFFICIENT EQUATION.	EQUATION SYSTEM IN MATHEMATICAL FORM.
GRAVITY MODEL	$rk^{X_i} = \frac{ro^{X_i} \cdot ok^{X_i}}{oo^{X_i}} rk^{q_i}$	$T'dX = S[AdX + dY]$ $[T' - SA]dX = SdY$ $dX = [T'-SA]^{-1}SdY$
ROW COEFFTS.	$rk^{X_i} = rk^{\underline{r_i}} \cdot ro^{X_i}$	$R'dX = AdX + dY$ $[R' - A]dX = dY$ $dX = [R'-A]^{-1}dY$
COLUMN COEFFTS.	$rk^{X_i} = rk^{\underline{c_i}} \cdot ok^{X_i}$	$dX = C[AdX + dY]$ $[I - CA]dX = CdY$ $dX = [I-CA]^{-1}CdY$

APPENDIX III: Calculation of Interregional Trade Coefficients.

The fact that trade coefficients are used to separate demand for input by region of origin has been mentioned both in the text and in the last appendix. Ideally this coefficient embodies all the data on trade flows between sectors and regions, i.e. it shows the region of origin and destination as well as the sector using and supplying the commodity. If this coefficient could be calculated in this degree of detail, the magnitude $_{rk}t_{ij}$ would be referred to as the "Ideal Coefficient" as the value first discussed by Isard (1951) has been labelled. The fact that the cost of a full scale survey in which all the data required to calculate this coefficient would be prohibitive has compelled some authors to derive workable equivalents from data that is regularly published, and these are classified as the Leontief-Strout, Leontief-Moses and the Chenery-Moses approximations with the reformulation by Riefler and Tiebout being considered a special case of the Chenery-Moses coefficient. These cases are discussed here in turn.

The Leontief-Strout idea (Leontief and Strout 1963) is to approximate the interregional flow of any commodity by

$$ {}_{rk}t_{ij} = \frac{{}_{rk}X_i \cdot {}_{k}U_i}{X_i} \cdot \frac{{}_{rk}Q_i}{{}_{k}X_j} $$

where

X_i = the output of sector i in the nation;

${}_{r}X_i$ = the output of sector i in region r;

${}_{rk}X_i$ = the amount of sector i's output shipped from region r to k ;

${}_{k}U_i$ = total use of sector i's output in region k;

and ${}_{rk}Q_i$ is a location coefficient incorporating factors like transport costs and the locations of regions r,k relative to each other and relative to other users and suppliers of sector i's output.

Thus trade flows are influenced by demand in the using region, by supply (production) in the exporting region and by the locational advantage any one of them may have. If both regions are not too much at a locational disadvantage relative to each other (i.e. if none of the above demands, supplies or locational values for each region is zero) then this coefficient allows for cross hauling of the same

commodity between each set of two regions. This (cross hauling) and the fact that no new data on actual trade flows needs to be estimated are the two major advantages of this coefficient.

The second approximation to the trade coefficient stems from a reformulation of Leontief's system by Moses (Moses 1952, Leontief 1951) and is similar to the earlier value, only the locational coefficient is a lot simpler. Thus

$$rk^{t}_{ij} = \frac{k^{X}_{j} \cdot {}_{r}L_{i}}{{}_{r}X_{j}}$$

Now the location coefficient given by ${}_{r}L_{i}$ is represented by the demand for sector i's output in region r relative to its demand in the nation. This coefficient was developed with the notion of a hierarchy of sectors - local sectors being those with a limited market area (and hence not being traded interregionally) and national sectors being the ones whose production is located at fixed points and the other regions have to be importers of the output. If such a heirarchy does not exist, and this coefficient is based on the notion that there are many local goods that do not enter into interregional trade, it will surely understate the importance of trade to the regional economy. Again by not allowing for transport costs or other expressions of the frictions of distance to affect the location coefficient, the model fails

to consider the most crucial element of spatial economics.

The Chenery-Moses reformulation (Chenery 1953, 1956, Moses 1955) makes the best use of regularly published statistics on interregional commodity shipments. It relies on the assumption that the proportion of any sector's output demanded by region k from any region r applies uniformly to all receiving sectors in region k. The trade coefficient thus has no subscript relating to the receiving sector, and is given by

$$ {}_{rk}t_i = \frac{{}_{rk}Z_i}{{}_{k}Z_i} $$

where ${}_{rk}Z_i$ is the amount of sector i's output shipped from region r to all sectors (for intermediate plus final use) in region k;

and ${}_{k}Z_i$ is the amount of sector i's output shipped to region k by all regions.

This coefficient again assumes constant trading patterns between regions and also does not allow for the explicit influence of costs of transport on the coefficient. The idea that this coefficient assumes that each individual sector's demand for an input is an average of the demand by the whole region has been used by Hartwick (1971) to derive

some interesting parallels between this and the Isard value of the trade coefficient. Riefler and Tiebout (1970) extend the same idea by assuming that the trading coefficient applies to the interregional but not to the intraregional component of trade flows, so the overall magnitude of trade is represented by

$$ {}_{rk}a_{ij} = {}_{rk}t_i \left({}_{k}a_{ij} - {}_{kk}a_{ij} \right) ; $$

where ${}_{kk}a_{ij}$ is the proportion of demand supplied from within the region.

While this model is less restrictive than the original Chenery-Moses model in that it allows for variations in the proportions of inputs supplied by one sector to others intraregionally, the fact that knowledge of the purely regional I-O coefficients is essential considerably adds to the data requirements of this model compared to the earlier version.

CHAPTER 3: THE REGIONAL DIMENSION IN CANADIAN ECONOMICS.

3.1 Introduction

In the previous chapter, some causes and consequences of regional income disparities were presented. In this chapter, this analysis is extended to the Canadian economy. Thus section 3.2 presents some evidence on the degree of income disparity across regions. It is noted that the poverty of the poor regions stems from a multiplicity of causes, from reliance on industries that are in a period of decline (textiles are one prime example) to dependence on some mineral wealth that is exhausted or close to it (coal in Nova Scotia). In section 3.3 some reasons why incomes of both factors are low (and also growing so slowly) in these regions are put forward. This is followed, in Section 3.4, by a fairly brief discussion of government actions, both of a fiscal and a developmental nature, that are designed to remove these disparities. It is seen that the magnitudes involved are substantial, both in terms of the tax breaks provided to private enterprise to locate in the depressed regions and by way of income transfers to residents in the poor regions in the form of equalisation payments. Sections 3.5 and 3.6 present some observations about the general nature of these efforts, the extent to which the measures adopted were successful, and what steps could be taken to make these efforts more efficient.

3.2 Some Evidence on Regional Income Disparities in Canada

There exist fairly wide disparities in the standard of living in various provinces in Canada. This fact is easily seen from a large variety of sources, from Statistics Canada publications to some observations by various authors. There are wide differences in the lifestyle and levels of material well being of people living in, say, the Atlantic provinces as compared to those in Ontario or British Columbia. In a country the size of Canada such differences are to be expected; indeed to expect the contrary - perfect equality in welfare across so vast a territory - is to expect the impossible. This existing discrepancy is well known and fairly comprehensive documentation can be found in two Annual Reviews of the Economic Council of Canada,[1] and in the works of various authors.[2] Even though these differences persist to the present day, it is perhaps better to look at the situation as it existed two odd decades back prior to the introduction of deliberate government policies aimed at reducing this divergence. Thus the picture in the early 1960's will help show how market forces by themselves lead to interregional inequalities.

In the early 1960's (1960-62) the richer provinces of Ontario and British Columbia enjoyed an average per capita

income between 14% and 17% above the Canadian average while the Atlantic provinces were almost 33% below this average. The income levels for Quebec and the Prairie provinces though not as far below the average were still between 10% and 12% lower. Thus the maximum spread between the richest and poorest provinces was of the order of 45%-50% while that between the richest and the second best off group was also close to 20%. While it is quite valid to argue that mere comparisons of per capita incomes do not adequately reflect welfare differences, further analysis has not altered these conclusions. Clearly, a better comparison could be made if "real income per capita" were compared so that regional variations in price levels could be accounted for. However, the conclusions reached by Abouchar[3] do not seem to show that deflation of regional money incomes by regional price indices would significantly alter the picture.

Similarly it is seen that there are wide differences in employment rates and in participation rates across regions. While in this case the relative ordering of provinces is somewhat altered with the Prairie provinces having low unemployment rates alongside Ontario and British Columbia, the rate of unemployment in both Quebec and the Atlantic provinces is noticeably higher than the national average. In fact even in most boom periods the Atlantic region is seen to experience unemployment rates in excess of

those seen in what can be termed "depression years" in Ontario. The situation in Newfoundland for example is such that even during relatively good years 14%-17% unemployment is not unheard of[4] while rates greater than 6% are rather rare for Ontario or the Prairies. The fact that the Atlantic provinces and Quebec also have lower participation rates than the national average may be a result of the fact that since unemployment opportunities are lower, a smaller proportion of the population of working age offers itself for any productive employment. A similar picture is seen when one looks at the extent of social services available to residents of different regions. While an index of service availability may not be easy to derive, a proxy that can be used is the dollar value of expenditure for various services such as education and health care, police and fire protection, etc. Here again the picture seen is one of differences of over 30%[5] in the amount spent for these services between the provinces with the highest and the lowest expenditure.

There is hardly any need to go further into indices to show that income and welfare differences exist. What may be pointed out is that not only has the free market lead to these differences but that it has also lead to a situation in which the poorer provinces have a lower potential for future growth and progress. This may be seen, for instance, from the fact that investment per head also varies by province, with

the poor regions again below average.[6] Thus these provinces have a lower rate of capital formation which is essential to the growth of income levels. This variation in (private) investment per capita is also responsible for the poorer regions' generally being more dependent on agriculture or having an industrial structure comprising relatively large proportions of industry that uses mainly unskilled labour - textiles, primary processing and the packaging industry come to mind. These low value added industries are known to have a very low growth potential.

3.3 Some Causes of Unequal Growth

In large measure while the evidence referred to above is an indicator of the existence of differences in living standards among regions, most of the individual factors mentioned above are also the causes of the divergence of income levels and growth over time. For instance while the level of unemployment is an index of the degree of aggregate demand in the economy at any time (assuming a fixed supply of labour), the persistence of large amounts of unemployed labour will lead to reduced incomes per capita because it will reduce the ratio of employed to total population and thereby reduce incomes and aggregate demand. As earned income depends on both average wages and the number employed, a low value of the latter will surely lead to low income

levels. On the other hand low wage rates are likely to result from low levels of education and training of the labour force (where again the Atlantic region and Quebec are the relatively underprivileged provinces), and from the type of employment that is dominant in the economy. Similarly it is to be expected that employers have a much higher leverage in keeping wage rates low when there is a large pool of unemployed labour to draw from.

Whereas these are a summary of the main factors responsible for a divergence in incomes due to the labour input, the other inputs do not yield a different picture. Economic theory leads one to the conclusion that income due to labour will be high in all activities where production is highly capital intensive (so that the marginal product of labour is high). Even though in this case the marginal product of (and so the income due to) capital will be low, the greater effect is likely to be of the higher labour productivity since labour incomes comprise around 70% of personal income. In fact the degree of capital intensity is so adverse from the point of view of the poorer provinces that the amount of capital per head in the Atlantic provinces is between 55% and 70% of the Canadian average while in Ontario and British Columbia it is between 12% and 14% above the average. The highly mechanical nature of farming in Saskatchewan and Manitoba and the extent of mechanisation of

Alberta's economy are responsible for raising the capital intensity in "all sectors combined" in these provinces above the national average. In manufacturing industry alone, though, only Ontario and British Columbia depict capital intensities above the average, and the indices for the other provinces range from 10% of the average for Prince Edward Island, 21% for Saskatchewan, to around 90% for Quebec. There was mention previously of discrepancies in investment rates per head between regions, especially for the Atlantic provinces versus the rest of Canada, which result in not just low current values of capital per head but also lower growth rates of capital intensity in the regions that are most in need of higher capital stocks.

A further cause of unequal income growth is to be found in the general economic structure of the provinces. At a general level, decline and decay are depicted by the following kinds of regions (see Chapter 2.2 above):

i) Traditional resource rich regions whose main mineral wealth has been exploited away or replaced by some more efficient alternative;

ii) Areas that are so overpopulated as to become unattractive for industry to locate there due to the existing and possible future levels of congestion (a feature rarely releveant to

any area in Canada);

iii) Regions whose industrial or overall economic structure is dependent largely on activities that are slow growing and do not lead to significant forward and backward linkages;

iv) What are termed as resource frontier regions - areas that are in general far removed from the rest of the economy by some geographic barriers and are thus not conducive to industrial expansion. The case in point here would seem to be the Canadian Arctic.

Of these four major causes at least i) and iii) apply in significant measure to at least the Atlantic provinces and in some measure to Quebec. These eastern five provinces variously depend on natural resources that are now not efficient to use (coal in Nova Scotia), on industries that are not too quick growing (e.g. textiles which are heavily concentrated in Quebec) or on industries that do not lead to large forward and backward linkages (the most obvious of which is the fishing industry on which all the Atlantic provinces rely fairly heavily).

These causes of regional disparity are supplemented by the non-quantifiable factors that were variously categorised as "flow of information and interpersonal

contact", "high degree of interaction" and "incentive to innovation" offered by an environment of research and development. Since most of the latter work has traditionally been the preserve of large corporations, it is centered on the metropolitan areas, and even among these the major beneficiaries would seem to be those lying in the Windsor-Quebec City corridor. In general, then, it can be concluded that the causes of regional disparity in Canada cover almost the entire spectrum of causes associated with why some areas stagnate while others depict quick growth all over the world.

3.4 Policies Pursued in Recent Years

Although this section is primarily designed to list the various roles and various forms of policies pursued by all levels of government (most notably the federal level), there will be considerable emphasis on the evaluation of these policies and actions because this evaluation will anticipate the discussion of the next section. As spelled out elsewhere,[7] there are two main threads to federal government policies that are especially aimed at reducing income disparities. The federal government is the prime mover in these policies because the provincial governments are more concerned with removing inequalities within each province and there is evidence to suggest that provincial and local

government expenditure has not been very conducive to removing disparities between regions. The two avenues of federal government action can be classified under the following headings:

3.4.1 Fiscal

Under this category can be classified all attempts by the federal government that are of a budgetary nature and thus involve revenue collection from the provinces or any expenditure or revenue transfer to the provinces, either to the lower level of government or to individuals. In the past two decades and more, federal transfer payments to persons and to the governments of the provinces have become rather important sources of income for the poor provinces in particular. While in case of Alberta, Ontario and British Columbia, federal sources were seen to be contributing between 15% and 20% of local government revenue per capita, this share for the Atlantic provinces was between 35% and 50%.[8] The theoretical justification for this transfer of finances to the lower levels of government is explained by Graham[9] and is based on the principle of fisal equity - i.e. that a resident of a country should receive the same level of public services and incur the same tax burden as any other resident, irrespective of where the two reside. As is clear from casual observation, the provision of services comparable

to those available in rich regions would entail a significantly higher tax burden in the poorer regions, and would thus violate the criterion of fiscal equity unless relief were provided from federal sources. At the present moment these payments to the provinces are provided both via easily observed cash payments and via the transfer of tax base to the provinces, effected by a reduction of a federal tax simultaneously with an equal increase in the same tax at provincial levels.

In addition to these transfers to provincial and municipal governments the federal government provides direct payments to residents in the form of unemployment insurance and welfare payments, mothers' allowance and the like. In the regions where the level of unemployment can reach as high as 20% these unemployment insurance payments are the only income source of around 10% of the total population, and thus cannot be taken as negligible parts of the income stream. There is reason to conclude that in the absence of federal government efforts at reducing the income inequalities the spread between incomes of the richer and poorer provinces would not have shown the (however moderate) reduction it has shown over the past twenty years. Indices of earned income for both labour and capital depict remarkable stability in preserving the relative ordering that has been seen to result from the past operation of the free market.

3.4.2 Developmental

The developmental approach to regional disparities is in many ways the more dynamic focus of federal government action in this field. Seen over the last twenty odd years this approach has taken on quite a few forms.[10] The overriding concern surely has been to provide avenues for employment creation and income generation in the depressed regions. However, in the pursuit of this concern, the federal government has lacked a single strategy, a uniform direction or even a consistent decision making apparatus. Thus while at times the primary concern has been with rural (agricultural) problems, at others it was felt that the provision of infra-structure and some services would be enough to promote growth. At other times the emphasis has been on research and technological change or investment in human capital while now finally the emphasis seems to be on providing some limited subsidies to cover some of the losses that may have been incurred by an industry in locating in a depressed region that would not have otherwise located in the poorer region. There is still the realisation that it is the private sector of the economy that generates the majority of jobs in the Canadian economy, and thus government efforts should be directed more towards making the climate amenable to private investment and job creation than towards stepping

in with projects run or operated by the public sector.

The historical summary of these development related efforts of the federal government given here will be very brief mainly because these efforts are well documented in the government's own publications, and in many other sources. Again the aim here is to evaluate rather than document these efforts. Concern with rural poverty led to the Agricultural Rehabilitation and Development Act of 1961 (changed in 1966 to Agricultural and Rural Development Act - ARDA) that was mainly concerned with rural problems like increasing output from land and in improving the physical qualities of the land. The Atlantic Development Board (also known at other times as Council) established in 1962 was at one time given only advisory powers, at others it had finances at its disposal to actually assist in setting up projects in the four provinces. The Area Development Agency (ADA) set up in 1962 was provided a financial base to help set up projects in areas of chronic unemployment. Again in 1966 the Fund for Rural Economic Development (FRED) was created with much vigour and high hopes but the emphasis fizzled out after three odd years. In 1968-69 the Regional Development Incentives Act (RDIA) was passed in Parliament and the subsequent creation of the Department of Regional Economic Expansion (DREE) led to a cessation or a superceding of all of the above mentioned boards and agencies. Each one of the

agencies and boards had their own role (minor or major) in helping generate incomes in the poor provinces, and in some cases the sums of money involved were also not minor. Each of them was seen to direct its efforts at only one facet of the problem. To a certain degree this also characterises the current approach of DREE. The current purpose of DREE under the RDIA is to provide cash grants to investors who are willing to set up, expand or modernise plants in the depressed regions (defined in the Act). The cash grants have at times been related to the cost of capital (upto a certain percentage of the total), to the wages bill from hiring more labour and thus creating more jobs, and at times to combinations of these two. At the outset it is made clear that DREE grants are not available to concerns that would have located in the depressed area by themselves (i.e. to firms for whom the depressed area is the primary location), or to firms that are expected to turn a profit on all operations, even in the depressed regions. Thus the grant is in no way a windfall for locations in a prespecified set of areas but a partial compensation for operations that would otherwise prove unprofitable due to the disadvantages business sees in locating in areas removed from the main centres of economic activity.

In evaluating the effectiveness of these support and subsidy policies by various federal government agencies and

boards some mention should be made of the magnitudes involved. There are some signs that the amounts involved were substantial. For one it is estimated that without ADA's help, total investment in Quebec may have been lower by 1 billion in a three year period - a figure that is not too unreasonable given the absolute size of the Quebec economy. Similarly there is reason to believe that if the magnitude of investments encouraged by ADA and other agencies were subtracted from total investment in the Atlantic provinces, the outwardly booming investment picture in these regions would actually approximate a large recession.[11] This sort of conclusion about the gloomy picture is further darkened when one realises that the private sector investments that were diverted to the Atlantic provinces or to Quebec as a result of the subsidies could otherwise have taken place in some of the other prosperous regions - and hence the relative position of these poor regions would have been a lot worse than it is. But it must also be noted that this conclusion relies on the assumption that the investment undertaken in the poor regions would actually be undertaken elsewhere and that the funds diverted to a DREE supported project did not come from some other project in the same region. In case of the latter being true, the loss of investment attributed to removals of all federally supported projects actually overstates the poor regions' loss of investment.

On balance there is no denying that federal government attempts at attaining income equality have helped narrow the spread between the richest and the poorest regions. The rates of growth of per capita income in the latter in the past twenty years are higher than the Canadian average, while the former are growing at or below this average. Tendencies for convergence to the national average standard of living are thus present from above and below, and can mainly be attributed to conscious government efforts in this direction. But this should not lead to the conclusion that the approaches undertaken were the only ones available, or even the best or most efficient of the ones available. Quite the contrary, the approaches have all along been one sided in emphasis and action, and have failed to take account of significant interdependencies in the economy.

As noted earlier, the basic notion has been to support the private sector to create jobs in the designated areas by cash grants or by some subsidised provision of services. Even though DREE now is going through evaluations of individual projects requesting grants on the basis both of the needs of the project and the benefits the project may provide to the relevant areas, the method is still what is defined in the next section as a "partial equilibrium" analysis. The approach is to date restricted to the search for avenues to create jobs in the region, and to encourage

capital inflows if this helps in job creation, but not to look for what constitutes the more stringent bottlenecks of the particular regional economy. Whether income growth is encouraged in the depressed region by industrial location or by transfer of revenues or purchasing power to individuals, there is no guarantee that the policy pursued in the actual circumstances helped relieve the economy's most binding constraint. Similarly the idea of economic interdependence over all sectors and facets of the economy is limited to the idea of intersectoral interdependence depicted by interindustry purchases and supplies (the input-output table). Thus while DREE has attempted to ensure an optimal diversification of the industrial structure of each region by encouraging variety in its choice of sectors to subsidise, it is not simultaneously analysing to what extent this sectoral expansion is compatible with the other constraints faced by the region in the form of balance of trade equalities, monetary supplies, availability of finances and constraints imposed by accumulation and decumulation of wealth. In what follows it is hopefully made clear how these interdependencies should best be analysed so that efforts can be directed towards relaxing the most stringent constraints on the economic system. In the linear programming model (see Chapter 4 below) this is accomplished by stressing activities that attain high shadow prices, because a high shadow price in a solution implies that one more unit of this commodity,

resource or asset will help relax a strictly binding constraint on the economy. When any such constraint is relaxed by one unit, the value of the objective function rises by the amount of the shadow price.

3.5 A Critical Analysis of Policies Pursued in the Past

As mentioned, the federal government has attempted to moderate these interregional income disparities in Canada. However it is essential to appraise this role from the point of view of optimality of plans and actions. The first aspect to note is that these expenditures to promote growth are all undertaken with the equity criterion in mind. There is the fairly well known debate in economic theory on the tradeoff between equity and efficient resource allocation (which is most conducive to growth). Since there does not seem to have been any formal analysis of this tradeoff, there is no idea of the cost of equity in terms of foregone output. Whereas this is not to suggest that the promotion of more equity is not desirable, it is felt that by not even considering the tradeoff, DREE and the other government agencies are ignoring the alternative outputs that could be produced by the same resources if the latter were put to their most efficient use.

This by itself would not be too big a problem if the agencies were at least seen to follow some criterion of

optimisation like maximising a weighted sum of regional outputs, minimising the resource cost of any incremental output after each region's per capita output were forced to some minimum level, or minimising the (sum of squared) differences between each region's output and the national average - to name only a few of the criteria which could be adopted. If some such rule were followed then projects and policies would be pursued only if they aided in moving the economy further in the direction of optimality, and not be aided solely because they were being implemented in one of the poor regions. This is one of the ways of ensuring a better balance of resource allocation across regions. To give an example, if a resource is now seen to be more productive in region A rather than in region B it would more likely be allocated to region A whereas in the absence of the optimality criterion it would be allocated to A or B whichever applied for the funds first. The former system is obviously more conducive to harmony across the national space and makes full use of the potential of each region's economy by maximising each region's contribution to the national system. It is strongly felt here that the attainment of such optimality is the aim of regionally designed and applied policies, and not just the production of outputs in the poorer regions, irrespective of how large the loss of alternative output is. By not having interregional optimality so incorporated into its objectives, the government is at

present helping the economy to attain one out of an infinity of possible attainable points (i.e. a point on the Production Possibility Frontier), not one that conforms to the notion of being the best from among the various choices available. It may also be the case that the economy attains only one feasible point, and this point may not even be on the boundary defined by the Production Possibility Frontier because the marginal returns to all factors are not being equalised in all uses.

Related to this question of a lack of optimality criteria in the government's allocation of funds for fiscal and developmental aims is the problem that the analysis conducted each time represents a partial equilibrium. If the aim is to support projects that may not be otherwise undertaken or if investment in infrastructure is attempted, the only consideration is the (demand and supply) balance of commodities. If fiscal incentives are undertaken, the aim of the relevant government agency is the provision of aggregate purchasing power to individuals or to the lower level of government. There is no analysis of how each one of these expenditures is related to others by overall balance and behavioural equations that characterise the economy. For instance, the provision of a certain support to any project will mean a larger supply in the commodity market, but if simultaneously purchasing power is not transferred to

individuals in their income equations or identities it will not lead to an equal change in aggregate demand, and it is well known from trade cycle theory that the excess of supply over demand leads to a recession. While this example is surely an oversimplification as the excess output can be exported, this solution for the excess supply also assumes that either the other regions face excess demand pressures and so are willing to increase imports, or that production in this depressed region is so competitive as to always be exportable to other nations (and there are very valid reasons for believing neither of these situations may exist). If any government agency like DREE were to conduct its analysis via a full scale model of the economy that accounted for not just the commodity demands and supplies but also the financial side of the economy (the savings-wealth relation), the supply of labour and capital, and the regional and national trade balance conditions, then any developing surpluses at one side would immediately show up as relative shortages elsewhere. Thus the allocation of funds would be better suited to overall optimality by helping relieve the most binding constraint. Such an analysis (which could be called "general equilibrium" as compared to the partial equilibrium approaches currently used) would simultaneously fulfill the need for an optimality criterion and make the allocation of funds reflect the true scarcity exhibited by the most binding constraints on the economy.

Finally as a consequence of stress on a single section of the economy at a time, the government agencies have been seen to stress only one of a multitude of avenues that could be utilised in any situation. Thus there seems to be a stress only on moving jobs into the poor regions rather than looking into whether the movement of people to jobs could accomplish the same ends at lower costs. True, the political infeasibility of "emptying" any province and transferring the total population to others makes this movement only partially feasible. But another avenue that the agencies seem to ignore totally is the fact that if some poor and sparsely populated province depicts such a low level of aggregate demand that location of industry is not feasible, the provision of an adequate level of living there may be better served by giving purchasing power to the poor province via transfer payments rather than trying to get industry to locate there. All this is designed to throw some light on the fact that partial equilibrium ideas are likely to not only misrepresent the true scarcity of some resources and to not realise the degree any specific constraint is binding, but also may not be able to see all the possible avenues of economic adjustment and their relative effectiveness.

3.6 An Overview

The above discussion may be summed up as follows. It is clear that when left to itself, the market system has led to and perpetuated income and standard of living inequalities between provinces in Canada. There is no discernable evidence that without government intervention, the market economy would have created conditions favourable to a reduction in these disparities over time. But because this problem of diverse income levels, widely different employment rates and opportunities, and quite diverse prospects for growth of high income industries has been recognised, more than adequate steps have been taken to curtail this spread and to reduce it. Over the last two decades there is some slight tendency for incomes per capita to move towards the national average both from above and below. In this regard while government transfer payments to persons may be seen as providing purchasing power (to help create aggregate demand), various regionalised incentives to industry to locate in poorer regions are designed to help generate supply.

The discussion above has pointed out the degree of disparity in standards of living across various provinces of Canada, the factors responsible and the attempts made to remedy this state of affairs. Among the main indicators are divergences in the levels of income, unemployment rates,

amounts of social services available, and investment rates between regions. These result from all the factors that were seen to retard the growth of some areas and make others centers of dynamic change in Chapter 2. While the federal government has realised the role it has to play in moderating these divergences, and has created a specific department (DREE) to co-ordinate all efforts in this field, there are still quite a few ways in which these governmental efforts could be improved upon. The issues raised above relate to the question of a "partial equilibrium" versus a "general equilibrium" analysis, the fact that there is no optimality criterion in the DREE approach and the fact that the main focus of DREE is only one of the segments of the economy that could be constraining the growth of income levels in the poor regions.

But while the extent of progress that has been made in attacking the problem of poverty of the depressed areas cannot be denied, the approach followed seems to lack a single consistent and comprehensive basis. As a result, when and if the government agencies are helping out any project with funds or providing transfers to the unemployed, the marginal return to a dollar of expenditure is not necessarily equalised across all uses or all regions. In fact it is rarely possible that different constraints on the regions' economies are not relaxed to very widely divergent degrees

without any single comprehensive model. Such a model shall be presented in the following chapter and an attempt will be made there to integrate all the facets of the economy. Although when implemented, the version of the model will be a grossly simpler one, this is done more for needs of simplicity and ease of interpretation, as well as some data and computational bottlenecks, than because the results of a higher degree of aggregation are more suitable for any experiments. In its theoretical structure the model accounts for the interdependencies of income earned, aggregate expenditure for all goods and services, the savings-wealth relation and the trade balance constraint. In addition factor availability is given a prominent role in determining maximum producible output.

FOOTNOTES.
(to Chapter 3.)

1. Although specific concern for regional issues is mentioned at length in the 1965 and 1975 annual reviews, in other annual reviews too this problem receives more than just passing mention - e.g. there is a chapter on Economic Expansion and Regional Development in the 1966 issue, i.e. in the Third Annual Review.

2. To name a few of the works, one can note Brewis (1972, 1970), Green (1971), and the collection of articles in Lithwick (1975).

3. The author discusses various adjustments that should be made to the simple income measure if it is to correctly reflect economic welfare, e.g. adjustments for regional price differences, differences in consumer debt patterns, and in the shape of the income distribution, but in his final conclusion he asserts that perhaps the only useful correction needed to have income reflect welfare is to consider household rather than individual incomes.

4. Although the figures on p339 of Brewis (1970) show the Atlantic provinces as one region (and this tends to hide high unemployment level of Newfoundland) there is no denying that the lowest unemployment rate in this region is close to the highest levels experienced by Ontario in the yearly cycles from 1963 to 1969.

5. Table 9 in the Second Annual Review of the Economic Council of Canada shows that average per capita expenditure for services by the provincial-municipal governments ranged from a high of $391 for Alberta to a low of $260 for Nova Scotia.

6. See Table 5 (and 6) of the Second Annual Review.

7. Lithwick has divided his collection of articles into sections which a) define the regional problem, and b) search for solutions. In the latter section there is emphasis on both the i) Fiscal and ii) Developmental approaches to the regional problem.

8. Table 9 of the Second Annual Review and Fig. 3 and Table 3 of the 12th Annual Review clearly show that federal transfers to the provinces are increasingly important for the Atlantic provinces.

9. See Graham, J. F. Fiscal adjustment in a Federal Country, p188-205 of Lithwick, op.cit.

10. The following few words from Brewis (1970) make quite clear the frequent changes in direction and emphasis:

> "The past decade displays a picture of manifold shifts in emphasis, administration and policy direction. Over the last few years, an observer who took his eye off what was happening for even a short while was apt to find that by the time he looked again the scene and the action had both changed", p339.

11. These values are some of the figures derived and quoted by Dan Usher, p283-302 of Lithwick op. cit.

CHAPTER 4: A LINEAR PROGRAMMING MODEL FOR CANADA.

4.1 Introduction

This chapter is devoted to outlining the economic model that is to be used in this study, with particular emphasis on bringing out all the constraints faced by any region's economy within a national system. The various equations of the model are derived in Section 4.2 below. While there is little emphasis on the derivation of the Objective Function and the Material Balance constraints, the Financial Constraints are explicitly derived from the two sides of the Savings-Wealth relation. Sections 4.3 and 4.4 list the data values that had to be generated or derived from existing material, and the ones that were available from regularly published statistics. Finally, Section 4.5 defines what the general nature of the experiments to be conducted is, and how various degrees of factor and financial mobility are allowed for. It is acknowledged that, contrary to what was said earlier (Chapter 2), the economic nature of this model ignores all non-economic influences that complement the picture, but this is done mainly to keep the analysis within manageable limits, and because non-economic factors are not that easily quantifiable. Again, in the discussion of "Analytical techniques" in Chapter 2, it was stated that economic models could be used to duplicate and simulate the structure and performance of regional or national economies,

to determine the effects of exogenous changes in some parameters or values of variables, and also to determine the costs and requirements of any set of targets. The model defined below is used for only the first of these purposes since the linear programming formulation can be used to trace the impact of exogenous changes in coefficients and in the formulation of various constraints on the final value of the objective function directly. However, the model can be turned around to the latter kind of experiments by inverting the matrix of coefficients; it is then possible to work out the output, factor and trade requirements of any set of targets. The model defined is a static analysis of the structure of the Canadian economy across space, and does not study the dynamic process by which any injection or change in value of a variable or parameter leads to changes in values of all the other endogenous variables. Thus what is seen are snapshots of the economy before and after all adjustments have been made, and because the model is run with various sets of exogenous variables and assumptions about factor mobility and trade flows, it can be called a "sensitivity analysis" of the economic structure.

While the details of the model will be spelled out in what follows, at this point it will be useful to outline some ways in which it complements earlier work in regional analysis. To start with, the model represents a linear

programming optimisation, and thus utilises an optimality criterion, the lack of which is one of the flaws mentioned in the approach taken by DREE and other government agencies. The maximisation of this function subject to a set of constraints makes this consistent with the essential nature of a planning problem. In the choice of the objective function and the constraints this aspect is evident because, for example, the coefficients and variables in the former represent the relative distribution of activities and outputs, consumption and trade patterns that in the opinion of the policy maker are desirable. Similarly, the choice of constraints that will actually be imposed represents the policy maker's judgement about what are the real bottlenecks of this system. Also this formulation helps develop the notion that an improvement in current conditions will be attained only if society has more of what is considered desireable, subject to the constraints of the system. These constraints relate to the domestic endowments of resources and the level of technology that prevails in the economy. Similarly the model attempts to incorporate both sides of the debate between moving jobs to people and people to jobs by allowing for both factor mobility to regions that have an excess demand for factors and mobility of industry and jobs to regions where needed. The optimisation exercise will determine which effect dominates the other, i.e. is the pull of aggregate demand so low in any region that jobs cannot be

located there (so people have to be moved to jobs) or is, say, the regional trade balance constraint so binding that in order to fulfill a certain level of demand, more imports are not possible (and so jobs must be moved to these areas).

Second, the model is made more of a general equilibrium exercise by the incorporation of the financial accounts in the savings-wealth relation. For example, a trade balance deficit does not solely run down the level of foreign exchange reserves. It also affects all components of the circle in which foreign exchange reserves are just one form of wealth holding. These holdings can be increased only by savings out of income, and income in turn is derived partly from interest earnings on holdings of various assets. The model is thus not restricted to the analysis of income growth via the growth of productive facilities alone, but also goes into the issues raised because the creation of investment is financed by some form of borrowing, and thus is a reduction from future wealth because of the repayment costs implied. While this mention of the financial side of the accounts is likely to open up a host of difficult issues, attention will be focused on the following two facets below:

(i) the idea that savings (treated roughly as the excess of income over all expenses) is the only way to add to wealth holdings, and borrowing and lending are opposite sides

of the same coin. So both lending and borrowing influence the level of wealth;

(ii) that foreign exchange reserves (and other financial reserves that a region could use to pay off an interregional or international trade deficit) are just another form of wealth holding, so that the trade deficit has implications for the entire savings-wealth relation because it has to be financed by running down the stock of wealth.

The model allows for each region's economy to face factor constraints that place upper limits on sectoral output, trade balance constraints that limit the amount each region can import and export, and financial constraints that limit the amount by which a region can live beyond its means by spending more than the income it generates. This aspect of the model is felt to be necessary because for some regions the current level of demand may be so low that it may not be feasible to locate production facilities there. These regions can be expected to increase consumption mainly by increasing imports, and while the financing of this deficit reduces the regions' wealth, federal government transfer payments to the regions will be an addition to their stock of wealth. The impact of reductions in the stock of wealth or foreign exchange reserves on the monetary base is not analysed because the model is a static exercise into the spatial

pattern of economic activity. While a one period outflow of reserves will contract the monetary base and thus the monetary impact needs to be incorporated, in a steady state (which is assumed to exist) there are no changes in such stocks, and so such complications are assumed away.

Recapping briefly what was said about the general nature of economic models in the previous two chapters, it was noted that "Top Down" and "Bottoms Up" represented the two extremes of regional analysis. Top Down merely represents an extension of the quest for greater detail and accuracy in building general economic models as it is an avenue by which results can be disaggregated to a smaller spatial unit in a fashion parallel to the sectoral disaggregation of results via an I-O table. Since one of the considerations in building these single region models is to attach the model to an existing national model and work out the implications of various movements in the national economy for the region, the models have a special utility for local governments and for local businesses. The models can be built with a reasonable role for regional policy makers in the regional model while the national model already incorporates a substantial role for the central counterpart. The limitations of these models for regional analysis mentioned included the fact that the region's economy seems to be of a nature secondary to the national economy and also that these models were highly

recursive. On the other side, Bottoms Up is seen to lay a bit too much emphasis on the regional system, even to the extent that there is no guarantee that the sum of regional magnitudes equals the known national total, so that special assumptions are needed to allocate the excess or the shortfall to all regions. In this case, the various interlinks that make the nation the sum of its component regions are clearly spelled out, and the regional system is not secondary to an existing national system. While in the Top Down case it is possible to delineate only a limited role for a regional policy maker (which in the regional economy is far less than the role of a national policy maker in the national system), in Bottoms Up there is no real avenue for centralised policy and decision making. This, in some ways, runs contrary to the aims of model building because one of the reasons for constructing any model in the first place is to study how the economy responds to various policy prescriptions. The model presented here attempts a compromise between these two extremes because the regional economy is described in detail by various equations and parameters, but among the overall balance equations one of the significant ones describes the central government's budget, and equates expenditures across various regions and sectors with revenues from all these sources. Hence the central policy maker can manipulate the economy through various allocations of central government funds to each

region, both via transfers to the region and government expenditures in the region, while justice is also done to the particular economic structure of each region.

4.2 The Model

The equations of the model are described in this section; as the first three sub-sections refer to equations and relationships that are fairly standard in the literature, there is no need to go into too much detail about their construction. However, the relationships defined in the fourth sub-section need to be developed in detail and the theoretical background is explained in depth because these represent the savings-wealth relation, and, as these represent a link between the commodity balance constraints and any region's financial structure, their application to regional analysis is not seen in earlier work. Apart from this relationship, the model is a reflection of the general nature of regional optimisation models defined by Kendrick (1971). In the numbering of equations below only those marked with an "M" are part of the model, the remainder are used for illustration or derivation of the final equations. Also, presubscripts (generally represented by r,k = 1,2 .. ,m) refer to regions and postsubscripts (represented by i,j = 1,2 .. ,n) refer to productive sectors, and, unless otherwise stated, each of the equations except for the objective

function apply to all the regions. The total number of equations is thus ten times as many as those derived here.

4.2.1 The Objective Function

While the presence of an objective function was seen to be an important part of the structure of this model, the actual specification of the relation poses problems because, while ideally the function should represent the social welfare function, such a welfare function cannot be derived under very plausible conditions without in some sense being imposed.[1] The most common proxies used for this maximand are the levels of regional income, consumption or employment levels, each of which is actually an indicator of the level of one aspect of economic activity. These indicators can be improved upon by attaching a set of weights to the variables used, with variations in the weights attached to each region's indicator allowing the plan or policy maker to attach an extra importance to a unit improvement in performance in the region where it is needed most. Now as the objective function represents the level and the distribution of activity, it comes closer to being a proxy for the social welfare function. In the present model the objective function is a sum of the income per capita level across regions, (eqn. 4.1M).

(4.1M) Max. $Z = {}_1Y/{}_1P + {}_2Y/{}_2P + \ldots + {}_{10}Y/{}_{10}P$;

where

${}_rY$ is the income level in region r and

${}_rP$ is the population of region r.

While a better proxy for welfare across regions may be the level of per capita consumption, the reason income per capita is used as the optimand here is because there is an explicit income variable in the model. Also, because of the assumption of a steady state, the numerical values of income and consumption are equal (there being no additions to capital stock and hence no savings in a steady state). The maximand used here represents an unweighted sum of regional income per capita; the lack of any wieghts stems from the fact that it is also possible to impose regional equity criteria as separate constraints, and thus to determine what is the maximum value of this objective without the equity requirement and how much the value of the same function changes when the equity condition is imposed. A comparison of two such experiments could be taken as yielding the price of equity in terms of lost consumption. Finally, when the equity constraint is applied as part of the maximisation exercise, it is assumed that the unconstrained distribution of consumption across regions is not optimal, and needs to be improved upon.

The objective function is to be maximised subject to the following constraints relating to the resources, technology and production structure of the economy.

4.2.2 Commodity Balances

The first set of constraints on this maximisation stem from the demand-supply balance for each sector's output. The term Commodity Balance is not really appropriate here because at the level of aggregation used in this model, the output of each sector comprises more than one commodity grouping; a better term would be the commonly used one of Material Balances. However the latter refers to the supply demand balance of assets also, and so whenever the demand and supply of goods and services in under discussion, the terms Sectoral Balances, Material Balances and Commodity Balances are used interchangeably. The supply of each sector's output in each region consists of local production and (interregional and international) imports for final use. To keep the number of variables manageable these two categories of imports are lumped into one - this being one of the compromises made between theoretical rigour and practical applicability in this model.[2] The demand for each sector's output comes about both from intermediate and final demand, and each of these categories can be split into local

(intraregional) and external (interregional) demands. In this model only interindustry demands and consumption demands are distinguished by region of origin and use of the goods, investment demand and demands by the government sector are fulfilled by local production only. Thus a fraction of the amount of each sector's output required for consumption is supplied from within the region, the rest is imported from other regions. The sum of all these imports plus the fraction of consumption supplied locally equals the total consumption spending by the region. Again, exports for final use are not distinguished as being interregional or international, but only represent external demands for a region's output. When this set of equations is summed for each region (across all sectors) Gross Regional Product (GRP) is obtained, and when this summation is done over all regions for a single sector, the result is national output and the associated demands for the output of that sector. To get Gross National Product, the output of all sectors in all regions, the complementary summation to any of these values needs to be performed - GRP summed for all regions or national sectoral output summed over all sectors. The Commodity Balance equation for one sector in one region is given by (4.2M)

$$(4.2M)\quad {}_rX_i + {}_rm_i = {}_rc_i \cdot {}_rY + {}_rG_i + {}_rB_i + {}_re_i$$

$$+ \Sigma_j\ {}_{rr}a_{ij} \cdot {}_rX_j + \sum_{j=1}^{n} \sum_{k=1}^{m} {}_{rk}a_{ij} \cdot {}_kX_j \quad ;$$

where

${}_rX_i$ is the output of sector i in region r;

${}_rm_i$ is the import of sector i into region r (final);

${}_rG_i$ is government spending for output of sector i, region r;

${}_rB_i$ is the investment use of output of sector i, region r;

${}_re_i$ is the exports of sector i from region r (final);

${}_{rr}a_{ij}$ represent intraregional I-O purchases;

and

${}_{rk}a_{ij}$ is the interregional input-output coefficient.

4.2.3 Factor Constraints

The second set of constraints on maximum producible output stems from factor availabilities. Here again the assumption of fixed coefficients technology is retained so that there is a fixed ratio of factors to output for both capital and labour. Thus unless a factor is in general excess supply and so poses no real constraint on output, its availability will put an upper bound on the output that can be produced by any sector in any region. The exact formulation of this constraint will change with the degree of mobility of factors assumed. At the one extreme if factors are totally immobile, the maximum of each sector's output that can be produced is given by:

$$(4.3M) \quad {}_r\underline{k}_{1} \cdot {}_rX_1 \leq {}_rK_1 \; ; \; \ldots \; {}_r\underline{k}_{4} \cdot {}_rX_4 \leq {}_rK_4 \; ;$$

where

$_r\underline{k}_i$ is the capital/output ratio for sector i, region r, and $_rK$ or K_i are the capital stocks in the region/sector.

Another variant of this mobility assumption would allow factors to move to similar jobs between regions. In this case national output of any sector is limited by the national availability of factors with the necessary skills, but any sector's output in one region can be expanded by inflows from other regions. Thus:

$$(4.4M)\quad {}_1\underline{k}_i \cdot {}_1X_i + {}_2\underline{k}_i \cdot {}_2X_i + \ldots + {}_{10}\underline{k}_i \cdot {}_{10}X_i \leq K_i \ ;$$

Similarly, factors can be allowed to move from one job to another within the same region. These equations are shown by:

$$(4.5M)\quad {}_1\underline{k}_1 \cdot {}_1X_1 + {}_1\underline{k}_2 \cdot {}_1X_2 \ldots + {}_1\underline{k}_4 \cdot {}_1X_4 \leq {}_1K \ ;$$

Similar constraints hold for all sectors for all regions.

An even more liberal mobility assumption than these partial mobility cases stems from allowing factors to move both between regions and sectors. In this case there is only one limit on GNP due to capital and one due to labour, but no real limits on the outputs of any sector or any region.

Hence:

$$(4.6M)\quad {}_1\underline{k}\quad {}_{1\cdot 1}X_1 + {}_2\underline{k}\quad {}_{1\cdot 2}X_1 + \cdots + {}_{10}\underline{k}\quad {}_{4\cdot 10}X_4 \leq \quad \underline{K} \quad ;$$

These equations are the mirror images of the equations that will be imposed based on the amount of labour available in each region for use by each sector ${}_rL_i$, and the labour/output ratios in each sector in each region ${}_r\underline{l}_i$. The maximum output that can be produced by any sector is thus the lowest of these two magnitudes.

4.2.4. Financial Constraints

In this section the financial (asset holding) side of each region's economy is linked to the production structure via the savings-wealth relation. As stated earlier, these constraints are imposed because they may be actually binding for some of the poor regions in Canada whose levels of aggregate demand are so low that it is not feasible to locate production facilities there. If it is optimal for these regions to increase consumption and improve living standards through imports, the regions might well be constrained by financial limits on their ability to pay for these imports. Their level of asset holding may not be high enough for them to reduce wealth holdings to pay for their excess of expenditures over income, and this may justify government

transfer payments to these provinces. When transfer payments are provided to a region, these transfers help to relieve this constraint on the economy of any area. Hence, the model not only ensures that the poorer regions are able to finance increased consumption but also ensures that government funds are disbursed optimally, the amounts transferred chosen so that the shadow value of an additional dollar of transfers is the same for all regions. On the other hand, it is also seen that in case this constraint holds for any region, traditional methods to induce industry to locate there are likely to fail (incentives such as favourable tax rates, provision of power and other service facilities at reduced rates, etc.) because the reason for the lack of industry in the first place is the lack of aggregate demand resulting from low income levels in the region.

The Financial Constraints are developed primarily as an equality between the supply of various assets that can be held as wealth and the demand for such assets that arises when savings add to the amount of wealth. Some assumptions and simplifications are used to convert this equality into a relationship between the trade deficit run up by a region and additions to (or subtractions from) the level of wealth. In the detailed derivation of these equations an individual wealth holder in any region is allowed to hold wealth as currency C, bank (and other intermediary) deposits M,

non-monetary financial assets F and shares of stock S. Each of these assets, except currency, can be issued by institutions within the region or from other regions or abroad, while currency can only be issued by the national government. The second subscript used with any asset variable refers to the issuing region and the first to the region the asset is held in, with "f" standing for all foreign countries. As these wealth holdings are net holdings, the amount borrowed from all sources is netted out. This relation for an individual wealth holder is shown by (4.7)

$$(4.7)\quad {}_rW = {}_{rr}M + \sum_k {}_{rk}M + {}_{rf}M + {}_{rr}F + \sum_k {}_{rk}F + {}_{rf}F + {}_{rr}S +$$

$$\sum_k {}_{rk}S + {}_{rf}S - {}_{rr}B - \sum_k {}_{rk}B - {}_{rf}B + {}_rC \quad ;$$

The asset liability position of financial institutions within the region is shown by (4.8), with assets being given by holdings of high powered cash reserves and foreign exchange, by the institutions' holdings of financial assets issued in other regions (FIH), and by the amounts borrowed by local and outside residents. On the liability side are all deposits created and non-monetary financial assets issued by institutions in region r that are held by local and outside residents and institutions (holdings by institutions being shown by ${}_{kr}FIH$). These two sides are equated in

$$(4.8)\quad {}_{rr}B + \sum_k {}_{kr}B + {}_{fr}B + \sum_k {}_{rk}FIH + {}_{r}H + {}_{r}FE =$$

$$ {}_{rr}M + \sum_k {}_{kr}M + {}_{fr}M + {}_{rr}F + \sum_k {}_{kr}F + {}_{fr}F + \sum_k {}_{kr}FIH$$

Equating the common ${}_{rr}M$ term in these two equations and simplifying yields (4.9) as the definition of a region's wealth holdings. This definition equates wealth with the excess of assets region r holds on others over the outsiders' holdings of region r's issues of assets. Thus the definition equates wealth with Net Worth.

$$(4.9)\quad {}_{r}W = \sum_k ({}_{rk}M - {}_{kr}M) + ({}_{rf}M - {}_{fr}M) + {}_{rr}S + \sum_k {}_{rk}S +$$

$$ {}_{rf}S + {}_{r}C + {}_{r}H + {}_{r}FE + \sum_k ({}_{rk}F - {}_{kr}F) + ({}_{rf}F - {}_{fr}F)$$

$$ + \sum_k ({}_{rk}FIH - {}_{kr}FIH) - \sum_k ({}_{rk}B - {}_{kr}B) - ({}_{rf}B - {}_{fr}B) \ ;$$

It can be noted that the terms ${}_{r}C$ and ${}_{r}H$ represent the same variable - currency - with one being held by the private individual and the other by financial institutions. Hence these can be consolidated into one variable - ${}_{r}CU$. Similarly the various categories of asset holdings are not relevant to the exercise, and only help illustrate the way a certain amount of wealth can be held. Thus the categories denoted by M, F, FIH, S and B are consolidated into one NA or "Net

Asset" variable. In addition, these assets are also consolidated into two categories; a) intraregional and b) outside. Hence the subscripts relating to other regions, k, and other nations, f, are combined into one * representing all external sources of issue. Thus

$$(4.10)\quad {}_rW = {}_{r*}NA - {}_{*r}NA + {}_{rr}S + {}_rCU + {}_rFE \ ;$$

If (4.10) defines how a certain level of wealth is held, a change in wealth holdings can be held in each of these forms also. The change in holdings of all these assets equals the total change in wealth. Therefore

$$(4.11)\quad d_rW = d({}_{r*}NA - {}_{*r}NA) + d_{rr}S + d_rCU + d_rFE \ ;$$

Moreover, the only way to add to wealth holdings is via savings out of disposable income (i.e. income includes transfers from outside). Gross Domestic Final Product in any region or the income generated by sector i in region r is shown by (4.12), and this can be summed over all sectors to get regional income:

$$(4.12)\quad {}_rX_i - \sum_j {}_{rr}a_{ij}\cdot{}_rX_j = {}_rc_i\cdot{}_rY + {}_rG_i + {}_rB_i$$

$$+ {}_re_i - {}_rm_i + \sum_{j,k} ({}_{rk}a_{ij}\cdot{}_kX_j - {}_{kr}a_{ji}\cdot{}_rX_i)$$

To this can be added each region's share of income earned outside (which in the present instance includes interest income on assets held and private remittances from outside as well as transfers from the government). The first two of these are lumped under TRPIN and TRPOUT representing private transfers into and out of any region respectively, while government transfers to any province are labelled TRG. Regional income is thus listed as:

$$(4.13)\quad \text{Regional Income} = \sum_i [{}_rc_i \cdot {}_rY + {}_rG_i + {}_rB_i + {}_re_i - {}_rm_i + \sum_{j,k}({}_rk a_{ij} \cdot {}_kX_j - {}_kr a_{ji} \cdot {}_rX_i)] + {}_rTRPIN + {}_rTRG - {}_rTRPOUT \;;$$

Regional savings are obtained from this equation if the foreign trade sector has been aggregated into one "net export" figure and if consumption and taxes are subtracted from income. This is shown in (4.14):

$$(4.14)\quad \text{Regional Savings} = \sum_i [{}_rc_i \cdot {}_rY + {}_rG_i + {}_rB_i + {}_re_i - {}_rm_i + \sum_{j,k}({}_rk a_{ij} \cdot {}_kX_j - {}_kr a_{ji} \cdot {}_rX_i) + {}_rTRPIN + {}_rTRG + {}_rTRPOUT - {}_rc_i \cdot {}_rY - {}_rT] \;;$$

Given that a steady state is assumed to hold in the model, the change in wealth holdings given by (4.11) is equal to zero. But as total regional savings are equal to this change in wealth holdings then (4.14) also equals zero. Hence

$$(4.15)\quad \sum_i [{}_re_i - {}_rm_i + \sum_{j,k}({}_rk a_{ij} \cdot {}_kX_j - {}_kr a_{ji} \cdot {}_rX_i) +$$

$${}_rG_i + {}_rB_i] + {}_rTRPIN + {}_rTRG - {}_rTRPOUT - {}_rT = 0 \ ;$$

Taking the exogenous terms (government and investment goods purchases and taxes) to the right hand side yields this financial constraint for each region's economy as:

$$(4.16M)\quad \sum_i [{}_re_i - {}_rm_i + \sum_{j,k}({}_rk a_{ij} \cdot {}_kX_j - {}_kr a_{ji} \cdot {}_rX_i)$$

$$+ {}_rTRPIN + {}_rTRG - {}_rTRPOUT = {}_rT - {}_rG_i + {}_rB_i] \ ;$$

When financial resource mobility is limited this constraint holds for each region and thus the maximum amount of commodities available to any region is given by local production plus the maximum deficit that can be financed within this constraint. Transfer payments from the government are determined endogenously in this model. Thus when a region finds its trade balance to be a strict constraint on the growth of consumption it is optimal for this region to borrow from the government and finance increased consumption. Thus

the value for ${}_rTRG$ will be pushed to its upper limit for this region, and carry a high shadow value in the solution.

4.2.5 Other Constraints

Finally the model is completed by two sets of constraints, the first of which are implicit in the above set and the second of which are designed to prevent extreme results like zero or very large outputs for some variables. Thus in the first set are constraints that relate the amount of value added to output (and thus link income to output) in each region. Regional income is defined as

$$(4.17M) \quad {}_rY = \sum_i {}_rva_i \cdot {}_rX_i + {}_rTRPIN + {}_rTRG - {}_rTRPOUT - {}_rT \; ;$$

Similarly the federal government sector's budget constraint is imposed so as to equate total government sector purchases and transfers with the revenue collected via direct and indirect taxes.

$$(4.18M) \quad \sum_i [{}_rt_i \cdot {}_rX_i - {}_rTRG = ({}_rG_i - {}_rT)]$$

where

${}_rt_i$ is the indirect tax rate on output of sector i, region r.

The second set of constraints are imposed because in the linear programming solution zero outputs and very high outputs of some variables are to be expected. To prevent these and other extremes such as production in only one region and consumption in one other (because the former has a lower input use ratio and the latter is more heavily weighted in the objective function) the model needs to have some restrictions on the amount of trade any economy can enter into with the other regions and the outside world. The former limits the amount which one region can import from all others and the latter allows the nation to run up only a limited deficit, while individual regions are not so strongly constrained. These constraints will only be imposed in some of the exercises, while other restrictions are imposed in other runs. This enables the model to point out adjustments within the economy's reach, not any unrealistic solutions such as borrowing huge sums from other regions and consuming only what is available through imports. The non-negativity constraints that are a part of the linear programming solution are also imposed.

4.3 Data Values Generated

In the model regional income is defined as the sum of value added in all productive sectors plus transfers into the

region from all sources minus transfers out. But as specified above, value added has to be defined as the residual after intermediate inputs and indirect taxes are subtracted from gross output. Thus the magnitude of indirect taxes per unit of sectoral output have to be calculated for each region, a task that is not possible from the current degree of detail available on indirect tax statistics. Thus it is assumed that all the productive sectors in a region face a uniform indirect tax rate and so the regional rate of indirect taxes is applied to each sector. This rate for each province as a whole is available from Statistics Canada publications for the period from 1961 (Statistics Canada, Provincial Economic Accounts, 13-213). A casual observation reveals that when looked at in this manner the rate of indirect taxation is the highest of all regions in Quebec, followed in decreasing order by Ontario, British Columbia, New Brunswick, Nova Scotia, Manitoba, Saskatchewan, Prince Edward Island, Newfoundland and Alberta.

The second important series of data that have to be derived relate to capital stock and labour supply per sector per region. These statistics are essential if any upper bounds are to be imposed on the output of any sector that can be produced in any region, and while statistics on both labour force and capital stock are available by sector and by region, there is no disaggregation of the former by region or

the latter by sector, especially for capital. For the required detail on labour force statistics, the two Statistics Canada publications can be used (Statistics Canada, Historical Labour Force Statistics, and Labour Force, Annual Averages, Cat. Nos. 71-201 and 71-529). The labour/output ratio is derived as an average of the ratio of labour force to sectoral output for the 5 years 1964-68.

A consistent series for capital stock per sector per region was calculated for the period 1961-1975 using the formula:

$$(4.18) \qquad K_t = (1 - d)K_{t-1} + I_t \quad ;$$

where K_t is the capital stock in year t, and
I_t is investment during the year in question, while
d is the rate of depreciation defined below.

The two extreme values that could be used to represent deprecition are given by

d = (Capital consumption allowance/Capital Stock), and

d = (Total repair expenditure/Capital stock).

While the former of these two measures is a sort of upper

limit on the amount of depreciation, the latter can be considered a lower limit. In actual calculations the stock obtained from each of these two rates was compared to the level of capital used by the sector at a national level, and the series that came closest to this level in 1975 was the one used. The value of this deprectiation rate was obtainable only for a sector at the national level when the first definition was used, and this was assumed to apply to all regions. Statistics on investment per region and repair and maintenance expenditure are all published regularly for each sector in each region so this rate could be separately calculated on the second definition. Whenever needed, this assumption of uniformity across regions for each productive sector was applied, for instance in getting a value for the stock of capital in year zero

d = (Repair Expenditure/Capital Stock), so

K_r = (Repair Expenditure$_r$/d).

Again the value of the capital/output ratio given by $\underline{k}$ is calculated as the average of the ratio of the stock of capital to the level of output over 5 years.

Finally, the data on the Input-Output table is far too detailed to permit extensive calculations like those that

were envisaged here. While it is not too difficult to invert the (340 x 340) matrix of coefficients from the DREE table for any impact analysis, when this matrix is seen to form the basis for only one set of equations out of 5 or 6 possible sets, the computational aspect of the problem could get out of hand. Thus the matrix was aggregated to a 4 sector, 10 region system so that the Input-Output system is now of order (40 x 40) only and is supplemented by a set of constraints due to factor availability, a set of financial equations, a set of income definition equations, and a government budget constraint in all experiments. In special cases, trade balance constraints for each region or for the nation and equality of income constraints are also imposed. The aggregated sectors now are given by

1. Primary Industry: including agriculture, forestry, fishing, hunting, mining and quarrying, and oil wells;

2. Manufacturing Industry: including both light and heavy manufacturing activity;

3. Utilities: including electric power, gas and fuel, telecommunications, transport services etc;

4. Service: including banking, finance, insurance and real estate brokerage, commercial business and trade activities.

This aggregation is done in two stages - along rows and along columns. Thus when a set of rows are aggregated, any sector i's demand from a new sector j (which previously comprised of sectors l,m,..p) is equal to the sum of i's demand from l,m,..p in the original table. Similarly when columns are aggregated, any sector t's supply of output to a new sector u is equal to the sum of t's supply to all of the sectors v,w,..z that are now aggregated into sector u. While this aggregation has to be performed in value terms, the respective coefficients are again obtained as fractions of the output of the receiving sector in the receiving region. These coefficients are then used to represent the demand for output for intermediate use in the commodity balance equations.

4.4 Data Values Directly Obtained

In the first 40 equations the remaining magnitudes that need to be obtained are estimates of the values of the exogenous variables, government purchases of goods and services, and investment demand for each sector's output. Both of these series are obtained from Statistics Canada publications, but the values are an aggregate for the whole province. These are split up into demands per sector by using the fraction of each sector's output in regional output as a

weight. This is the most convenient assumption in the absence of regularly available data on what proportion of government demand and investment demand are fulfilled from each sector. The actual number used for investment demand has to represent replacement demand only, and so is a fraction of the value in the Statistics Canada publication (13-213), the fraction being derived in conjunction with the depreciation rate d defined above.

The magnitudes on the right hand side of all the other equations are rather easy to calculate because these equations are seen to apply to the entire region and not to individual sectors therein. Statistics Canada 13-213 has full series on the magnitudes of the relevant variables required from 1961 on. Hence the right hand side of each of the financial equations is given by (personal + corporate taxes - government spending - investment spending) for each region. Similarly, in the equations defining income as the sum of value added plus transfers in minus transfers out and taxes, the magnitudes that are taken as given exogenously are taxes and government payments of wages and salaries. Taxes are a subtraction from income and given the way these equations are structured appear on the right hand side with a positive sign while government wage and salary payments add to income and so have to carry the opposite sign on the right hand side. The number finally used is the resultant of these

two numbers from the relevant columns of Statistics Canada 13-213.

4.5 Experiments

As is fairly clear by now, the concern for regional economic problems emerges from the equity related questions that arise when some parts of the nation cannot share in the fruits of progress and well being enjoyed by others. The model presented here is to be used for a series of experiments that will help determine what constitutes an optimal degree of government intervention in the market, if the government is to take on itself the task of curing the imbalances that result from a free market process. Such an investigation will help to make resource use more efficient by allocating factors to uses where their productivity or utility to the economy is maximised. Thus the experiments will normally be directed towards issues that arise when efforts are made to raise the standard of living in the poor and underprivileged regions to the level of the rich ones.

Foremost among these is the question of whether by imposing a constraint that requires equality of per capita incomes or consumption levels across regions, overall national output falls from the level attainable otherwise, and what the magnitude of this reduction is. If the results

of an experiment that does not incorporate this equity requirement can be called an "efficiency" solution (the result of an efficient market system complemented by some degree of government intervention), then the trade-off between equity and efficiency can be studied. In most of the experiments described in the following chapters, this trade-off is analysed under various assumptions about factor and resource mobility and given varied specifications of the regional or national trade balance constraint. These trade balance constraints will be imposed in varying degrees of severity to see to what extent some regions are forced to rely on imports to support an improvement in standards of living. Not only do these regions reveal a situation where imports rather than production may be optimal, they also may present cases where an estimate could be obtained of the shadow value of government equalisation payments to the provinces, as the latter may help relieve the relevant regions' financial constraint.

While the above is a general discussion of the experiments to be performed, the specific experiments run are as follows. There will be some analysis of the degree to which any region can raise its income per head by solely re-organising the pròduction structure to make it more conformable with local resource endowments. This version

constrains a region to grow relying on its own endowments only, since the trade balance and factor supply constraints are imposed separately for each region. A simple step towards relaxation of this strict set of conditions can be taken by imposing a national rather than separate regional trade balance constraints so that regions that need imports very urgently can afford to run up a larger deficit at the expense of some regions that are not so constrained by trade flows. Similarly the financial limit on each region's trade can be relaxed by allowing for more exogenous transfers.

Finally, the constraints on a region's economy can be relaxed by allowing for factor mobility across sectors and regions. These will be allowed for in two ways, with limits and with no limits on the amount of migration. Thus one can see to what extent a certain region's income alters when, for example, labour (or capital) is allowed to change by $\pm$ 20% compared to the state when this mobility is unchecked. Again, some variants will allow for mobility of one factor, some for mobility of both factors; some experiments will also be conducted with inter-sectoral (intraregional) mobility to see which sector it is most efficient to expand in any region - the sector is normally expected to be one in which the conflicting requirements of low factor/output ratios and high value-added coefficients are optimally satisfied.

Footnotes
(to Chapter 4.)

1. The first statement on this problem is in the work of Arrow. See "A Difficulty in the Concept of Social Welfare", Journal of Political Economy, Vol. 58, p328-46, 1950. Also Arrow, K. J., Social Choice and Individual Values, John Wiley and Son, New York, 1963. Despite these problems associated with defining a social welfare function that is non-dictatorial, a linear programming model is incomplete without an OF, the choice of variables and coefficients in which has to reflect the preferences of all of society.

2. Some of the problems associated with these simplifying assumptions are discussed in Section 4.3 below, while others are discussed in Chapter 7. These assumptions, relating both to the functional forms of the equations used and to the data values, make the model and the analysis much simpler; but each of these simplifications can be a source of reduced accuracy of the results.

CHAPTER 5: SOME PRELIMINARY RESULTS OF THE STATIC LINEAR PROGRAMMING ENQUIRY INTO THE PATTERN OF ECONOMIC ACTIVITY IN CANADA.

5.1 Introduction

The following two chapters are devoted to analysing the results of a series of optimisation exercises. Varying specifications of constraints and parameter values are used in order to study the extent to which these results depend on particular assumptions. The overall methodology of these two chapters is described in this section, while the specifics of the results are dealt with in later sections. To begin with, the results are divided into experiments with no interregional equity constraint (termed the efficiency solutions) and experiments with such a constraint (the equity solutions). The former results are analysed in this chapter and the latter in Chapter 6. In each of these cases the results cover a wide spectrum of assumptions, going from no resource mobility to an allowance for a 20% or 50% increase (decrease) in output due to in-migration (out-migration) of factors, and also to cases where there is no explicit limit on the amount of migration, so that the entire endowment of a certain factor in a nation can be transferred to just one region if the model finds it optimal to do so. Other variations of the experiments allow for restrictive or liberal specifications of the regional trade balance

condition, so that at one extreme each region's trade balance deficit cannot exceed an upper limit and at the other only a national limit is explicit while individual regions can transfer some of their deficits to others whose economies are not so dependent on trade flows (especially imports).

Furthermore, during the investigation it was noted that some constraints are more often binding than are others, and some variables attain (unrealistically) high values all too soon. Some experiments are conducted to determine the extent to which these results are due to any particular parameter values or assumptions, failing which these extraordinary results have to be taken to be a reflection of the respective regional economies. In what follows, cases with no factor mobility are discussed in earlier sections (Section 5.2) with the results of various mobility assumptions being discussed in later sections (5.3, 5.4). A brief summary of these findings is presented at the end of Chapter 6 with some links back to the theoretical discussion of the earlier chapters.

5.2 The impact of various specifications of the trade balance constraint on total consumption

In this section the main focus is on how the value of the objective function (OF) changes in response to more or

less restrictive trade balance requirements. Each sector in each region faces an upper bound on output brought about by the most restrictive of the two factors (capital and labour) so that mobility of inputs across space or across sectors is not allowed. The first experiment is with no trade balance constraint at all and in latter experiments this is made progressively more limiting. Hence the model maximises consumption subject to:

a) Demand-supply balances for each sector in each region, 40 constraints in all;

b) One financial equation per region, defining the asset market;

c) Income definition equations, 10 in all;

d) One national government sector budget constraint;

e) Other conditions or constraints imposed as and when necessary.

The actual magnitude of the national trade balance deficit yielded by the first run is taken as an outside limit, to which subsequent versions are constrained, and this is reduced progressively in latter cases to find out what is

the smallest national deficit that is consistent with a feasible solution. Again, the national constraint is replaced by 10 regional constraints, in which the upper limits on the deficit are equal to the actual level of the deficit in 1966. In the course of these experiments it was noted that imports of sector 4 (services) into each region are large. The causes and implications of this result must be ascertained. Is this result due to high consumption coefficients for the output of sector 4 or a result of high levels of intermediate and final demand (shown by the coefficient values given in the I-O table), and what happens to the OF when this import is subjected to upper bounds?

In the discussion to follow, the main variables stressed are the income levels per region, output per sector per region, and the three categories of transfers into (or out of) a region. The three facets of each result that are stressed are the value the relevant variable attains, the extent to which upper or lower bounds are seen to be binding, and whether shadow prices are zero or non-zero. While the first two of these relate to solution values of each variable, the third can be interpreted as showing the extent to which the OF could be raised or lowered by a unit relaxation of the constraint regarding supply of the variable.

5.2.1 No Trade Balance Restrictions

To begin with, a brief summary of the workings of the optimisation is presented. It is to be noted that:

1. An increase in ${}_rX_i$ (sectoral output) leads to:

i. an increase in supply of output produced and an increase in the demand for intermediate inputs in the commodity balance equation. The increased output also makes possible a higher supply of production for intermediate use in all using sectors in all regions. Since output is also used for final demand, it is not possible to say whether an additional unit of output raises supply by more than it raises total demand or not,

ii. an increase in intermediate imports and in the amount of output available for intermediate and final exports in the financial equations. Again, the final impact on demand depends on the magnitudes of the relevant coefficients in the I-O table,

iii. an increase in the value of income, and thus consumption, in each region,

iv. an increase in indirect tax revenues in the

government budget constraint.

2. An increase in exports (imports) ${}_re_i$ (${}_rm_i$) leads to:

i. an increase in aggregate demand for (supply of) output in the commodity balance equations,

ii. an increase in the trade surplus (deficit) in the trade balance constraints,

iii. an increase (decrease) in the financial resources available to the region.

3. An additional unit of TRPIN (TRPOUT) leads to:

i. an increase in injections (withdrawals) into the financial equations that add to the region's wealth holdings, and help finance larger expenditures (reduce the level of wealth),

ii. an increase (reduction) in the value of regional income and consumption.

4. An additional unit of transfers from the government (TRG) leads to:

i. both of the effects noted for TRPIN above,

ii. an increase in the value of expenditures in the government budget constraint,

iii. an increase in the output of at least one industry in one region, in order to generate indirect tax revenue to finance the additional transfers (or an increase in a weighted sum of sectoral outputs).

From the definition of equations, it is seen that the model maximises disposable income (the value of the OF, which is equal to total consumption) by increasing output per sector subject to upper bounds, by raising transfers into each region from abroad and from the government to their upper bounds, while reducing transfers out of each region to their lower limits. This is a very simple statement of how the maximisation is accomplished. As the objective is to increase the amount of output of each sector available after intermediate inputs have been subtracted, priority is given to raising the output of those sectors that have high value added coefficients and also to sectors whose outputs are most required for consumption. A major part of increased income is thus supplied by increased output. But since more output of any sector is also available through imports, the model can allocate foreign exchange resources to regions and sectors

whose output is in high demand. In experiments in which no equity constraints are imposed, the income level of each region carries the same weight in the objective function, so that the model increases the output of the region whose output can be increased most easily subject to the constraints. But in the versions where an equity constraint is imposed, the model forces up the level of income in the poorest regions first, even if this means a relative loss of income in the other regions.

In most of the experiments described below it is noted that the output of sector 4 (the services sector) is in high demand for final use, so that the upper limit on its output defined by factor availability is always binding. Since the output of this sector could still be used to increase consumption if more were available, the output also carries a high shadow price (adding one more unit of output leads to a relatively large increase in the OF). If the model were free to import as large a quantity as is optimal, it would import a very large amount of the output of sector 4. But given that trade balance constraints are also imposed, the model maximises this import subject to bounds, and in some cases is seen to export the output of some other sectors so that a higher import of sector 4 is possible, while remaining consistent with the trade balance constraint.

Transfers from abroad help the model in relaxing the severity of the trade condition because these are payments that allow the purchase of more imports, as do exports. Hence, to the extent that these transfers are available, the model can import more of the output that is required to help raise the value of the OF. Transfers from abroad also increase the level of wealth. Transfers from the government perform these functions and also help offset the tax revenues that are generated when production of output generates indirect taxes, and so help satisfy this constraint. In order for output to increase, government transfers must increase since the government budget constraint holds as an equality and government spending is fixed. Government transfers are also a direct addition to disposable income. In case the output of any region is in high demand for intermediate use, the model is forced to produce in this region to supply inputs to other regions. Similarly, if some region relies heavily on output of an industry that uses large amounts of intermediate inputs and a reasonable magnitude of these are imported, the model is seen to allocate a large fraction of foreign exchange resources to this region so that the required output can be imported. Since private transfers into and out of any region are relatively free variables, these are used to satisfy any shortages or excess in the trade constraints for any region.

As is mentioned in the section defining data values (Chapter 4.3, 4.4 above), the I-O table for the 10 provinces (Zuker 1976) endogenises only a part of total primary factor payments. As the ratio of value added to output that is derived by not considering rental and profit incomes is expected to be an underestimate of the true value, the results derived from the first experiment (summarised in Table 1) are expected to impute a far smaller proportion of output to value added (income) than is actually true. Thus while the sum of sectoral outputs in Table 1 is far higher than the actual level in that year (119 billion to 63 billion), predicted national income is less than actual income (31.9 billion rather than 39.8 billion). Again as this run does not incorporate indirect taxes in the government's budget constraint, it is not too relevant for any policy prescriptions. This underestimation of the value added coefficient is removed by defining value added to be equal to gross output per sector less the amount of intermediate inputs used, and the amount of indirect taxes paid.

Once these changes have been made, a significant improvement is observed in the model's ability to predict income and its relation to total product, as shown by Table 2. Here the sum of sectoral output is about 1.7 times the actual level in 1966, while the level of predicted income is 1.79 times greater than observed income, so that the fraction

of output attributed to value added is more realistic. The incorporation of indirect taxes in the government sector's budget constraint allows the government to fulfill the exogenously given demands for goods and services and to meet the balanced budget requirement with positive transfers to all regions. This budget constraint imposes a bound on aggregate national output independent of those imposed by factor supplies. As there are limits on the amounts of TRG, the constraint being an equality, there is a finite maximum of tax revenues that can be generated in the model (and hence a maximum weighted sum of sectoral outputs that can be produced) that satisfies this constraint. Indirect taxes are uniform across sectors within a region. It is unlikely that these two limits would coincide; thus the fact that production of one sector (sector 2, manufacturing, in Quebec) is below the bound defined by factor availability (7248 million compared to 14085 million) can be explained by the limits on national output implied by this constraint. The output of all sectors in all regions except this sector is seen to reach the factor supply bound. This sector's output is reduced by the model first of all because the ratio (value added/indirect tax) for this industry in Quebec is the lowest of all productive activities. Hence per unit contribution to the OF, this sector contributes the most to the constraint that is binding on the economy. The shadow value of the most binding constraint in this run is equal to the (value

added/indirect tax) ratio and can be interpreted as the income equivalent of the marginal tax rate, i.e. the increase in the OF that could be obtained if this constraint were relaxed by one unit is given by the amount by which each sectoral output contributes to the OF relative to the increase in each output made possible by a unit relaxation of this constraint. This compares well with the fact that the long run multiplier derived from most macro models is the inverse of the marginal tax rate. It is also possible for the government budget constraint to hold in the opposite direction. If the output of all sectors in all regions is at the factor supply limit, there is an implied limit on total transfers because of the fixed tax revenues generated. Hence one or more of the government transfer variables would be below their upper bound in this case. This case does not occur in any of the experiments to be described below.

There is an export of sector 1's output (primary industry) from Manitoba, Saskatchewan and Alberta, while there is a surplus of sector 2 output in Newfoundland, Nova Scotia, New Brunswick, Ontario and British Columbia. There is an export of sector 3 (utilities and communications) from all regions (except Saskatchewan) while no region exports the output of sector 4, mainly because of the presence of particular coefficients, analysed in detail in Section 5.5 below. The Atlantic provinces, Quebec and British Columbia

import the output of sector 1, while Quebec, Manitoba, Saskatchewan and Alberta import sector 2 also. There are no significant imports of sector 3 while imports of sector 4 are very high for all regions. Overall, there is a trade deficit in all regions, ranging from 20% of regional income for Alberta to about 45% of income for Prince Edward Island. The deficit implies a reduction in assets or wealth in the financial equations, and has to be met by a maximum of transfers from abroad and from the government. The model is thus seen to follow the course outlined earlier - outputs are raised to whatever levels are possible and/or feasible, and so are transfers into each region, while tranfers out are minimised. If a given region does not have a large production base to satisfy its local demand, consumption is provided through imports - e. g. Prince Edward Island. As transfers from the government also help satisfy the government budget constraint, they have a special utility for the economy. The pattern of shadow prices associated with each activity is shown in Table 2a. It is noted that the shadow prices associated with transfers from the government are the highest of all, followed by shadow prices for other transfers, and finally the values of shadow prices for output variables. Shadow prices for manufacturing are the lowest among all sectors as their value added to indirect tax ratio is lower than the ratio for other sectors in each region. Similarly, the shadow values associated with each region's sector 3 are

higher than those of sector 4 because the former has a higher value added coefficient than the latter.

The above analysis can be verified by examining the numerical values of the shadow prices reported in Table 2a. The shadow price of the government budget constraint (an equality) is 2.308 which equals the ratio of value added to indirect tax coefficients (.3831/.1660) for sector 2 in Quebec. This sector has the lowest such ratio and is the only sector producing below its upper bound. The ratio represents an amount by which Quebec's income could be increased by allowing one more unit of indirect taxes to be collected. The shadow price on each government transfer variable (all are at the upper bound) is 3.308. Allowing one more unit of government transfers to any region increases income by one unit directly and in addition allows one more unit of indirect taxes to be collected in sector 2 in Quebec. The shadow prices of the constraints on outputs in other sectors are also consistent with this interpretation. For example if the output of sector 2 in Newfoundland is increased by one unit there are two effects. Income in the region increases (by .492 units) but indirect taxes (.092 units) are transferred to Newfoundland reducing income in Quebec (.212 units). Since imports are unconstrained, the additional intermediate inputs are imported with zero opportunity cost. The shadow price is the net increase in income in

Newfoundland and Quebec taken together (.280 units).

5.2.2 Regional or National Trade Balance Constraints

In the sets of experiments above each region's trade deficit, though deemed optimal by the solution at a level 20%-25% of income, is far higher than the actual value in that year. The next set of experiments discusses the impact of constraining this deficit to the actual value for 1966. But there is a problem with using this criterion for the constraint because in 1966 the trade balance for Ontario and Quebec was in surplus. Now if a constraint imposes an upper limit on the amount of surplus these regions can sustain, the specification is still consistent with a deficit of any magnitude. (See Section 5.5 for a discussion of why it is not feasible in this model to restrict the trade balance deficit for Quebec and Ontario). The results shown in Table 3 depict a very high deficit for these two regions, a value of close to 30% of regional income. To some extent this deficit is a reflection of the economies of these two regions being dependent on manufacturing output, which uses relatively large magnitudes of non-competitive imports. Since production of any output is going to lead to these imports, the solution may deem it optimal for these regions to import the output, rather than domestically produce it. The level of imports of sector 4's output in each of these exercises is very high on

account of its high final demand coefficients, especially for consumption.

In the present case the pattern of transfers to each province reflects the asymmetry in the specification of regional trade balance constraints for Ontario and Quebec versus all other regions. As a result of a high deficit in Ontario and Quebec, transfers into these two provinces reach their upper bounds while these are zero for all other provinces. Simultaneously, transfers out of these two provinces are zero but these are positive for all other regions. Not only are these transfers seen to display this pattern across regions for the present but also for subsequent increases in the value of the OF because shadow prices for transfers to Ontario and Quebec are high, as are shadow values associated with transfers out of other regions. Output levels of each sector again reach the upper limits allowed by factor availability (except for sector 2 in Quebec and Ontario). In this case as the trade balance is constrained, it implies a limit on the amount of transfers allowed in the financial equations. This limitation on TRPIN, in addition to the limitation on output via the government budget constraint, implies that the OF now is more constrained than earlier.

The impact of an upper limit on the imports of sector

4's output is seen in Table 4. In addition to significantly lowering the value of the OF this constraint is seen to realign outputs quite a bit. As this import is put at an arbitrary limit, lower than the level that the model deemed optimal earlier, a larger amount of imports is feasible for other sectors and so the outputs of a significant number of these (most often sectors 1 and 2) is set at a figure below the bounds and the balance is imported. Now imports and exports of sector 4's output carry high shadow prices because the value of the import variable reaches its upper bound. Since one of the causes for a severe trade balance deficit is now removed, each region finds its trade balance to be much less of a constraint than before, so that shadow prices for transfer variables are reasonably low. The relative ordering is still in favour of Ontario and Quebec as transfers to these provinces are closer to the limits allowed than are transfers for other provinces. As a result of the reduced supply of sector 4 there is a significant fall in total consumption (sector 4 contributes about 65% of its output for final use). Since consumption is equal to income, this leads to a lower level of output through the value added coefficients. The lower level of output on the one hand implies that a lower level of TRG can satisfy the government budget constraint and on the other hand leads to a reduced requirement for imported inputs. As a result, the level of TRPIN is also reduced from Table 3 levels. Each of these

effects contributes to the low income level observed.

Even though from the last two results it seems as if Ontario and Quebec are the only two regions for whom a large deficit is feasible or optimal in the model, it actually stems from the nature of the specification of regional trade balance constraints. On closer observation of the results in Table 2 it is noted that when there are no constraints on the trade balance, each region's deficit is 20%-25% of the income level, going from 20% for the western four, Ontario and Quebec to about 33% for Newfoundland, Nova Scotia and New Brunswick to about 50% of income for Prince Edward Island. The actual deficit in 1966 when used as an upper limit severely reduces the amount of this deficit for all provinces, with the largest reductions being for Alberta, Saskatchewan and Manitoba. Thus in the model these regions do not need to significantly reduce wealth to finance the excess of spending over income - there is correspondingly a far smaller need for transfers to finance this spending. However the structure of this constraint allows Ontario and Quebec to have a trade deficit close to the 25% of income figure that was found to be optimal. To finance this deficit these regions need transfers from outside, and if in a certain experiment the deficit can be financed out of government transfers alone there is a correspondingly smaller need for transfers from abroad, otherwise both these transfers reach

the upper limits.

But if a national trade balance constraint is imposed so that each region has more freedom to run up its own trade deficit to the level it finds optimal the picture changes significantly, as shown in Tables 6 and 7. The level of the national deficit observed in Table 2 (where no trade constraint is imposed) is about $18 billion, which is seen to be split up fairly evenly among all provinces in that table. The deficit for Ontario and Quebec is close to the 5 or 6 billion level, but in case of the Atlantic provinces the level is almost 100% higher than the regional deficits imposed in Table 3, with an even larger increase from the Table 3 levels for the western provinces. This deficit is close to 25% of regional income. In Table 6, the maximum national deficit allowed is reduced by approximately 60% from this level to $8000 million. This results in a significant change in trade patterns across regions, with Ontario and Quebec running high deficits while the marginal deficits observed for British Columbia, Manitoba, New Brunswick, Newfoundland, Nova Scotia and Prince Edward Island are offset by surpluses for Saskatchewan and Alberta. This deficit pattern reflects the structure of production found to be optimal in this exercise. It was noted earlier (Table 2) that the model reduces to zero or low levels the output of sectors with low (value added/indirect tax) ratios. Since the present

case is one in which the trade constraint also limits the OF, the model forces to zero the output of all sectors that either have high indirect tax coefficients or lead to significant imports of inputs. This results in sectors 1 and 2 in all provinces except Manitoba, Saskatchewan and Alberta producing at a zero level, while for Manitoba, sector 2 alone produces at a zero level. Sectors 1 and 2 both produce at capacity in Alberta and Saskatchewan. As the balance of output required has to be imported, there are significant imports of the outputs that are not produced into all regions.

Summing the financial constraints across all regions nets out intraregional trade, leaving the national trade balance related to the sums of transfers in, transfers out and government transfers. If transfers in are at their upper bound and transfers out at their lower bound, government transfers and thus indirect taxes and output are limited by the national trade balance constraint. As a result, the regional financial constraints and the national trade balance constraint all have the same shadow price. The sum of shadow prices for all other constraints combined is equal to the shadow price for the regional trade balance constraint for each region. For Ontario and Quebec, the material balance constraints are also binding, and the sum of these equations across all 4 productive sectors imposes a constraint on

material balance equation, while the shadow price of government transfers is subtracted. The reason why subtracting this shadow price for these two regions while adding it for all other regions leads to the same shadow value is because this transfer variable is positive only for these two regions, zero for all other regions. Thus the model finds it optimal to reduce TRG to all other regions and raise it to Ontario and Quebec. In each region's financial equation, the TRG variable enables a higher level of deficit to be financed. It can be concluded that it is optimal to have Ontario and Quebec run up a deficit to obtain the outputs of sectors 1 and 2. These outputs are used in significant amounts for intermediate inputs, but domestic production also leads to large non-competitive imports of inputs. As in each region's financial equation, all 4 sectoral export and import values appear with the same sign and coefficient, the model is indifferent between which particular sector's output is exported to provide more imports of sectors 1 and 2. This indifference among sectors is borne out by the fact that all sectoral outputs in a region attain the same shadow prices in the solution.

In Table 7 this same national trade balance constraint is imposed alongside limits on sector 4's imports. As in the earlier case with these import limits, there is a large fall in the value of the OF. But more significantly the

national trade balance constraint is free by about 45%. A lot of this is due to the curtailed supply of sector 4 to Ontario, from around 10 billion to only 1750 million. As a result, Ontario's economy cannot operate at a very high level, and because now its output of all of sectors 1-3 is below potential, there is less of a supply of the outputs that are used in reasonably large magnitudes by all sectors in all regions. The reduction that this forces on output levels in the other regions is large, though there is still a need for significant transfers to all regions except Ontario, which now can finance its own deficit from its own resources because its economy is not operating close to capacity.

5.3 Factor Mobility, Intra-Sectoral, Interregional

Factors are allowed to move in various stages between regions but within the same sector (geographic mobility). In this case the results obtained from the model define regional comparative advantages - i.e. the results reveal which region can produce any specific output with a lower shadow cost of inputs per unit of income generated. Solutions which include zero outputs for some sectors are to be expected as are extraordinarily high outputs for other sectors in other regions. While this can be justified as a direct result of regional comparative advantage in the production of these commodities, in reality not only are these extremes of zero

and very large outputs politically unacceptable, the economic reasoning behind them may be faulty as well. This is so because, while at any one time one region may be using lower amounts of inputs per unit of output than other regions, when the output of this sector in this region is increased by a factor of 20 or 30, regional input use coefficients are not expected to remain invariant, and the result may well be that this region is no longer the best region in terms of input use ratios. Hence this mobility is allowed for within limits so that each region is allowed to raise output of any one sector 20% or 50% because factor availability is increased due to factor migration from other regions. The model is most often seen to follow a Max-Min framework in these mobility experiments. Thus the solution searches for the most constraining factor in each region (per unit contribution to the OF) across all sectors, i.e. Min (K/k, L/l). Then resources are allocated first to a region that has the highest of these minima, till a bound or a limitation on the variable from some other constraint is hit, and then to the region whose minimum is the second highest, and so on till the factor in short supply is exhausted. In all the experiments below, at least one of the constraints due to the availability of one of the factors is always binding.

No costs are associated with movements of factors. Thus the results of these experiments should be interpreted

as showing what would have happened if the allocation of capital and/or labour across regions had differed from the observed historical pattern.

5.3.1 Mobility with no bounds on output; two trade balance specifications

The allocation of production in this case is dependent upon value added and factor input ratios for both inputs. Thus the model checks for regions with the highest (value added/factor input) ratio for any factor, and allocates labour and capital resources to the region where the highest income can be generated. An example of this allocation can be seen in Table 8. Although Alberta and British Columbia have the highest (value added/labourinput) ratio for sector 1, production is allocated to Ontario alone, the value of output being about $30 billion even though Ontario's value added/labour ratio is low. This apparent discrepancy is removed when the capital constraint is looked at. The production of this amount of output in the western two provinces violates the capital constraint. This Min-Max schema determines the region to whose particular sector labour and capital are allocated. However, the overall amount of output it is possible to produce is determined by the magnitude of tax revenues generated and transfers allowed in

the government budget constraint. Since some commodity balance conditions are again binding, it is noted that the shadow prices for individual activities do not match those for any constraint, and each variable is constrained by a number of equations and inequalities.

The above mentioned extremes of zero output for some regions and very large values for other regions is borne out in the first set of results (Tables 8, 9), because the output level of two of Alberta's production sectors rises far above existing levels. Alberta's income level too is seen to be almost 8 times the actual figure in 1966. In these results most regions (6) produce only one output, and some produce two or more, and because of this specialisation in production, each region has to import all of its requirements of other sectors. This results in very high trade flows and very high deficits for all regions (except Alberta) which are financed by each region getting its full complement of transfers from abroad and from the government. As in this case there are no bounds on output per sector per region, and there is only a limit on national output per sector, the solution values are the optimal values. Because these values by themselves are optimal and no further increases are feasible or preferable, these variables carry no positive shadow prices. The highest shadow prices observed are for transfers from the government followed by the values for

transfers from abroad.

When 10 regional trade balance constraints are imposed each region has to produce at least one sector's output to be able to export some output and get the imports it needs in return, and remain within the bounds defined by its own trade deficit. This results in a transfer of some factors to regions that are not the first choices, and so there is a slight fall in the value of the OF. Trade flows are still quite large because of the fact that each region still specialises in only one or two sectors and imports the outputs of others, but now the shadow prices for all material balance constraints are not zero because some output has been shifted from the first choice regions to other less efficient regions. A one unit reduction in the output of these latter regions will free enough factors to enable a larger increase in output in other regions, and this scenario is confirmed by the structure of shadow prices. However, with the regional trade balance specification, all regions except Ontario and Quebec are forced to very low levels of deficits, and so need very little by way of private transfers in, while the shadow values for transfers into these two provinces are almost twice as high as the other shadow prices.

5.3.2 Mobility with upper bounds on outputs

When these results are compared to the versions where output can only be raised within limits of ± 20% because of increased factor availability - Tables 10, 11 - there is production of more outputs within each region than was seen in Tables 8 and 9 and hence there is far less specialisation by each region. Since factors are allocated in each sector to the region with the lowest value added to input use ratio till some bound is reached, then to the next region and so on, subject to the indirect tax constraint, it is the output of each sector that is a constraint on income growth, and not the availability of foreign exchange to finance a trade deficit, since this constraint is not binding. Hence the shadow prices associated with outputs per sector are higher than those for transfers from outside or from the government. With a national trade balance specification there is more trade in the economy by almost all regions (Ontario and Quebec excepted) while in the case of the regional trade balance constraints, all regions except these two provinces cannot run up a large trade deficit and so are not in need of significant transfers from abroad or from the government. Since the overall national economy is more constrained by regional trade balance conditions than by one national constraint, in each of the above cases the value of the OF is 10%-15% lower in the exercise with the former condition

imposed than it is with the latter.

5.3.3 One factor mobile at a time

When factors are allowed to move about between regions within any sector, national output is seen to be higher than the versions where no such mobility was allowed for. As this allowance for mobility relaxes the more limiting conditions on output, it is useful to study which of these factors is the more restricting factor. This investigation is performed in the following manner:

The amount of factor mobility allowed for any one factor is given by the above mentioned system of equations while the other factor is, at one extreme, left totally free and at the other, is used only to specify very liberal upper bounds on output (these bounds being equal to 1.5 times the amount of output that could be produced by the factor supply available to the region in isolation).

In these cases where mobility of only one factor is allowed, there are instances where the other factor is left completely free (see Section 5.4.1 and the relevant sections in Chapter 6 in addition to this section). The reason these cases are analysed here is solely because it was felt useful to find out which of the two factors was the more stringent

constraint on overall national and specific regional incomes. Such an experiment could only be performed if there was a limitation on income and output from this specific factor alone, with no constraints due to the other factor. This is the reason why the level of the deficit allowed in the national trade constraint is also not altered in various experiments. By leaving one constraint unaltered (say the trade balance) and allowing for various specifications of the other (factor mobility) and vice versa, the impact of each individual constraint can be determined and compared to the effect of the other constraint. Thus for example comparison of Tables 4, 6, and 7 with Tables 8, 9, 12 and 13 yields the relative effectiveness of trade versus factor movements in raising the level of income. To quote one of the results, with strict factor immobility and no trade constraints, Table 2, national income is about $70 billion, but with free mobility and a national or 10 regional trade constraints, this income level is between $87 and $73 billion (Tables 8, 9). These results are described in Tables 12, 13 for mobility equations for capital and labour respecitvely with no bounds on output. The OF is now seen to be clearly higher than the corresponding cases with constraints due to both factors, but the case where capital is mobile leads to a higher value of the OF than the version where labour is mobile. It is thus to be concluded that for the Canadian economy as a whole it is labour that is the most stringent

constraint. Since both these tables show cases where a regional trade balance specification was used, they can be compared with the results of Table 9. As there are no upper bounds on output, non-zero shadow prices are seen for only a few of the outputs. There is the well established transfer of large amounts of output to the two provinces of Alberta and British Columbia in this case also. The 5 eastern provinces produce only the outputs of sectors 1 or 2 while the high value added sectors 3 or 4 are positive only for Alberta and Ontario in both tables. The only exception to these cases which is of considerable interest is the version where labour is relatively free and capital mobility is defined by the equations. In this case the output of the services sector (4) in Newfoundland is very high, the increase being more than 10 fold. While this increase itself should be viewed with caution given the doubts expressed earlier, it may be concluded that this sector in Newfoundland is relatively labour intensive, and that its capital use ratios are about the lowest in the nation.

In both of these cases the previously observed phenomenon of high trade deficits for Ontario and Quebec is seen but in this case there is a significant high value for government transfers into Alberta as well. When the mobility allowed is that of labour the transfer of outputs from all other regions to Alberta is even more pronounced than in the

case where only capital mobility is allowed. This is a reflection of the relative "modernness" of Alberta's production structure with its very low emphasis on labour inputs relative to the rest of the country. In these cases where labour and capital are allowed to move out of one region into others in response to low input use ratios, Alberta and British Columbi almost always attain a far higher income level than at least Quebec and at times even that of Ontario.

5.3.4 One factor mobility, bounds on output

The two results that are the easiest to observe when upper bounds are imposed on output per sector per region (Tables 12a and 13a) are the fall in overall national income (as shown by the fall in the value of the OF) from about $81 billion with capital mobile ($75 billion with labour) to about $63.7 billion ($60.6 billion) and the fact that now output levels are positive for most sectors in all regions. The former results from factors being shifted from their most productive employment to other less productive regions as upper bounds become binding in the more efficient ones. Even with the bounds imposed there is a substantial shift of factors among regions because the final result is an output level in Alberta and British Columbia that is greater than that of Quebec, whereas the actual position in 1966 showed

that Quebec's income level was almost three times as great as that in these western provinces. Since the bounds allow each region to raise its output per sector by as much as 50% via increased factor supplies, the shift of a large segment of the working population to the western regions leaves little or no factors for Quebec and as a result there is no production of sectors 1 and 3 in the latter. This evidence that the production structure of Quebec uses relatively more inputs per unit value added than a few other regions does not make too much of a case for the location of production facilities there, and the loss of output that is incurred by transferring production there from other regions is likely to be substantial. Hence, unless production in the eastern provinces like Quebec can be substantially modernised, a better method of income generation may be via the unconventional route of production in the western provinces and the provision of purchasing power to the eastern regions through federal government transfers. It also means that any investment in improving the production structure in the eastern provinces is likely to yield large dividends in the form of substantial increases in output.

In this exercise again most output values hit their upper limits, and there are substantial trade flows, but for a change it is the production sectors of Alberta and British Columbia that display the highest shadow prices (higher than

those for any productive sectors observed so far). However, overall shadow prices are still higher for transfers into Ontario and Quebec when these regions are seen to face large deficits. From the values seen in Tables 12a and 13a it is again clear that a higher income level can be produced with capital binding than with labour binding so that labour is the more binding constraint on the national economy.

5.4 Inter-sectoral, intraregional factor mobility

In this case of intraregional factor mobility not too much is revealed by the results about the interrelations of various regional economies in the national system, of how the national structure is dependent on various regions and what trade and factor flows help link the regions together. This is so because each region is now constrained to produce the maximum output it can from its own factor endowments alone. Thus the model is expected to stress the sectors in each region that use low ratios of inputs per unit of value added regardless of how useful or redundant this sector is to the national system, as the output can always be exported. However, the importance and utility of each sector for each region is brought out now because the allocation of a fixed magnitude of resources to the four sectors in each region has to result from a balancing of very different factor input ratios and value added coefficients. In the earlier cases

these input ratios and value added coefficients were not too dissimilar between the sectors competing for the resources (as each individual sector is expected to have a fairly uniform input structure across the nation). But in the current run input use ratios differ by a factor of 3 and value added coefficients also differ from a low of around .40 of any sector's output to a high value of .75 of output between the relevant sectors.

5.4.1 One factor mobile at a time, with and without upper bounds

The fairly consistent pattern that is seen to emerge with all regions in this experiment (Tables 14, 15) is that except for Ontario and Quebec all provinces produce the output of sectors 1, 2 and 4 at or close to upper bounds while sector 3 is produced in smaller amounts or not produced at all in any of these regions. There are two cases where this pattern is not seen, both in the case where labour is the relatively mobile factor while capital mobility is defined by the equation system. In case of Nova Scotia and Prince Edward Island this results in zero outputs of sector 4. For the provinces of Quebec and Ontario it is sectors 1 and 2 that are most often produced at low or zero levels while the output of the other two sectors is at the bounds allowed. The regularly observed high deficit in both Ontario

and Quebec is again seen in these exercises, so shadow prices again are high for federal government transfers to these provinces while for the other provinces it is the shadow value of transfers out of the province that are high. There are positive shadow prices for most outputs also but these are significantly lower than those for the transfers listed above.

5.5 A Summary

In all the cases of the regional trade balance constraint, there is an asymmetry in the specification for Ontario and Quebec relative to the specification for all other regions (5.2.2 above). Since the bounds on the deficit are taken from the actual level in 1966, the trade balance for Ontario and Quebec is in surplus, and as a result, the national deficit is only $325 million. This level is not found to be feasible in various experiments with the model; in fact the lowest level that yields a feasible solution is $3000 million. Thus the level of deficit used in various exercises with a national trade constraint in the model is not the same as that implied by the 10 regional deficits in the regional trade constraint cases. However, the regional trade constraints for Ontario and Quebec are free to run up any deficit, so the model is allowed to sustain at least as great a national deficit in the regional trade constraint

case as in the national trade constraint case. The asymmetrical treatment of Ontario and Quebec is also forced on the model by the feasibility requirement because in case an arbitrary limit is imposed on the deficit for the 2 regions (not quoted here), the result is an income level almost 33% below the actual level in 1966. This asymmetry is thus maintained in the experiments described because the model does not seem to be able to handle a strict restriction on the supply of various sectoral outputs in Ontario and Quebec.

These results enable some general conclusions to be drawn about the overall nature of various regional economies. First, despite the fact that the two industrial provinces of Ontario and Quebec are able to produce and rely heavily on the output of the manufacturing sector (sector 2), there is also a high level of (mainly intermediate) demand for this output from these two provinces so that there is not too much of a surplus left for exports. In most experiments this sector's output is not exported from these two provinces. Again whenever a trade balance constraint is felt to be severe, this model puts the output of these two region's manufacturing sector at zero. Rather than produce the output domestically and have to pay out scarce foreign exchange resources for non-competitive imports, the model puts output at zero and imports whatever amount is required by the

regional economies, which seems to be the best way to satisfy the trade balance condition. This result probably also reflects the low value added (high intermediate demand) coefficients for manufacturing in Ontario and Quebec.

Again, more often than not, it is optimal to produce and export the output of sector 1 from the four western provinces, and from Quebec and Ontario than it is from the eastern provinces. This reflects not only the fact that agriculture and primary mining and extraction sectors dominate the economies of the western provinces but also the fact that there is not too high a demand for these outputs for any intermediate or domestic final use so that a surplus is always available for export. The results obtained for sector 3 and 4 seem to reflect the presence of trade and financial constraints, and also result from the differences in value added and final demand coefficients. While both of these sectors depict fairly high value added coefficients and thus contribute significantly to the OF, the fact that more of the output of sector 4 is used for final demand than is the output of sector 3 leads to a situation where it is optimal for all regions to produce and import sector 4's output while the trade balance condition, requiring some exports to compensate for this deficit, is satisfied by producing the output of sector 3 at its limit and using the surplus for exports.

Although these sets of results do not help too much in analysing how the picture would change with some form of equity imposed on the optimisation, they are still indicative of the utility of government transfer payments to the provinces. In each case it is most often the government's transfers to provinces that attain the highest shadow prices among all variables, and these thus represent cases where the most stringent constraint on each region's economy may not be a production or supply constraint but the above defined financial constraint on the ability to pay for an excess of spending over income. The government budget constraint is also a limitation on income because there is only a finite amount of transfers allowed in the model, and so only a limited amount of indirect tax revenue that can be generated.

Chapter 6: SOME FURTHER RESULTS OF THE OPTIMISATION FOR CANADA.

6.1 Introduction

This chapter discusses some of the results that were obtained from optimisation exercises in which an additonal constraint was imposed, i.e. that the level of per capita income (consumption) in all regions be forced to equality. This constraint was imposed in the following manner:

$$(6.1M) \qquad (1/{}_1P)({}_1Y) = (1/{}_2P)({}_2Y) \;;$$

$$(6.2M) \qquad (1/{}_2P)({}_2Y) = (1/{}_3P)({}_3Y) \;;$$

$$\vdots$$

$$(6.9M) \qquad (1/{}_9P)({}_9Y) = (1/{}_{10}P)({}_{10}Y) \;;$$

where

${}_rP$ is the population level in region r, and

${}_rY$ is the level of income in region r.

In this chapter the results are an extension of the discussion of the previous chapter and so the respective sections that follow are extensions of the corresponding

sections in Chapter 5. The only cases discussed in detail, therefore, refer to results that were obtained from adding an equality constraint to the experiments analysed earlier. The pattern of the text is the same as before with the equity constraint first imposed alongside various trade balance conditions and no resource mobility, followed by the different categories of factor mobility. In each of these cases the results are compared to those obtained from similar versions in Chapter 5, with special mention being made of significant changes in shadow prices because these prices reveal which constraints are now found to be the most binding. The concluding section of this chapter presents a detailed analysis of the structure of various regional economies and how various distributions of trade and factor flows are optimal in specific versions of the model.

6.2 Two Specifications of the Trade Balance Constraint

The following subsections focus on the impact of this equity condition alongside regional and national trade balance constraints, in each case there also being a discussion of the versions with restrictions on the imports of sector 4. It is to be expected that in these runs the model will yield reduced income levels for at least Alberta, British Columbia and Ontario, while the income levels of all of the Atlantic provinces will be increased relative to the

experiments with this constraint not imposed.[1] National income is also expected to be lower in the versions with equity superimposed on the optimisation because now resources have to be transferred to the less efficient provinces to produce outputs there.

In this series of experiments with an equity constraint, the model goes through the following stages:

1) Transfers into the poorer regions are raised to their upper bounds first, followed by transfers to other regions. This helps to raise incomes in the poorer regions.

2) Outputs are raised to the bounds allowed by factor availability per region and sector, or are constrained by the limit implied on a weighted sum of regional outputs by the government budget constraint.

3) As there are limits on the amount of income that can be generated in any region, and a limit on the extent to which each region can live beyond its means by using transfers, the equity constraint is best satisfied by lowering the level of per capita income in the richer regions to the level of the poorest region.

4) When there is no explicit bound on regional output per

sector, the only limits that can be effective are those due to the government budget constraint. However, any particular region's output will be raised to a level far higher than that possible with local resources alone. The equalisation of per capita consumption levels is now accomplished more via trade flows than through transfers of output.

Even though this seems to imply that the equity condition results in a severe loss of output and income compared to the "efficiency" solutions, the picture is not as pessimistic as it seems. As a result of the more efficient organisation of economic activity in the optimisation, national income is never lower in the model than the actual level in 1966 (except where the imports of sector 4 are restricted - and these cases are obviously stringent constraints on the free allocation of resources to their most productive uses) even with the equity condition. Thus it can be claimed that through a more efficient allocation of existing factor and financial resources, the economy can sustain an income level higher than the current level and attain perfect equality of incomes across all regions. It is true that in all of the results described, the trade deficit observed is far higher than the actual level in 1966. To the extent that this magnitude is considered unrealistic, the results of this model and various policy prescriptions that emerge have to be scaled down.

6.2.1 Regional trade balances, equity conditions, bounds on imports of sector 4

In the first set of results that can be compared to versions where the equity condition is not imposed (Tables 3, 16 and 4, 17) the first point to note is that Prince Edward Island has all 4 of its productive sectors operating at capacity while all of the other 9 regions have at least one sector (and except for Newfoundland and British Columbia this sector is always the manufacturing sector) producing either a zero output or at a level below the upper bounds allowed. Two sectors are seen to operate at a zero level in Saskatchewan (sectors 2, 3) while in Alberta sector 2 operates at the zero level and sector 3 produces less than 10% of its capacity output, (see Table 16). When the level of national income and its distribution across provinces is looked at closely the expectations about results are borne out because, while there is a 25% odd reduction in overall income from a level of $56 billion in Table 3 to about $42 billion in Table 16, its impact across regions is quite varied. Thus, for instance, there is a reduction of almost 50% in income levels for Alberta and close to 35% for British Columbia, close to 30% for each of Ontario, Manitoba and Saskatchewan, and 15% or so for Nova Scotia, New Brunswick and Newfoundland, but there is

a fall of only 2% in Quebec's income level and there is a marginal increase for Prince Edward Island. The eastern 5 provinces are the high gainers relative to others from this equity exercise, the order being Prince Edward Island, Quebec, and Newfoundland with Nova Scotia and New Brunswick following. As the output level of sector 2 in most cases was set to zero, this output is imported by all except British Columbia and Newfoundland, while the low level of final and intermediate demand for sector 3 makes this ideal for exports. Only the 3 Prairie regions export the outputs of sector 1 and not of sector 3; all others find it optimal to export sector 3 and import the respective output they did not find it optimal to produce (especially sector 4). The structure of shadow prices in this experiment shows that the regional economies are held back by the limited income growth possible in Prince Edward Island because its 4 production sectors have shadow prices nearly 100 times as high as the shadow prices for any other productive sector. Not only are these the highest shadow prices for outputs in any runs seen so far, these go as high as a figure of 139 for the output of sector 4.[2] This leads to the conclusion that overall national income growth in this exeperiment is held back by the lack of production facilities and opportunities in Prince Edward Island. As a result, the model is forced to operate all other regional economies at a level below their capacity in order to equate per capita consumption and incomes.

Turning to the magnitude of trade deficits, it is seen that while the limits of the allowed deficit are hit by all the Atlantic provinces and the deficit for Ontario and Quebec is the high value seen earlier, each of the western provinces is either seen to run up a trade surplus or a marginal deficit. This is another evidence of the fact that the western provinces rely heavily on the output of sector 1, production of which does not lead to significant non-competitive imports. Thus, while for the eastern provinces and Ontario the levels of transfers from the outside are positive, for the western regions (except Manitoba) the picture is reversed with positive transfers out of the economy. With upper limits on imports of sector 4 there is seen to be a large reduction in income levels and the economy is left with a large slack because of this lack of availability of the output that was such a high proportion of final use. As there are reduced imports of this sector's output, the import of other sectors is increased, especially of sector 1 and 2, and the resulting lack of production reduces national income. This very obvious "import bias" of the model is discussed in some detail in the concluding section of this chapter, particularly in the context of the government budget constraint and how this is best satisfied by imports rather than domestic production.

6.2.2 National trade constraints, equity conditions and limits on imports of sector 4

When the regional trade constraints are replaced by one national equation each region is free to run up a deficit of the level that was found optimal in earlier experiments (of about 25% of income). These results are discussed in Tables 18, 19 and these are an extension of the conditions analysed in Tables 6, 7. From the first of these two sets of tables (Tables 6, 18) it is seen that the fall in national income is substantial - from around $69 billion to about $45 billion but the relative distribution of this decrease again favour the eastern provinces with only the change that the fall in Ontario's income level is also between 45-50% and Quebec's income falls by about 15%. The order of the loss is now Alberta 50%, Ontario 45%, Saskatchewan and British Columbia 40%, Manitoba 33%, Quebec, Nova Scotia, New Brunswick and Newfoundland around 15% while there is no significant change for Prince Edward Island. Again the fall seems to be imposed on the model by the lack of income increasing opportunities in Prince Edward Island. Since each sector in this province is already producing at its capacity while each of the other regions has at least one sector producing below capacity, there is an immense scope for

increasing the OF by transferring some resources and production to the former. That Prince Edward Island's economy is the only major bottleneck for the entire nation is again seen in this version from the structure of shadow prices here. Not only are the only shadow prices that are positive those of various productive sectors in Prince Edward Island, these are again of a magnitude that is very much higher than most observed earlier. The fact that there are upper bounds on all outputs means that there is a finite limit on the level of income in this region, and even though some increased consumption can be afforded to Prince Edward Island by the trade deficit of close to 30% of income, this deficit cannot be too much larger because there are upper bounds on the amounts of transfers into each region. Shadow prices for transfers are again very high for this region but not positive for any other region. The implictions of this result for the national economy are brought out in the conclusion to this chapter, but for now it suffices to say that because of a low potential for income growth and because of a limit on the amount of transfers allowed into Prince Edward Island in the model, national income cannot be expanded to its full potential if equality of living standards across regions is also to be attained. Restricting the imports of sector 4 into each region is again seen to be a significant constraint on the national economy, because the supply of this output is so necessary for final use.

To tie up some loose ends, it is noted that by imposing equality of per capita incomes across all regions, the regions that gain relative to others are the eastern 5 provinces at the expense of the western regions, with Manitoba and Saskatchewan not really losing too much. The eastern 6 provinces face rather severe trade balance problems, and while in Quebec and Ontario this is a reflection of the economic structure and its high dependence on non-competitive imports, in the 4 Atlantic provinces this may well be the result of a low potential for increasing income and output, with the result that it is optimal to import large amounts, but the lack of means and avenues to pay for these imports results in balance of payments problems.

6.3 Factor Mobility and Interregional Equity[3]

The following discussion again is parallel to the analysis in Chapter 5, with both interregional and inter-sectoral mobility of factors being allowed for in turn. To allow interregional migration of factors to have a real impact on the output of various sectors and various regions, this mobility has to be coupled with some relaxation of the upper bounds on the output of each sector in each region. The various categories of bounds imposed in this set of exercises

has been described in detail in the last chapter.

6.3.1 National and Regional trade balance constraints alongside factor mobility and the equity condition

Table 20 analyses a version of the model where the equity constraint is imposed with factors mobile across regional boundaries but to similar jobs (within the same productive sector) when the national trade constraint is imposed (see Table 10 for a comparable version without the equity condition). The direct result of this equity condition is that the output level of all 4 productive sectors in Prince Edward Island is forced up to the bounds, and in all other regions there is some slack represented by a zero output of some sector or an output below the upper bound. Significantly though, in none of the cases of zero output is this the output of the manufacturing sector, the sector that in the cases analysed above regularly hits the zero output level. It is noted that the regional trade balance constraint is more of a restriction on the economy of the country than is a national constraint, a fact that is confirmed because in the latter case national output and income is consistently higher than with the former equations. With the exception of

New Brunswick all 6 eastern provinces run up significant trade balance deficits while the level of the deficit for the Prairie provinces and British Columbia is close to 10% of regional income. Again a national income decline of close to 25% is felt most severely by Alberta because its income level is 40% lower; British Columbia and Manitoba see their income levels reduced by close to 35%, while 20% reductions are observed for Nova Scotiaand Ontario and 10% for New Brunswick. Regional incomes rise marginally in Newfoundland and in Saskatchewan while there is an increase of about 10% in Quebec and close to 80% in Prince Edward Island. While the deficit in case of Manitoba, Ontario and the eastern 5 provinces (with the exception of New Brunswick) is high enough to warrant the full allocation of government transfer payments, only in case of Prince Edward Island do these display the very high shadow prices that were seen earlier. As the picture with regards shadow prices is a mirror image of the situation in Table 18 it can be concluded here that the major constraint on the national economy is the limited potential for income growth in Prince Edward Island, and there also the main bottleneck to growth seems to be the above mentioned financial inability to pay for any imports. This contrasts with the view that commodity demand and supply represent the only bottlenecks to regional income growth, because in various experiments with this model, when regions are allowed to draw upon factors and finances from others,

the lack of financial assets replaces the availability of goods as the most binding constraint.

With the change to a regional trade balance constraint specification the picture is again one of very high deficits allowed for Ontario and Quebec, and the resulting high imports mean relatively lower levels of output and thus lower income levels in these two provinces. This again means that the model finds it optimal to transfer large amounts from the government and from the outside world to these two provinces. The highest shadow prices now are observed for government transfers to these two regions, while there are positive shadow prices for some outputs of certain sectors too. As a regional trade balance specification by itself forces some output to be shifted to each province, to provide for exports, the equity requirement does not make as big a difference as it does with a national trade balance condition. Hence in comparison with Table 11 the fall in national income by the added equity constraint is close to 10%, but now the most significant gainer from the equity constraint is Quebec because its income level is around 40% higher than is the case in Table 11 while the reduction or increase for other regions follows the pattern detailed earlier. Given that Ontario's income level is relatively lower due to the high degree of imports even without the equity condition there is only a 2% odd reduction in its

output and income level when this constraint is imposed.

6.3.2 One factor mobility, no other bounds on output

In the relevant sections of Chapter 5 it was seen that this allowance of factor mobility without any bounds on output resulted in very large increments in the output of some sectors of Alberta and British Columbia. It is to be expected that imposing an equity condition will prevent such extreme transfers of resources to the western regions, though the high transfer was originally a reflection of the low input use per unit of value added in these regions. Also to be expected is the fact that even though some factors are now not shifted to these regions, when they remain in the home region or are transferred to the poorer regions, these will not be used to produce just any output but will specifically be directed toward the high value added sectors as this will ensure interregional equity at the lowest cost (with the least amount of factors transferred to the poor regions). The results in Table 22, 23 show that these extreme transfers of resources (which included an output of sector 4 in Newfoundland in excess of $5.5 billion) are no longer observed. However it is still true that when there are no bounds on output, the level of output of any sector that is produced is greater than the amount that could be produced with local resources alone. The results thus follow the

conventional wisdom that each region should specialise in the production of any output if there is a comparative advantage in this production in the region, and thus trade flows are substantial. The structure of each region's deficit forces Ontario and Quebec alongside the Atlantic provinces into a situation where shadow prices for transfers to these regions are the highest of all shadow prices, but the shadow prices for some of the production sectors in Alberta and British Columbia are close to .6 or .7, these being the highest shadow prices from among those for any outputs. This result is a reflection of the fact that with the equity condition, large amounts of output have to be shifted from these two provinces where input ratios are very low to other regions which are not so efficient in using inputs, and so a unit reduction in the severity of the equity constraint would shift resources to these provinces and thus substantially increase the value of the OF.

6.3.3 One factor mobile at a time, bounds on output

regional trade balance constraint

In the runs where one factor is allowed to move but output can only be expanded within limits alongside an equity constraint (Tables 12b, 13b) the picture that emerges is in

some ways quite perverse. Thus in both cases of labour and of capital mobility the overall national income level is between 10 and 15% lower than without the equity constraint, but in each case Quebec's income level rises, while in one case Ontario also sees its income go up, but there are (big or small) reductions in the incomes of all other regions.

6.4 Inter-sectoral and Intraregional Factor Mobility

The final set of mobility conditions analysed in each chapter allows factors to move about between sectors but within the same region. This run is obviously biased in favour of the status quo with respect to the sizes of various provincial economies because the bigger provinces at the current time have larger factor endowments than the smaller ones and can thus produce larger outputs than others, even if these are the relatively more efficient provinces of Alberta and British Columbia. Thus the maximum levels of output of all sectors in Ontario and in Quebec that are allowed in this run are far greater than the amounts the economies of the two western provinces are constrained to. Within each region, however, the model optimises by allocation of scarce inputs to the sector that best balances off the requirements of low input use ratios, indirect tax rates and high value-added coefficients. When the runs that allow for this mobility are compared between versions that have and do not have an equity

constraint, there is a large fall in the value of the OF, a larger fall being observed in the case when there are equations defining capital mobility than the case when labour mobility is described by the equations and the other factor is relatively free. The fall in national income in each case is between 25 and 30%. All 4 productive sectors in Prince Edward Island are seen to produce at capacity with high shadow prices for 3 of these sectoral outputs, while none of the other outputs have shadow prices that are even closely comparable. Shadow prices for transfers to Prince Edward Island complement the picture in case of labour mobility while in the case of capital mobility these shadow prices are not outstanding. What is more interesting about this set of results is the degree of slack in various regional economies that emerges when the per capita income equality condition is imposed. Since income per capita in each region cannot rise above the level that is attainable in the poorest region, other provincial economies are forced to produce below potential and their labour or capital stock constraints have a slack. Table 6.1 below shows that when equity is imposed on the nation, all of the western provinces produce output substantially below their potential - except for the case of British Columbia, there being no surplus labour in this region when labour mobility is defined by a constraint and capital is completely free. In the eastern 5 provinces, there is only one instance - Nova Scotia has a surplus of factors

in both runs - where the economy of the region could be said to be operating with a slack, while all the other provincial economies are operating much closer to their limits as shown by the fact that at least one factor is being fully used.

Table 6.1 Factors left unused in each Region.

Region.	Proportion of Capital left unused (slack).	Proportion of Labour left unutilised (slack).
Newfoundland	----	28%
Prince E. I.	----	----
Nova Scotia	20%	48%
New Brunswick	20-22%	----
Quebec	14-15%	----
Ontario	30%	6-7%
Manitoba	18-20%	40%
Saskatchewan	40%	33%
Alberta	55%	65%
British Col.	28-30%	----

6.5 Conclusion

This section is devoted to some analysis of the various results seen earlier - both from the point of view of what these mean for the structure of each region's economy and from the point of view of why each set of results are in

fact to be expected. First, it is easy to note that the regional economies fall into two distinct groups - those for whom sector 1 is the largest productive sector and those whose output of sector 2 is the largest of all productive sectors. In none of the 10 provinces is the output of either sector 3 or 4 the largest sector, though outputs of these sectors are fairly significant for the economy of each province. The two provinces of Nova Scotia and New Brunswick fall into a grey area where sector 1's maximum output is around 15% lower than the maximum allowed output for sector 2, but for all the other provinces this spread is larger than 15%. Thus for Alberta, Prince Edward Island, Newfoundland and Saskatchewan sector 1 is the dominant sector, with a maximum allowed output of anywhere from twice as large as the output of sector 2 for the first three regions to an allowed output nearly 4 times as high as sector 2's output for Saskatchewan. Sector 2 is the largest sector for Manitoba, British Columbia, Ontario and Quebec, and while in case of Manitoba and British Columbia the highest output of sector 2 is 25-30% larger than the that allowed for sector 1, for Ontario and Quebec the maximum allowed output for the former is nearly 300% larger than that for the latter. This difference in structures is represented well in the various bounds imposed on regional outputs across regions, but it does not show up in all the results themselves because the output of sector 2 (manufacturing) is seen to hit lower bounds of a zero output

or a low level because of the import bias present in the model's structure.

As the budget of the government sector is balanced, the model is forced to rely on solutions that stress the need for imports more than the need for domestic production. This is seen because in an effort to keep the government budget balanced, the model has to look for a means of disposing of revenues generated whenever there is a positive output of any sector, because the production of any output leads to indirect tax revenues. The only way revenues can be spent in this model is via transfers to the provinces, because the model treats government purchases of goods and services (along with the total revenue generated from direct taxes) as being given exogenously and thus cannot be changed as part of the optimisation. As a result, even in the versions in which a trade balance constraint need not be binding, the model favours imports at the expense of domestic production because a) reducing the latter reduces the amount of indirect tax revenue generated (that has to be spent somewhere) and b) increasing the former leads to regional trade deficits that can be financed by government transfer payments, leading to a means of disposing of the revenues. While this constraint on the model can be removed by allowing the government sector's budget constraint to be an inequality (consistent with a surplus budget, say) and so not all of the revenue has to be

spent, there are some theoretical difficulties associated with this specification of the constraint. If a budget surplus is allowed for, the need for all transfers to be positive is no longer that extreme, but now the government acquires some resources above the level of its expenditures. What happens to these resources is an important question because if the government sector is assumed to hoard away this wealth, there is a reduction in private net worth over time, but such a fall is not consistent with a steady state. If, on the other hand, the central government is allowed to use its surplus for open market operations or, at the other extreme, to finance any deficit by printing more money, each of these actions again violates the equilibrium imposed on the asset market because of the assumption of a steady state.

Second, a measure of interregional equity across regions is built into the structure of the model by the limits on private and governments transfer payments to each region. As these limits imposed were equal to the actual dollar values of the transfers to the relevant region from the government or from abroad in 1966, these are biased in favour of the poor provinces because transfers were a high proportion of income in 1966 and all other years for these regions. Thus when the model finds it optimal to transfer an amount equal to the allowed bounds to all regions, the eastern provinces receive a level close to 50% of their

income levels while the western provinces are allowed a far lower fraction. Since the former regions now attain an income level a lot higher than value added as compared to the western provinces, their incomes per capita are raised at the expense of other potential recipients of funds.

Another significant point that emerges from these results has to do with the discussion of the nature of the most binding constraint on the economy of the nation and the various regional economies. For example the case of Tables 18, 19 (which are the equity constrained versions of Tables 6, 7) is analysed here, especially the structure of shadow prices seen. From these shadow prices it is seen that expansion of the various sectoral outputs in Prince Edward Island yields between 60 and 130 units more to the value of the OF (as the shadow prices range from around 60 for sectors 1, 2 to a high of 139 for sector 4). These shadow prices, as was related earlier, are close to 100 times as high as shadow prices for any other sectoral output observed in all runs. However, in the same run it is noted that the shadow value of transfers into Prince Edward Island is 186.00. Hence by providing transfers to the province in question, overall national income shown by the value of the OF can be raised by between 50% and 200% more than could be raised by providing an extra unit of production capacity. This is as clear a case as any that can be found for the claim that now the most

binding constraint on the economy of Prince Edward Island is not a production or a supply constraint but the financial limitation on its ability to pay for more imports. While emphasising the differential value of shadow prices for transfers relative to the value of this shadow price for outputs in this run alone may create the impression that such a variation is seen only in this one case, this is not really true. In almost all the results discussed elsewhere, shadow prices for transfers exceed the numerical value of 2 while shadow prices for output variables rarely exceed unity. Hence in the versions where shadow values for output variables are high, conventional wisdom stands justified and the provision of facilities to industry to move to these areas may relieve the most binding constraints facing the region's economy, but in the great majority of cases this relaxation is best accomplished by financial transfers. This would at least justify the added emphasis placed on the specification of this constraint in the description of this model, and at best show that the cost of equity is not really the large loss of output in all provinces that results from a transfer of resources to the poorer regions but the far smaller cost involved in federal government equalisation payments to the economies of the poor regions. If these regions had the finances to pay for their excess of spending over incomes generated locally, equity in income levels would not be attained by operating the economies of all the rich provinces

with a slack (as is seen in this model) but would be attained at a far higher level of income and output with larger outputs in all regions and significantly larger imports into the poorer regions, financed out of transfers from the rich regions. These transfers would be in the interest of the rich regions because they would help create a demand for their outputs.

Since in all these versions there is seen to be the distinct transfer of output and income to the eastern 5 provinces whenever a constraint requiring equality of income levels is imposed, the observed disparity in per capita incomes is borne out.

Footnotes
(to Chapter 6.)

1. Equity will be attained in this model by lowering the per capita income level in all regions to the level of the poorest region, or to the level of the region with the lowest potential for increasing income.

2. It is noted all along that (a weighted sum of) national output is is constrained by the limits imposed on the government transfer variables, acting through the government budget constraint. In the concluding section of this chapter and in Chapter 7 below some arguments are put forth regarding why it is not theoretically correct to allow this constraint to be an inequality, but that individual limits on the transfer variables could be relaxed to allow higher transfers to (and incomes in) the poorest regions.

3. There are a few qualifiers about this allowance for factor mobility, especially of labour. As labour force is a function of population levels, there is an impact of any change in the former on the latter. Thus when labour mobility across regions is allowed, each region's population is no longer constant, and so the coefficients in the equity constraint - which are expressed in terms of per capita income - should change as labour is shifted. To avoid the added complexity associated with making the model non-linear, these coefficients ar held constant. Now, however, the only way to reconcile a constant population and a variable labour force is to assume that factor services commute across regions, but generate income only in the region where the services are used. It is true that assuming such high rates of daily labour movements across regions is not realistic, but the simplicity this assumption affords allows the model to be worked with, and the results interpreted, much more easily.

Table 1: RESULTS OF THE LINEAR PROGRAMMING OPTIMISATION FOR CANADA, DREE COEFFICIENTS.

	CANADA	NFLD.	P.E.I.	N.B	N.S.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		587.2	103.4	722.7	648.2	5237.8	7395.4	1303.1	2947.1	3780.0	3102.6
OUTPUT2		312.4	55.3	952.0	758.7	14085.0	26181.1	1576.2	602.5	1999.9	4168.1
OUTPUT3		396.1	78.7	1112.8	548.8	6374.0	9902.7	1294.1	885.8	2155.3	2727.8
OUTPUT4		339.4	50.4	470.9	434.4	4619.0	6110.3	990.9	670.9	1664.9	2166.1
GNP	119498.1	1635.0	287.8	3258.4	2390.1	30315.8	49595.5	5164.3	5106.3	9580.1	12164.7
EXPORT1		351.1	0.0	0.0	310.6	339.7	0.0	0.0	159.4	0.0	0.0
EXPORT2		0.0	0.0	0.0	284.0	0.0	8391.7	393.2	.8	447.6	1906.6
EXPORT3		0.0	33.3	0.0	0.0	0.0	5414.5	770.7	323.2	1152.2	1471.2
EXPORT4		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT1		0.0	69.5	0.0	0.0	0.0	11683.5	810.2	0.0	1502.4	2748.0
IMPORT2		0.0	17.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT3		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT4		954.1	63.6	762.8	634.6	795.4	3120.2	192.8	570.4	408.9	344.9
TR.BAL.		-603.0	-117.3	-762.8	-40.1	455.7	-997.5	160.8	-87.1	-311.4	284.9
INCOME	31871.6	1185.1	179.3	1537.9	576.9	7787.0	11946.0	1449.5	1599.4	2473.6	3136.9
TRPOUT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRPIN		5.67	1.33	9.00	7.66	69.3	92.0	11.33	10.0	19.67	27.3
TRG		614.67	105.0	656.83	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ACTUAL VALUES FOR VARIABLES IN 1966											
GNP	62706.2	804.5	165.4	1491.9	1184.4	16291.1	25594.4	2628.6	2980.7	5009.2	6412.6
TR.BAL.		-272.9	-88.7	-505.9	-340.1	+574.4	+1103.7	-115.6	-29.9	-91.7	-496.4
INCOME	39831	615	136	1142	864	10419	15850	1785	1819	2984	4149
TRPOUT		6.0	1.0	9.0	7.37	66.67	88.3	10.67	9.67	19.33	26.33
TRPIN		5.67	1.33	9.00	7.66	69.3	92.0	11.33	10.0	19.67	27.3
TRG		614.67	105.0	661.0	583.33	4926.67	5496.67	664.67	648.33	1114.00	1962.00

Table 2: MODIFIED INPUT-OUTPUT COEFFICIENTS, NO TRADE BALANCE CONSTRAINTS.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		587.2	103.4	722.7	648.2	5237.8	7395.4	1303.1	2947.1	3780.0	3102.6
OUTPUT2		312.4	55.3	952.0	758.7	7248.6	26181.1	1576.2	602.5	1999.9	4168.1
OUTPUT3		396.1	78.7	1112.8	548.8	6374.0	9908.7	1294.1	885.8	2155.3	2727.8
OUTPUT4		339.4	50.4	470.9	434.4	4619.0	6110.3	990.9	670.9	1644.9	2166.1
GNP	112661.1	1635.0	287.8	3258.4	2390.1	23479.4	49595.5	5164.3	5106.3	9580.1	12164.7
EXPORT1		0.0	0.0	0.0	0.0	0.0	0.0	89.0	956.3	973.6	0.0
EXPORT2		22.2	0.0	41.2	30.0	0.0	1676.2	0.0	0.0	0.0	922.9
EXPORT3		56.1	24.8	551.4	295.1	2217.5	2841.2	508.8	0.0	458.3	699.5
EXPORT4		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT1		297.9	9.5	459.8	323.5	139.1	0.0	0.0	0.0	0.0	1005.1
IMPORT2		0.0	43.5	0.0	0.0	4598.0	0.0	209.4	325.6	522.6	0.0
IMPORT3		0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0
IMPORT4		373.0	87.0	871.4	608.3	3626.6	10392.3	877.6	1345.6	2297.1	2279.3
TR.BAL.	-18329.9	-591.8	-115.2	-738.6	-606.7	-6146.2	-5874.9	-489.2	-717.6	-1387.8	-1662.0
INCOME	69667.2	1448.9	246.1	2337.2	1804.6	15266.0	27381.0	3084.2	3508.4	6888.0	7702.8
TRPOUT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRPIN		5.67	1.33	9.0	7.66	69.3	92.0	11.33	10.00	19.67	27.3
TRG		614.67	105.0	661.0	583.33	4926.67	5496.67	664.67	648.33	1114.00	1962.00

Table 2a: SHADOW PRICES FOR ACTIVITY LEVELS AND CONSTRAINTS FOR Table 2.

	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MANITOBA	SASK.	ALBERTA	B.C.
OUTPUT1	.1686	.2425	.1269	.2123	.0990	.1480	.2778	.3867	.4209	.2038
OUTPUT2	.2796	.0997	.2252	.1574	0.0	.0824	.0959	.0597	.4188	.1112
OUTPUT3	.5196	.4774	.4654	.4034	.2855	.3849	.4588	.4917	.5805	.4020
OUTPUT4	.4574	.3866	.2640	.4039	.1733	.2098	.2751	.3988	.4731	.3407
EXPORT1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXPORT2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXPORT3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXPORT4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INCOME	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRPOUT	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
TRPIN	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
TRG	3.3077	3.3077	3.3077	3.3077	3.3077	3.3077	3.3077	3.3077	3.3077	3.3077

Table 3: LIMITS ON REGIONAL TRADE BALANCE DEFICITS.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		587.2	103.3	722.2	648.2	5237.8	7395.4	1303.1	2947.1	3780.0	3102.6
OUTPUT2		312.4	55.3	952.0	758.7	0.0	10000.3	1576.2	602.5	1999.9	4168.1
OUTPUT3		396.1	78.7	1112.8	548.8	6374.0	9902.7	1294.1	885.8	2155.3	2727.8
OUTPUT4		339.4	50.4	470.9	434.4	4619.0	6110.3	990.9	670.9	1664.9	2166.1
GNP	89226.3	1635.0	287.8	3258.4	2390.1	16230.8	33408.7	5164.3	5106.3	9580.1	12164.7
EXPORT1		0.0	0.0	152.4	0.0	2362.1	2852.0	76.2	2279.6	1340.4	428.3
EXPORT2		0.0	0.0	137.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXPORT3		93.3	27.7	0.0	307.3	2880.3	4465.1	560.6	0.0	625.6	881.3
EXPORT4		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT1		99.6	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT2		0.0	32.1	0.0	134.2	9243.1	7552.3	9.6	220.5	215.9	0.0
IMPORT3		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT4		266.5	78.6	795.8	513.2	2195.5	6222.6	742.6	2089.1	1841.8	1811.0
TR.BAL.		-272.9	-88.7	-505.9	-340.1	-6196.2	-6457.8	-115.6	-29.9	-91.7	-496.4
INCOME	56336.3	1161.3	223.2	2151.5	1585.5	12488.7	20580.9	2762.1	2961.9	5823.6	6957.6
TRPOUT		6.0	1.0	9.0	7.33	0.0	0.0	10.67	9.67	19.33	26.33
TRPIN		0.0	0.0	0.0	0.0	69.3	92.0	0.0	0.0	0.0	0.0
TRG		338.7	84.4	493.2	379.2	4926.67	5496.67	364.6	121.5	88.6	910.4

Table 4: REGIONAL TRADE DEFICIT LIMITS, BOUNDS ON IMPORTS OF SECTOR 4.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA.	B.C.
OUTPUT1		51.5	88.9	0.0	0.0	0.0	0.0	1246.5	2031.6	1226.9	247.2
OUTPUT2		312.3	55.3	128.6	758.7	1567.4	3273.3	1576.2	315.4	1999.9	4168.1
OUTPUT3		396.1	78.7	1112.8	548.8	6374.0	9902.7	1294.1	885.8	2155.3	2727.8
OUTPUT4		339.4	50.4	470.9	434.4	4619.0	6110.3	990.9	670.9	1664.9	2166.1
GNP	62041.01	1099.3	273.3	1712.2	1741.9	12560.5	19286.3	5107.6	3903.7	7047.0	9309.3
EXPORT1		0.0	49.7	0.0	0.0	0.0	0.0	0.0	1527.5	0.0	0.0
EXPORT2		177.3	0.0	0.0	382.7	0.0	0.0	189.9	0.0	0.0	241.9
EXPORT3		179.0	0.0	793.8	0.0	3368.4	6441.9	444.5	0.0	1027.0	1308.5
EXPORT4		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT1		504.2	0.0	541.0	242.6	3097.7	1836.2	0.0	0.0	118.7	1046.8
IMPORT2		0.0	63.4	285.7	0.0	4691.8	6903.5	0.0	807.4	0.0	0.0
IMPORT3		0.0	0.0	0.0	11.3	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT4		125.0	75.0	250.0	200.0	1200.0	1750.0	750.0	750.0	1000.0	1000.0
TR.BAL.		-272.9	-88.7	-282.9	-71.3	-5621.1	-4047.8	-115.6	-29.9	-91.7	-496.4
INCOME	39617.07	904.0	215.7	980.5	945.4	10563.8	11700.1	2788.6	2209.5	4230.8	5078.7
TRPOUT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRPIN		5.67	1.33	9.0	7.66	69.3	92.0	11.33	10.0	13.2	27.3
TRG		273.8	81.4	0.0	44.9	4926.67	3036.15	399.2	0.0	0.0	761.34

Table 5: ARBITRARY REDUCTIONS IN VALUE-ADDED COEFFICIENTS OF SECTOR 4.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		587.2	103.4	722.7	648.2	5237.8	7395.4	1303.1	2947.1	3780.0	3102.6
OUTPUT2		312.4	55.3	952.0	758.7	0.0	19669.4	1576.2	494.6	1999.9	4168.1
OUTPUT3		396.1	78.7	1112.8	548.8	6374.0	9902.7	1294.1	885.8	2155.3	2727.8
OUTPUT4		339.4	50.4	470.9	434.4	0.0	0.0	990.9	670.9	1664.9	2166.1
GNP	88078.08	1635.0	287.8	3258.4	2390.1	11611.8	36967.5	5164.3	4998.4	9600.0	12164.7
EXPORT1		0.0	0.0	0.0	290.5	4105.3	1481.9	692.6	2252.9	727.6	0.0
EXPORT2		67.5	0.0	170.0	0.0	0.0	588.5	0.0	0.0	0.0	0.0
EXPORT3		113.0	30.1	595.0	0.0	2840.9	4585.2	607.3	0.0	745.3	1031.0
EXPORT4		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT1		243.3	0.0	533.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT2		0.0	47.1	0.0	0.0	8737.0	0.0	795.1	1318.0	48.5	79.1
IMPORT3		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT4		209.9	71.7	737.7	630.6	5296.0	12380.6	620.3	964.8	1516.1	1448.3
TR.BAL.		-272.9	-88.7	-505.9	-340.1	-7086.8	-5725.0	-115.6	-29.9	-91.7	-496.4
INCOME	51670.8	1008.6	204.3	2009.0	1380.5	9918.2	21298.1	2470.1	2578.5	5062.1	5741.4
TRPOUT		6.0	1.0	9.0	7.33	0.0	0.0	10.67	9.67	19.33	26.3
TRPIN		0.0	0.0	0.0	0.0	69.3	92.0	0.0	0.0	0.0	0.0
TRG		328.3	83.7	484.8	363.8	4926.67	5496.67	348.8	25.2	0.0	889.1

Table 6: NATIONAL TRADE BALANCE CONSTRAINT.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		0.0	0.0	0.0	0.0	0.0	0.0	1303.1	2947.1	3780.0	0.0
OUTPUT2		0.0	0.0	0.0	0.0	0.0	0.0	0.0	602.5	1999.9	0.0
OUTPUT3		396.1	78.7	1112.8	548.8	3079.6	6199.1	1294.1	885.8	2155.3	2727.8
OUTPUT4		339.4	50.4	0.0	434.4	4619.0	6110.3	861.7	670.9	1664.9	2166.1
GNP	46026.6	735.5	129.1	1112.8	983.2	7698.6	12309.4	3458.9	5106.3	9599.9	4893.9
EXPORT1		0.0	0.0	0.0	0.0	0.0	0.0	602.6	1396.1	1521.7	0.0
EXPORT2		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXPORT3		256.2	52.3	887.3	426.0	1309.1	3289.8	777.3	111.4	639.8	1896.2
EXPORT4		60.1	0.0	0.0	0.0	1585.0	0.0	0.0	0.0	0.0	287.4
IMPORT1		277.8	40.0	341.3	331.7	1010.3	1383.3	0.0	0.0	0.0	1164.7
IMPORT2		68.6	31.3	268.3	199.8	3753.0	7383.9	1041.3	129.9	0.0	1112.1
IMPORT3		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT4		0.0	14.9	525.9	1.4	0.0	749.1	392.2	1074.3	1803.9	0.0
TR.BAL.	-8000.0	-29.5	-33.7	-248.2	-106.9	-1869.2	-6226.5	-53.6	+303.3	+357.6	-93.2
INCOME	28708.1	445.3	72.7	647.0	551.7	4261.5	9928.0	1778.1	2840.4	5735.0	2448.3
TRPOUT		6.0	1.0	9.0	7.33	66.67	88.3	10.67	9.67	19.3	26.3
TRPIN		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRG		0.0	0.0	0.0	0.0	1563.6	5496.67	0.0	0.0	0.0	0.0

Table 7: NATIONAL TRADE BALANCE CONSTRAINT, LIMITS ON IMPORT OF SECTOR 4.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		0.0	52.1	0.0	0.0	0.0	0.0	860.8	1065.5	0.0	0.0
OUTPUT2		0.0	55.2	128.6	758.7	1567.4	9101.7	1576.2	602.5	1999.9	2063.9
OUTPUT3		396.1	78.7	1112.8	548.8	6374.0	9902.7	1294.1	885.8	2155.3	2727.8
OUTPUT4		339.4	50.4	470.9	434.4	4619.0	6110.3	990.9	670.9	1664.9	2166.1
GNP	62731.8	735.4	236.4	1712.2	1741.9	12560.7	25114.7	4827.8	3224.7	5820.0	6957.9
EXPORT1		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXPORT2		0.0	0.0	0.0	377.0	0.0	0.0	222.8	18.4	516.5	275.9
EXPORT3		191.6	29.8	793.8	373.8	3367.8	6351.4	563.5	270.6	1071.2	1350.3
EXPORT4		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT1		492.0	65.8	539.0	628.0	3102.8	2949.1	453.0	266.2	1729.4	2155.1
IMPORT2		120.3	11.0	279.8	0.0	4875.7	2063.0	0.0	0.0	0.0	0.0
IMPORT3		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT4		125.0	75.0	250.0	200.0	1200.0	1750.0	750.0	750.0	1000.0	1000.0
TR. BAL.	-11416.0	-545.7	-122.1	-274.9	77.3	-5810.7	-410.7	-416.7	-727.2	-1141.7	-1528.9
INCOME	39756.2	946.7	222.1	980.5	945.4	10563.8	11192.0	2849.1	2343.7	4411.1	5301.9
TRPOUT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRPIN		5.67	1.33	9.0	7.66	69.3	92.0	11.33	10.0	19.67	27.3
TRG		489.7	105.0	0.0	44.9	4926.67	78.6	664.67	648.3	69.9	1962.0

Table 8: INTERREGIONAL, INTRA-SECTORAL FACTOR MOBILITY, NATIONAL TRADE CONSTRAINT, NO BOUNDS ON OUTPUT.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		0.0	0.0	0.0	0.0	0.0	30712.9	0.0	0.0	0.0	0.0
OUTPUT2		0.0	0.0	0.0	0.0	13375.8	5665.9	0.0	0.0	40250.2	0.0
OUTPUT3		0.0	103.5	5505.2	0.0	0.0	0.0	0.0	174.1	22505.7	0.0
OUTPUT4		0.0	0.0	0.0	266.4	0.0	7681.4	4032.4	1384.9	0.0	4041.6
GNP	135700.1	0.0	103.5	5505.2	266.4	13375.8	44060.2	4032.4	1559.1	62755.9	4041.6
EXPORT1		0.0	0.0	0.0	0.0	0.0	27448.5	0.0	0.0	0.0	0.0
EXPORT2		0.0	0.0	0.0	0.0	2916.7	0.0	0.0	0.0	29321.8	0.0
EXPORT3		0.0	63.6	2833.2	0.0	0.0	0.0	0.0	0.0	13261.4	0.0
EXPORT4		0.0	0.0	0.0	0.0	0.0	0.0	2349.1	382.8	0.0	1561.0
IMPORT1		249.9	30.7	413.1	114.1	1846.4	0.0	941.8	557.2	17187.7	895.7
IMPORT2		73.0	89.0	1100.3	418.3	0.0	21667.0	2703.1	615.9	0.0	3423.8
IMPORT3		102.7	0.0	0.0	95.1	2268.4	6465.4	746.0	234.5	0.0	1006.9
IMPORT4		281.7	93.1	2262.2	180.1	4645.1	6997.6	0.0	0.0	20659.0	0.0
TR.BAL.	-18226.5	-707.3	-149.3	-942.3	-807.6	-5843.2	-7681.4	-2041.8	-1024.8	+4736.5	-3765.3
INCOME	87680.5	554.6	166.7	4559.4	658.3	8255.9	23972.8	2527.0	1443.7	41967.0	3755.2
TRPOUT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRPIN		5.67	1.33	9.0	7.66	69.3	92.0	11.33	10.0	19.67	27.3
TRG		614.67	105.0	661.0	583.33	4926.67	5496.67	664.67	648.3	1114.0	1962.0

Table 9: INTERREGIONAL, INTRA-SECTORAL MOBILITY, REGIONAL TRADE CONSTRAINTS, NO BOUNDS ON OUTPUT.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		640.5	0.0	0.0	3360.8	0.0	18944.1	0.0	0.0	0.0	7162.8
OUTPUT2		2490.6	327.0	3992.1	0.0	11284.8	0.0	5306.8	4734.1	13278.2	8053.5
OUTPUT3		0.0	0.0	0.0	0.0	0.0	1353.1	0.0	0.0	24589.3	0.0
OUTPUT4		0.0	0.0	0.0	0.0	0.0	15829.1	0.0	0.0	0.0	0.0
GNP	121346.8	3131.1	327.0	3992.1	3360.8	11284.8	36126.3	5306.8	4734.1	37867.5	15216.3
EXPORT1		79.3	0.0	0.0	2188.9	0.0	15769.0	0.0	0.0	0.0	2741.2
EXPORT2		1046.1	213.6	2023.3	0.0	1816.6	0.0	3234.1	3292.4	0.0	3142.0
EXPORT3		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18469.3	0.0
EXPORT4		0.0	0.0	0.0	0.0	0.0	2279.3	0.0	0.0	0.0	0.0
IMPORT1		0.0	145.2	585.7	0.0	1671.5	0.0	1336.5	1610.7	2684.0	0.0
IMPORT2		0.0	0.0	0.0	951.3	0.0	22162.2	0.0	0.0	2333.2	0.0
IMPORT3		448.7	45.7	573.5	334.9	2076.9	4812.5	577.1	547.8	0.0	2002.1
IMPORT4		949.6	111.8	1369.9	1242.8	4232.3	0.0	1436.1	1136.8	13543.8	4377.7
TR.BAL.		-272.9	-88.7	-505.9	-340.1	-6164.1	-8926.4	-115.6	-29.9	-91.7	113.6
INCOME	73904.0	1972.2	197.4	2468.6	2123.6	7454.8	21133.3	2228.0	1806.4	27335.4	7184.3
TRPOUT		6.0	1.0	9.0	7.33	0.0	0.0	10.67	9.67	19.33	26.33
TRPIN		0.0	0.0	0.0	0.0	69.3	92.0	0.0	0.0	0.0	0.0
TRG		614.67	105.0	661.0	583.33	4926.67	5496.67	664.67	648.33	1114.0	948.4

Table 10: INTERREGIONAL, INTRA-SECTORAL MOBILITY, NATIONAL TRADE CONSTRAINT, BOUNDS ON OUTPUT.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		0.0	0.0	903.4	810.2	6547.2	9244.2	1628.9	0.0	4490.9	3878.3
OUTPUT2		0.0	0.0	1190.0	0.0	11583.6	32726.4	1986.6	0.0	2499.8	2207.0
OUTPUT3		495.1	98.3	1081.6	685.6	0.0	3495.9	1617.6	1097.7	2694.1	3409.8
OUTPUT4		424.2	0.0	588.6	543.0	5773.8	4134.6	880.2	838.6	2081.1	2707.7
GNP	112353.8	919.3	98.3	3763.6	2038.9	23904.5	49611.2	6113.2	1936.2	11765.9	12202.7
EXPORT1		0.0	0.0	0.0	487.3	697.4	1030.9	55.3	0.0	1049.1	0.0
EXPORT2		0.0	0.0	257.3	0.0	0.0	7126.0	118.7	0.0	0.0	0.0
EXPORT3		249.6	59.2	463.1	450.4	0.0	0.0	719.4	622.7	655.9	1247.9
EXPORT4		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT1		179.3	39.7	470.9	0.0	0.0	0.0	0.0	1083.8	0.0	33.9
IMPORT2		212.0	79.7	0.0	681.6	282.2	0.0	0.0	501.9	258.8	1033.2
IMPORT3		0.0	0.0	0.0	0.0	3876.2	3049.1	0.0	0.0	0.0	0.0
IMPORT4		608.8	91.6	878.3	970.4	2046.9	10780.8	1232.2	283.6	2602.5	1947.4
TR.BAL.	-17934.6	-750.5	-151.8	-628.8	-714.3	-5507.9	-5673.0	-338.8	-1246.6	-1156.3	-1766.6
INCOME	66623.0	1165.3	163.1	2567.1	1719.4	13939.1	25317.7	3572.8	1767.5	8298.5	8112.6
TRPOUT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRPIN		5.67	1.33	9.0	7.66	69.3	92.0	11.0	10.0	19.67	27.3
TRG		579.1	105.0	661.0	583.3	4926.67	5496.67	664.67	648.3	1114.0	1962.0

Table 11: MOBILE RESOURCES, REGIONAL TRADE BALANCE CONSTRAINTS, BOUNDS ON OUTPUT.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		734.0	129.3	903.4	810.2	0.0	8953.9	1628.9	3121.4	4725.0	3878.3
OUTPUT2		390.5	69.1	1190.0	948.4	5210.9	18209.3	1986.6	710.6	2499.8	5210.2
OUTPUT3		495.1	98.3	1081.6	685.6	0.0	3495.9	1617.6	1097.7	2694.1	3409.8
OUTPUT4		424.2	63.0	588.6	543.0	5773.8	3711.8	1238.6	838.6	2081.1	2707.7
GNP	93964.7	2052.8	359.7	3763.6	2987.2	10984.7	34370.9	6471.7	5768.2	12000.0	15205.9
EXPORT1		0.0	0.0	0.0	367.5	0.0	4347.1	73.5	2292.7	3501.7	0.0
EXPORT2		73.9	0.0	265.5	0.0	0.0	0.0	0.0	0.0	0.0	1585.6
EXPORT3		130.8	38.7	51.8	0.0	0.0	0.0	698.9	0.0	788.8	1120.3
EXPORT4		0.0	0.0	0.0	0.0	842.5	0.0	0.0	0.0	0.0	0.0
IMPORT1		182.1	0.0	0.0	0.0	1638.1	0.0	0.0	0.0	0.0	1054.1
IMPORT2		0.0	28.5	0.0	115.1	2938.2	1287.1	0.0	203.7	2164.5	0.0
IMPORT3		0.0	0.0	0.0	0.0	2512.9	1481.2	0.0	0.0	0.0	0.0
IMPORT4		295.5	175.4	823.9	592.7	0.0	7821.1	888.1	2118.9	2217.7	2148.3
TR.BAL.		-272.9	-88.7	-505.9	-340.1	-6246.7	-6242.3	-115.6	-29.9	-91.7	-496.4
INCOME	55765.9	1401.5	268.8	2433.6	1948.8	8340.7	18844.2	3540.0	3306.6	7364.5	8317.1
TRPOUT		6.1	1.0	9.0	7.33	0.0	0.0	10.67	9.67	19.33	26.33
TRPIN		0.0	0.0	0.0	0.0	69.3	92.0	0.0	0.0	0.0	0.0
TRG		355.4	92.2	545.5	410.5	4926.67	5496.67	464.4	67.5	78.1	1000.9

Table 12: INTERREGIONAL, INTRA-SECTORAL CAPITAL MOBILITY, NO LABOUR BOUNDS, REGIONAL TRADE CONSTRAINTS.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		0.0	0.0	0.0	3387.4	0.0	0.0	0.0	0.0	0.0	23403.5
OUTPUT2		2623.0	402.8	4117.6	0.0	9778.5	3560.5	5691.9	4858.7	16463.5	4312.9
OUTPUT3		0.0	0.0	0.0	0.0	0.0	28988.3	0.0	0.0	0.0	0.0
OUTPUT4		5750.9	0.0	0.0	0.0	0.0	2867.5	0.0	0.0	11955.1	0.0
GNP	128162.1	8373.9	402.8	4117.6	3387.4	9778.5	35416.3	5691.9	4858.7	28418.6	27716.4
EXPORT1		0.0	0.0	0.0	2263.7	0.0	0.0	0.0	0.0	0.0	15082.4
EXPORT2		1861.3	162.8	2887.2	0.0	7.0	0.0	3602.4	3395.3	5221.2	0.0
EXPORT3		0.0	0.0	0.0	0.0	0.0	22542.1	0.0	0.0	0.0	0.0
EXPORT4		232.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1994.2	0.0
IMPORT1		1073.4	76.9	606.0	0.0	1552.1	2301.8	1436.4	1683.8	2844.8	0.0
IMPORT2		0.0	0.0	0.0	1016.8	0.0	18590.9	0.0	0.0	0.0	3251.5
IMPORT3		1293.6	50.9	586.6	336.9	1938.0	0.0	610.9	559.1	4462.4	4044.6
IMPORT4		0.0	123.6	2200.5	1249.9	3934.9	11547.3	1670.6	1182.3	1386.4	8282.7
TR.BAL.		-272.9	-88.7	-505.9	-340.1	-7418.0	-9897.9	-115.6	-29.9	-91.7	-496.4
INCOME	80884.3	5682.4	221.9	2530.9	2136.8	6877.7	26299.0	2362.6	1842.8	1837.4	14550.9
TRPOUT		6.0	1.0	9.0	7.33	0.0	0.0	10.67	9.67	0.0	26.3
TRPIN		0.0	0.0	0.0	0.0	69.3	92.0	0.0	0.0	19.67	0.0
TRG		614.67	105.0	661.0	583.3	4926.67	5496.67	664.67	648.33	1114.0	1962.0

Table 12a: CAPITAL MOBILITY, LABOUR BOUNDS = 1.5(ISOLATED REGIONAL AVAILABILITY).

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		959.	155.2	1131.5	972.3	0.0	3676.5	1954.7	3745.7	5670.0	4916.9
OUTPUT2		517.8	88.1	1477.6	1138.0	4665.3	12256.9	2383.9	903.8	3100.4	6377.1
OUTPUT3		650.0	126.6	1297.9	844.9	0.0	15359.9	994.3	0.0	3338.7	4309.8
OUTPUT4		509.0	75.6	716.2	651.7	6928.5	1102.0	1498.1	1006.3	2497.3	3313.4
GNP	101310.9	2635.9	445.6	4623.1	3606.9	11593.8	32395.3	6831.0	5655.7	14606.4	18917.2
EXPORT1		0.0	95.1	0.0	79.1	0.0	485.0	283.4	2896.6	4314.3	2737.7
EXPORT2		0.0	0.0	367.0	272.9	0.0	0.0	304.9	0.0	0.0	0.0
EXPORT3		114.1	56.2	583.0	0.0	0.0	10144.6	0.0	0.0	999.0	1455.2
EXPORT4		0.0	0.0	0.0	0.0	1725.3	0.0	0.0	0.0	0.0	0.0
IMPORT1		0.0	0.0	493.7	0.0	1675.9	0.0	0.0	0.0	0.0	0.0
IMPORT2		0.0	138.3	0.0	0.0	3873.7	6869.8	0.0	1157.8	2668.3	0.0
IMPORT3		0.0	0.0	0.0	0.0	2660.1	0.0	0.0	846.8	0.0	0.0
IMPORT4		387.0	101.7	962.3	692.2	0.0	10920.7	703.9	921.9	2736.7	4689.2
TR.BAL.		-272.9	-88.7	-505.9	-340.1	-6484.4	-7160.9	-115.6	-29.9	-91.7	-496.4
INCOME	63664.4	1781.7	325.5	2977.1	2356.3	8774.2	20923.6	3639.0	3153.8	9222.7	10509.6
TRPOUT		6.0	1.0	9.0	7.33	0.0	0.0	10.67	9.67	19.33	26.33
TRPIN		0.0	0.0	0.0	0.0	69.3	92.0	0.0	0.0	0.0	0.0
TRG		417.9	103.1	628.3	470.5	4926.67	5496.67	558.1	160.8	243.9	1189.9

Table 12b: MOBILE CAPITAL, BOUNDS DUE TO LABOUR, REGIONAL TRADE CONSTRAINTS, EQUITY CONDITIONS.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		959.0	153.7	1131.5	972.3	5145.2	0.0	1954.7	3745.7	4554.7	4916.9
OUTPUT2		517.8	88.1	1477.6	1138.0	2816.3	6431.6	2383.9	903.8	3100.4	6377.1
OURTPUT3		642.1	126.6	782.9	37.8	9685.9	15359.9	667.2	0.0	0.0	0.0
OUTPUT4		0.0	57.4	0.0	651.7	6928.5	8371.5	326.3	349.4	0.0	337.4
GNP	93092.9	2118.9	425.8	3392.0	2799.8	24575.9	30163.0	5332.1	4998.9	7655.1	11631.4
EXPORT1		457.0	0.0	756.2	0.0	3099.3	0.0	1234.3	2019.9	2741.8	1011.4
EXPORT2		0.0	0.0	521.6	401.1	0.0	0.0	103.3	56.0	990.8	3193.3
EXPORT3		0.0	57.6	0.0	0.0	1167.9	9872.3	0.0	0.0	0.0	0.0
EXPORT4		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT1		0.0	0.0	0.0	0.0	0.0	3657.4	0.0	0.0	0.0	0.0
IMPORT2		0.0	21.0	0.0	0.0	7784.8	10110.4	0.0	0.0	0.0	0.0
IMPORT3		0.0	0.0	0.0	217.6	0.0	0.0	39.7	734.1	1126.7	1543.0
IMPORT4		729.9	125.3	1783.7	523.6	2210.5	3862.3	1413.6	1371.7	2697.5	3158.0
TR.BAL.		-272.9	-88.7	-505.9	-340.1	-5728.1	-7757.8	-115.6	-29.9	-91.7	-496.4
INCOME	58805.5	1432.6	315.6	2192.3	1786.3	17022.6	20670.3	2782.5	2782.5	4255.7	5565.1
TRPOUT		6.0	1.0	9.0	7.33	0.0	0.0	10.67	9.67	19.33	26.3
TRPIN		0.0	0.0	0.0	0.0	69.3	92.0	0.0	0.0	0.0	0.0
TRG		414.4	105.0	605.5	454.2	4926.67	5496.67	554.3	204.0	124.8	1139.3

Table 13: INTERREGIONAL, INTRA-SECTORAL LABOUR MOBILITY, NO CAPITAL BOUNDS, REGIONAL TRADE CONSTRAINTS.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		2018.1	0.0	0.0	0.0	0.0	6048.1	0.0	0.0	0.0	27947.0
OUTPUT2		0.0	364.9	4048.5	3357.3	10980.8	10634.7	5654.3	5055.5	15441.5	0.0
OUTPUT3		0.0	0.0	0.0	0.0	0.0	3898.6	0.0	0.0	15220.0	0.0
OUTPUT4		0.0	0.0	0.0	0.0	0.0	15829.1	0.0	0.0	0.0	0.0
GNP	126498.4	2081.1	364.9	4048.5	3357.3	10980.8	36410.5	5654.3	5055.5	30661.5	27957.0
EXPORT1		1186.5	0.0	0.0	0.0	0.0	2510.0	0.0	0.0	0.0	20173.5
EXPORT2		0.0	129.7	2997.2	2498.3	1218.7	0.0	3432.1	3527.2	2657.8	0.0
EXPORT3		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19809.5	0.0
EXPORT4		0.0	0.0	0.0	0.0	0.0	2491.6	0.0	0.0	0.0	0.0
IMPORT1		0.0	52.4	603.4	1438.6	1721.0	0.0	1440.4	1768.8	2403.4	0.0
IMPORT2		324.8	0.0	0.0	0.0	0.0	12177.1	0.0	0.0	0.0	7825.9
IMPORT3		398.5	48.3	1516.4	298.1	2050.3	2210.9	607.6	576.8	0.0	4255.3
IMPORT4		736.0	117.7	1383.3	1101.7	4172.3	0.0	1499.6	1211.5	10775.6	8588.7
TR.BAL.		-272.9	-88.7	-505.9	-340.1	-6724.9	-9386.4	-115.6	-29.9	-91.7	-496.4
INCOME	75248.1	1311.6	209.7	2496.6	1937.5	7338.3	21176.1	2349.5	1900.3	21497.6	15031.0
TRPOUT		6.0	1.0	9.0	7.33	0.0	0.0	10.67	9.67	19.33	26.3
TRPIN		0.0	0.0	0.0	0.0	69.3	92.0	0.0	0.0	0.0	0.0
TRG		614.67	105.0	661.0	583.3	4926.67	5496.67	664.67	648.33	1114.0	1928.2

Table 13a: LABOUR MOBILITY ONLY, CAPITAL CONSTRAINTS = 1.5(ISOLATED REGIONAL STOCK).

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		880.9	156.4	1084.1	1039.9	0.0	7752.7	2484.2	3961.2	5918.2	4654.0
OUTPUT2		468.5	82.9	1428.0	1212.1	7098.2	16303.1	2364.3	852.7	2999.8	6252.2
OUTPUT3		594.1	118.0	1669.2	822.7	0.0	2464.8	1941.1	1317.2	3232.9	4091.7
OUTPUT4		530.6	77.8	706.3	654.3	4028.2	3940.9	1486.4	1006.5	2514.1	3249.2
GNP	101439.5	2474.1	435.2	4887.6	3729.0	11126.4	30461.5	8275.9	7137.7	14665.0	18247.1
EXPORT1		0.0	0.0	0.0	0.0	0.0	4983.4	316.8	3006.5	4523.9	0.0
EXPORT2		42.7	0.0	0.0	0.0	0.0	0.0	11.3	0.0	0.0	1895.4
EXPORT3		0.0	49.3	915.8	480.1	0.0	0.0	764.3	0.0	891.8	1351.9
EXPORT4		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT1		0.0	0.0	358.4	97.2	1667.6	0.0	0.0	0.0	0.0	0.0
IMPORT2		0.0	34.1	0.0	0.0	1471.7	3368.3	0.0	1615.6	2792.9	0.0
IMPORT3		0.0	0.0	0.0	0.0	2386.2	2052.5	0.0	0.0	0.0	0.0
IMPORT4		315.6	104.0	1063.3	722.9	710.8	6584.4	1208.0	1420.7	2714.6	3743.6
TR.BAL.		-272.9	-88.7	-505.9	-340.1	-6236.3	-7021.8	-115.6	-29.9	-91.7	-496.4
INCOME	60646.1	1671.8	317.1	3184.9	2420.2	8092.4	16839.8	4654.2	4227.3	9187.5	10051.0
TRPOUT		6.0	1.0	9.0	7.33	0.0	0.0	10.67	9.67	19.33	26.3
TRPIN		0.0	0.0	0.0	0.0	69.3	92.0	0.0	0.0	0.0	0.0
TRG		387.6	100.5	611.5	481.6	4926.67	5496.67	630.4	162.1	189.3	1105.8

Table 13b: REGIONAL TRADE CONSTRAINTS, LABOUR MOBILITY, CAPITAL BOUNDS, EQUITY CONSTRAINT.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		880.9	156.4	1084.1	1039.9	1078.6	11018.1	2458.0	2314.2	3980.7	4295.9
OUTPUT2		468.5	82.9	1428.0	1212.1	6189.8	12940.3	2363.3	852.7	2999.8	6252.2
OUTPUT3		521.0	118.0	502.7	31.1	7353.4	0.0	0.0	1317.2	0.0	0.0
OUTPUT4		0.0	8.6	0.0	235.4	7117.5	9165.4	0.0	0.0	0.0	0.0
GNP	89466.7	1870.4	365.9	3014.8	2518.5	21739.3	33123.8	4821.3	4484.1	6980.5	10548.1
EXPORT1		51.1	11.6	37.8	67.0	0.0	7928.4	1772.6	705.9	2249.5	754.9
EXPORT2		139.9	0.0	557.0	510.6	0.0	0.0	300.8	117.4	1095.7	3246.3
EXPORT3		187.3	54.8	33.3	0.0	17.1	0.0	0.0	652.8	0.0	0.0
EXPORT4		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT1		0.0	0.0	0.0	0.0	1068.8	0.0	0.0	0.0	0.0	0.0
IMPORT2		0.0	15.3	0.0	0.0	3442.9	5349.3	0.0	0.0	0.0	0.0
IMPORT3		0.0	0.0	0.0	214.1	0.0	5100.6	611.5	0.0	1005.8	1363.1
IMPORT4		651.2	139.8	1134.1	703.6	1009.5	4331.1	1577.6	1505.9	2431.0	3134.5
TR.BAL.		-272.9	-88.7	-505.9	-340.1	-5350.2	-6852.6	-115.9	-29.9	-91.7	-496.4
INCOME	51473.3	1254.0	276.2	1918.9	1563.6	14900.1	18093.0	2435.6	2435.6	3725.0	4871.2
TRPOUT		6.0	1.0	9.0	7.33	0.0	0.0	10.67	9.67	19.33	26.3
TRPIN		0.0	0.0	0.0	0.0	69.3	92.0	0.0	0.0	0.0	0.0
TRG		378.5	101.9	581.8	455.7	4926.67	5496.67	595.7	24.6	0.0	1019.2

Table 14: INTRAREGIONAL, INTER-SECTORAL CAPITAL MOBILITY, LABOUR BOUNDS, REGIONAL TRADE CONSTRAINT.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		959.0	155.2	1131.5	972.3	0.0	9707.5	1954.7	3745.7	5670.0	4916.9
OUTPUT2		305.2	88.1	1477.6	1138.0	0.0	0.0	2383.9	903.8	3100.4	6377.1
OUTPUT3		0.0	62.2	699.2	302.1	9685.9	15359.9	807.7	315.5	593.0	793.0
OUTPUT4		509.0	0.0	0.0	651.7	6928.5	9198.8	1498.1	1006.3	2497.3	3313.4
GNP	99208.2	1773.3	305.4	3308.2	3064.0	16614.4	34266.2	6644.4	5971.2	11860.7	15400.4
EXPORT1		199.9	39.2	1.7	0.0	0.0	5685.8	1148.0	2967.1	4556.9	0.0
EXPORT2		0.0	0.0	549.8	383.1	0.0	0.0	0.0	0.0	0.0	2549.5
EXPORT3		0.0	8.5	185.6	0.0	4720.9	9207.8	0.0	0.0	0.0	0.0
EXPORT4		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT1		0.0	0.0	0.0	0.0	1609.1	0.0	0.0	0.0	0.0	173.0
IMPORT2		12.9	7.9	0.0	0.0	9150.0	17806.6	0.0	74.8	1574.2	0.0
IMPORT3		326.9	0.0	0.0	0.0	0.0	0.0	109.7	606.3	1290.6	1410.9
IMPORT4		132.9	128.4	1242.8	723.2	372.6	4472.0	1153.9	2316.4	1783.8	1461.8
TR.BAL.		-272.9	-88.7	-505.9	-340.1	-6410.8	-7385.0	-115.6	-29.9	-91.7	-496.4
INCOME	64393.6	1176.2	232.5	2159.8	1994.6	13462.8	23137.3	3525.5	3489.0	7231.9	7984.0
TRPOUT		6.0	1.0	9.0	7.33	0.0	0.0	10.67	9.67	19.33	26.3
TRPIN		0.0	0.0	0.0	0.0	69.3	92.0	0.0	0.0	0.0	0.0
TRG		391.8	101.4	634.7	481.2	4926.67	5496.67	577.6	267.5	344.3	1114.6

Table 15: INTRAREGIONAL, INTER-SECTORAL LABOUR MOBILITY, CAPITAL BOUNDS, REGIONAL TRADE LIMITS.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		880.9	156.4	1084.1	1039.9	0.0	8782.5	2484.2	3961.2	5918.2	4654.0
OUTPUT2		468.5	82.9	1428.0	1212.1	0.0	0.0	2364.3	852.7	2999.8	6252.2
OUTPUT3		594.1	118.0	1669.2	822.7	9561.0	14854.1	1941.1	1317.2	3232.9	4091.7
OUTPUT4		182.2	16.3	188.1	140.0	7117.5	8873.2	269.7	98.1	675.3	941.2
GNP	101308.5	2125.7	373.6	4369.4	3214.8	16678.5	32509.8	7059.2	6229.3	12827.0	15921.0
EXPORT1		0.0	21.6	0.0	210.6	0.0	6379.3	706.0	1896.6	2715.8	0.0
EXPORT2		116.3	0.0	354.7	0.0	0.0	0.0	289.2	0.0	0.0	2226.3
EXPORT3		172.0	54.1	999.0	502.5	4793.5	8952.7	953.2	351.6	1194.3	1285.2
EXPORT4		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT1		0.0	0.0	444.3	0.0	1621.6	0.0	0.0	0.0	0.0	0.0
IMPORT2		0.0	29.5	0.0	0.0	9344.0	18594.0	0.0	210.2	47.2	0.0
IMPORT3		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT4		561.2	135.0	1415.3	1053.3	206.8	4270.9	2064.0	2067.9	3954.6	4007.9
TR.BAL.		-272.9	-88.7	-505.0	-340.1	-6378.9	-7532.9	-115.6	-29.9	-91.7	-496.4
INCOME	66951.1	1461.4	281.1	2924.7	2097.4	13484.5	22144.0	4020.2	3776.0	8163.7	8598.3
TRPOUT		6.0	1.0	9.0	7.33	0.0	0.0	10.67	9.67	19.33	26.3
TRPIN		0.0	0.0	0.0	0.0	69.3	92.0	0.0	0.0	0.0	0.0
TRG		410.4	102.0	628.3	512.0	4926.67	5496.67	639.8	284.0	368.4	1119.8

Table 16: REGIONAL TRADE BALANCE CONSTRAINTS, NO MOBILITY, EQUITY CONDITION.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		587.2	103.4	722.7	648.2	5237.8	7395.4	1303.1	2928.1	3780.0	3102.6
OUTPUT2		312.4	55.3	42.4	203.0	0.0	0.0	408.8	0.0	0.0	4168.1
OUTPUT3		396.1	78.7	1112.8	548.8	6374.0	9902.7	1294.1	0.0	239.4	338.9
OUTPUT4		130.8	50.4	470.9	434.4	4619.0	5031.6	990.9	670.9	1664.9	2166.1
GNP	67513.9	1426.4	287.8	2348.8	1834.4	16230.8	22329.7	3996.9	3599.0	5684.3	9775.8
EXPORT1		0.0	0.0	0.0	0.0	3797.1	4839.0	464.7	1896.7	3205.2	76.1
EXPORT2		67.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1987.1
EXPORT3		73.5	27.1	686.2	303.6	704.1	5802.3	717.8	0.0	0.0	0.0
EXPORT4		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT1		0.0	0.0	73.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT2		0.0	23.4	585.1	278.5	7725.3	12261.4	742.9	585.6	1383.4	0.0
IMPORT3		0.0	0.0	0.0	0.0	0.0	0.0	0.0	557.9	689.3	915.3
IMPORT4		413.6	92.4	533.4	365.2	2119.4	4395.2	385.6	684.6	1201.7	636.9
TR.BAL.		-272.9	-88.7	-505.9	-340.1	-5343.5	-6015.3	54.0	68.6	-49.2	358.8
INCOME	42508.1	1035.6	228.1	1584.7	1291.3	12304.9	14941.7	2011.4	2011.4	3076.2	4022.6
TRPOUT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.67	19.33	26.3
TRPIN		5.67	1.33	9.0	7.66	69.3	92.0	11.33	0.0	0.0	0.0
TRG		340.9	87.0	359.6	314.4	4724.5	4590.8	0.0	0.0	0.0	0.0

Table 17: REGIONAL TRADE CONSTRAINT, BOUNDS ON IMPORTS OF SECTOR 4, EQUITY IMPOSED.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		0.0	0.0	0.0	63.2	0.0	7395.4	210.9	1158.4	0.0	117.1
OUTPUT2		0.0	34.5	0.0	0.0	0.0	0.0	0.0	0.0	604.0	0.0
OUTPUT3		358.4	78.7	896.5	548.8	3185.9	5786.7	1294.1	503.0	1282.9	2727.8
OUTPUT4		339.4	50.4	470.9	434.4	4619.0	6110.3	990.9	670.9	1664.8	2166.1
GNP	43763.6	698.0	163.6	1367.4	1046.4	7804.9	19292.4	2495.9	2332.3	3551.7	5011.1
EXPORT1		0.0	0.0	0.0	0.0	0.0	4636.1	0.0	497.9	0.0	0.0
EXPORT2		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXPORT3		193.5	42.1	588.0	408.0	86.3	2678.8	889.8	111.5	286.7	1870.8
EXPORT4		107.8	32.3	0.0	77.9	1303.2	786.7	464.2	458.3	1129.8	1233.1
IMPORT1		359.2	74.0	515.9	360.0	1122.2	0.0	16.3	0.0	380.7	1240.9
IMPORT2		90.0	14.1	328.1	265.9	4492.9	8164.8	703.3	347.6	127.6	871.7
IMPORT3		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT4		125.0	75.0	250.0	200.0	1200.0	1750.0	750.0	750.0	1000.0	1000.0
TR.BAL.		-272.9	-88.7	-505.9	-340.1	-5425.6	-1785.2	-115.6	-29.9	-91.7	-8.7
INCOME	27054.7	659.1	145.2	1008.6	821.8	7831.6	9509.8	1280.2	1280.2	1957.9	2560.3
TRPOUT		0.0	0.0	0.0	0.0	0.0	0.0	7.8	9.67	19.3	0.0
TRPIN		5.67	1.33	9.0	7.66	69.3	92.0	11.33	0.0	0.0	27.3
TRG		229.7	59.0	251.1	223.8	4926.67	1602.8	0.0	0.0	0.0	0.0

Table 18: NATIONAL TRADE CONSTRAINT, NO MOBILITY, EQUITY IMPOSED.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		0.0	103.4	0.0	648.2	5237.8	7395.4	1303.1	2116.0	419.5	0.0
OUTPUT2		145.8	55.3	946.4	0.0	8524.9	0.0	0.0	0.0	1278.3	0.0
OUTPUT3		396.1	78.7	1112.8	548.8	6374.0	9902.7	1294.1	885.8	2155.3	2727.8
OUTPUT4		339.4	50.4	470.9	434.4	4619.0	6110.3	990.9	670.9	1664.9	2166.1
GNP	71207.4	881.2	287.8	2570.4	1631.4	24755.7	23408.4	3588.1	3672.7	5517.8	4894.0
EXPORT1		0.0	0.0	0.0	0.0	0.0	4630.6	545.8	1040.4	0.0	0.0
EXPORT2		0.0	0.0	335.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXPORT3		163.5	24.8	75.1	348.3	2505.5	5513.8	705.4	283.0	1243.2	1576.9
EXPORT4		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT1		605.4	17.0	335.0	30.9	1562.6	0.0	0.0	0.0	779.7	1625.5
IMPORT2		0.0	29.2	0.0	498.1	0.0	13056.8	1172.4	587.2	0.0	1397.4
IMPORT3		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT4		193.4	87.0	575.2	401.9	2851.1	3931.4	437.1	730.0	534.0	513.7
TR.BAL.	-12960.7	-272.9	-88.7	-505.0	-340.1	-1908.2	-6843.7	-359.3	6.2	-70.5	-1959.7
INCOME	45853.1	1117.7	246.1	1709.4	1392.9	13273.2	16117.5	2169.7	2169.7	3318.3	4339.3
TRPOUT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRPIN		5.67	1.33	9.0	7.66	69.3	92.0	11.33	10.0	19.67	27.3
TRG		588.39	105.0	323.2	505.4	2444.9	5235.8	301.2	0.0	0.0	1837.4

Table 19: NATIONAL TRADE CONSTRAINT, BOUNDS ON IMPORTS OF SECTOR 4, EQUITY CONSTRAINT.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		0.0	0.0	0.0	0.0	37.8	0.0	0.0	760.9	0.0	0.0
OUTPUT2		0.0	51.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OUTPUT3		396.1	78.7	394.0	548.8	6374.0	9902.7	1294.1	885.8	2155.3	2727.8
OUTPUT4		339.4	50.4	470.9	434.4	4619.0	6110.3	990.9	670.9	1262.1	2166.1
GNP		735.4	180.4	864.8	983.2	11030.8	16013.0	2285.0	2317.6	3417.4	4894.0
EXPORT1		0.0	0.0	0.0	0.0	0.0	0.0	0.0	87.2	0.0	0.0
EXPORT2		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXPORT3		225.3	40.9	0.0	409.2	3802.7	6845.5	889.8	479.7	1544.9	1860.5
EXPORT4		96.8	29.5	0.0	67.2	1061.6	901.2	750.0	448.9	717.8	1197.0
IMPORT1		373.7	80.8	182.9	421.7	2603.0	2073.9	486.4	0.0	741.4	1361.7
IMPORT2		93.1	0.0	329.8	265.8	4555.1	6941.8	681.7	339.8	717.7	805.2
IMPORT3		0.0	0.0	167.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT4		125.0	75.0	250.0	200.0	1200.0	1750.0	750.0	750.0	1000.0	1000.0
TR.BAL.	-8867.2	-269.7	-85.1	-930.3	-411.1	-3503.9	-3018.9	-278.3	-74.0	-196.5	-109.5
INCOME	28127.1	685.2	150.9	1048.6	854.4	8142.0	9886.8	1330.9	1330.9	2035.5	2661.8
TRPOUT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRPIN		5.67	1.33	9.0	7.66	69.3	92.0	11.33	10.0	19.67	27.3
TRG		228.3	59.3	661.0	287.7	3087.3	2598.4	155.0	0.0	0.0	159.9

Table 20: INTERREGIONAL FACTOR MOBILITY, NATIONAL TRADE CONSTRAINTS, EQUITY IMPOSED.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		225.4	129.3	0.0	810.2	6547.2	9244.2	1628.9	3121.4	1961.8	2892.3
OUTPUT2		390.5	69.1	1190.0	654.4	10573.3	14513.2	1986.6	710.6	2499.8	2353.7
OUTPUT3		236.4	98.3	1081.6	685.6	2646.5	3340.5	771.4	327.3	0.0	1460.5
OUTPUT4		424.2	63.0	149.7	543.0	5773.8	6058.1	0.0	0.0	2081.1	2707.7
GNP	90070.0	1276.5	360.0	2540.3	2693.2	25540.7	33156.1	4386.9	4159.4	6542.7	9414.2
EXPORT1		0.0	0.0	0.0	0.0	0.0	4384.6	482.8	1583.0	1047.5	0.0
EXPORT2		0.0	0.0	465.2	0.0	0.0	0.0	571.8	0.0	794.9	0.0
EXPORT3		0.0	36.8	0.0	430.3	0.0	0.0	152.1	0.0	0.0	0.0
EXPORT4		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT1		0.0	17.2	349.4	163.8	508.1	0.0	0.0	0.0	0.0	0.0
IMPORT2		360.0	29.1	0.0	0.0	0.0	4104.3	0.0	38.9	0.0	0.0
IMPORT3		46.3	0.0	0.0	0.0	1561.6	1695.0	0.0	319.1	1046.0	0.0
IMPORT4		201.4	93.4	980.4	433.9	2672.3	5483.4	1565.8	1544.3	1255.6	512.3
TR.BAL.	-15033	-607.7	-102.9	-864.6	-167.4	-4742.0	-6898.1	-359.2	-319.3	-477.1	-512.3
INCOME	52929.0	1289.4	284.0	1973.2	1607.8	15321.5	18604.7	2054.5	2054.5	3830.4	5009.0
TRPOUT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRPIN		5.67	1.33	9.0	7.66	69.3	92.0	11.33	10.0	19.67	27.3
TRG		614.67	105.0	661.0	183.9	4926.67	5496.67	664.67	332.6	220.1	648.4

Table 21: INTERREGIONAL, INTRA-SECTORAL MOBILITY, REGIONAL TRADE CONSTRAINTS, EQUITY IMPOSED.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		734.0	129.3	903.4	810.2	6547.2	6797.8	1628.9	1750.9	3246.9	3878.3
OUTPUT2		390.5	69.1	1190.0	948.4	11763.1	7743.7	1986.6	710.6	2499.8	5210.2
OUTPUT3		254.8	95.0	786.8	87.3	672.2	6272.7	891.3	1097.7	0.0	0.0
OUTPUT4		424.2	63.0	0.0	543.0	5773.8	7637.8	0.0	784.0	965.2	813.5
GNP	85900.8	1803.5	356.0	2880.2	2388.9	24756.3	28452.0	4506.8	4343.2	6711.9	9902.0
EXPORT1		0.0	0.0	0.0	181.7	0.0	2848.6	1012.0	244.2	2408.0	566.78
EXPORT2		0.0	0.0	367.1	0.0	1762.5	0.0	94.9	0.0	0.0	2531.7
EXPORT3		96.5	35.8	228.7	0.0	0.0	1449.0	288.3	426.4	0.0	0.0
EXPORT4		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT1		0.0	0.0	0.0	0.0	696.4	0.0	0.0	0.0	0.0	0.0
IMPORT2		0.0	24.8	0.0	0.0	0.0	8819.8	0.0	0.0	0.0	0.0
IMPORT3		69.7	0.0	0.0	139.8	3324.2	0.0	0.0	0.0	1002.0	1337.2
IMPORT4		299.8	99.7	1101.7	382.0	2291.8	3318.9	1510.9	700.4	1497.7	2257.7
TR.BAL.		-272.9	-88.7	-505.9	-340.1	-4549.9	-7841.1	-115.6	-29.9	-91.7	-496.4
INCOME	49943.7	1216.7	268.0	1861.9	1517.1	14457.4	17555.4	2363.2	2363.2	3614.3	4726.4
TRPOUT		6.0	1.0	9.0	7.33	0.0	0.0	10.67	9.67	19.33	26.3
TRPIN		0.0	0.0	0.0	0.0	69.3	92.0	0.0	0.0	0.0	0.0
TRG		345.8	93.6	503.7	388.3	4926.67	5496.67	458.6	0.0	0.0	988.3

Table 22: INTERREGIONAL, INTRA-SECTORAL CAPITAL MOBILITY, NO LABOUR BOUNDS, EQUITY IMPOSED.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		1296.1	0.0	0.0	0.0	11415.4	0.0	3195.1	2872.5	0.0	6789.3
OUTPUT2		1088.3	301.9	3853.8	3181.6	0.0	0.0	2810.1	2914.8	8186.4	6030.0
OUTPUT3		0.0	204.0	0.0	0.0	514.2	28225.1	0.0	0.0	0.0	0.0
OUTPUT4		0.0	0.0	0.0	123.7	17429.4	0,0	0.0	0.0	0.0	0.0
GNP	100431.7	2384.4	505.9	3853.8	3305.3	29359.0	28225.1	6005.2	5787.3	8186.4	12819.3
EXPORT1		196.8	0.0	0.0	0.0	8856.9	0.0	1655.1	635.7	0.0	4999.3
EXPORT2		746.6	2.7	2851.7	2346.2	0.0	0.0	883.1	1938.6	4859.9	9.0
EXPORT3		0.0	143.9	0.0	0.0	0.0	22778.3	0.0	0.0	0.0	0.0
EXPORT4		0.0	0.0	0.0	0.0	6690.6	0.0	0.0	0.0	0.0	0.0
IMPORT1		0.0	59.2	579.2	1400.9	0.0	2192.3	0.0	0.0	1088.2	0.0
IMPORT2		0.0	0.0	0.0	0.0	12015.3	16907.4	0.0	0.0	0.0	0.0
IMPORT3		406.5	0.0	559.8	293.4	8802.6	0.0	752.9	800.7	1099.0	1709.1
IMPORT4		809.8	176.2	2218.5	992.0	0.0	12411.4	1900.9	1803.5	2764.4	3795.6
TR.BAL.		-292.0	-88.7	-505.9	-340.1	-5270.4	-8732.8	-115.6	-29.9	-91.7	-496.4
INCOME	64524.8	1571.9	346.3	2405.5	1960.1	18678.2	22680.6	3053.2	3053.2	4669.5	5106.3
TRPOUT		6.0	1.0	3.5	0.0	0.0	0.0	10.67	9.67	19.33	26.3
TRPIN		0.0	0.0	0.0	7.66	69.3	92.0	0.0	0.0	0.0	0.0
TRG		614.67	105.0	661.0	583.3	4926.67	5496.67	664.67	648.33	229.5	1102.5

Table 23: INTERREGIONAL, INTRA-SECTORAL LABOUR MOBILITY, NO CAPITAL BOUNDS, EQUITY CONSTRAINT.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		1825.1	0.0	0.0	0.0	0.0	20270.1	0.0	0.0	0.0	10546.2
OUTPUT2		214.8	318.5	2302.9	2865.2	5389.5	7490.4	4268.2	4274.2	7439.4	0.0
OUTPUT3		0.0	144.6	0.0	0.0	1547.4	5688.0	1046.1	1295.7	0.0	0.0
OUTPUT4		0.0	0.0	0.0	0.0	17497.5	0.0	0.0	0.0	0.0	0.0
GNP	94424.0	2039.9	463.1	2302.9	2865.4	24434.4	33448.5	5314.3	5569.9	7439.4	10546.2
EXPORT1		965.4	0.0	0.0	0.0	0.0	16213.2	0.0	0.0	0.0	7683.3
EXPORT2		0.0	45.7	2425.0	2114.2	0.0	0.0	2212.1	3432.6	4511.9	0.0
EXPORT3		0.0	76.2	0.0	0.0	0.0	732.4	385.6	556.2	0.0	0.0
EXPORT4		0.0	0.0	0.0	0.0	8194.4	0.0	0.0	0.0	0.0	0.0
IMPORT1		0.0	55.5	1260.4	1220.3	2692.1	0.0	1117.5	2492.4	1188.1	0.0
IMPORT2		106.4	0.0	0.0	0.0	4652.6	12265.9	0.0	0.0	0.0	3178.4
IMPORT3		392.7	0.0	492.3	263.9	6046.8	0.0	0.0	0.0	966.8	1590.1
IMPORT4		739.2	154.6	1178.2	970.1	0.0	11679.9	1595.9	1526.3	2448.7	3411.3
TR.BAL.		-272.9	-88.7	-505.9	-340.1	-5197.1	-7000.2	-115.6	-29.9	-91.7	-496.4
INCOME	55162.0	1343.8	296.0	2056.5	1675.6	15967.9	19389.6	2160.1	2160.1	3992.0	5220.3
TRPOUT		6.0	1.0	9.0	7.33	0.0	0.0	10.67	9.67	19.33	26.3
TRPIN		0.0	0.0	0.0	0.0	69.3	92.0	0.0	0.0	0.0	0.0
TRG		614.67	105.0	590.6	538.0	4926.67	5496.67	664.67	648.33	0.0	795.0

Table 24: INTRAREGIONAL, INTER-SECTORAL CAPITAL MOBILITY, LABOUR BOUNDS, EQUITY CONDITION.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		959.0	27.7	1131.5	972.3	7884.7	6646.3	1954.7	2808.9	2258.0	4916.9
OUTPUT2		0.0	88.1	0.0	0.0	0.0	0.0	0.0	0.0	1274.9	6377.1
OUTPUT3		343.3	126.6	790.1	348.8	9296.5	15359.9	825.7	0.0	0.0	0.0
OUTPUT4		287.8	75.6	716.2	651.7	0.0	0.0	1498.1	1006.3	2497.3	137.0
GNP	71261.1	1590.2	318.1	2637.7	1972.8	17180.2	22006.2	4278.5	3815.3	6030.2	11430.9
EXPORT1		307.6	0.0	257.5	248.3	3614.7	4618.5	1098.4	1715.0	1595.0	1311.7
EXPORT2		0.0	6.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3607.3
EXPORT3		31.2	0.0	324.0	143.3	5807.9	11322.1	203.5	0.0	0.0	0.0
EXPORT4		0.0	0.0	0.0	0.0	0.0	0.0	12.9	0.0	0.0	0.0
IMPORT1		0.0	14.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT2		298.8	0.0	715.7	524.4	8614.5	13093.4	1315.3	610.8	718.8	0.0
IMPORT3		0.0	0.0	0.0	0.0	0.0	0.0	0.0	601.9	967.9	1315.1
IMPORT4		312.9	80.2	371.7	207.3	6866.4	9486.0	0.0	426.2	0.0	2806.3
TR.BAL.		-272.9	-88.7	-505.9	-340.1	-6058.3	-6638.8	-.5	76.1	-91.7	796.1
INCOME	45422.2	1106.6	243.8	1693.4	1379.8	13148.5	15966.0	2149.3	2149.3	3287.1	4298.5
TRPOUT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.67	19.3	26.3
TRPIN		5.67	1.33	9.9	7.66	69.3	92.0	11.3	0.0	0.0	0.0
TRG		357.4	78.4	433.2	320.0	4926.67	4850.6	0.0	0.0	0.0	0.0

Table 25: INTRAREGIONAL, INTER-SECTORAL LABOUR MOBILITY, CAPITAL BOUNDS, EQUITY CONDITIONS.

	CANADA	NFLD.	P.E.I.	N.S.	N.B.	QUEBEC	ONTARIO	MAN.	SASK.	ALBERTA	B.C.
OUTPUT1		880.9	156.4	573.3	1039.9	4966.8	1490.4	614.2	2468.0	0.0	1984.9
OUTPUT2		344.1	82.9	607.7	68.1	0.0	0.0	2003.7	852.7	2999.8	0.0
OUTPUT3		594.1	118.0	1669.2	822.7	9561.0	14854.1	1941.1	1317.2	3232.9	4091.7
OUTPUT4		0.0	16.3	0.0	392.6	6446.7	9165.4	0.0	0.0	0.0	3125.0
GNP	78381.9	1819.1	373.6	2850.2	2323.4	20974.5	25509.9	4559.0	4637.9	6232.7	9201.6
EXPORT1		85.3	12.6	0.0	196.7	3463.8	0.0	0.0	965.6	0.0	0.0
EXPORT2		53.3	0.0	0.0	0.0	0.0	0.0	139.5	119.8	1416.5	0.0
EXPORT3		254.7	53.5	1194.1	572.5	2324.9	9778.1	1295.3	631.4	1480.1	2553.8
EXPORT4		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT1		0.0	0.0	393.1	0.0	0.0	1356.0	0.0	0.0	603.1	549.4
IMPORT2		0.0	17.7	163.0	535.6	9137.5	13320.6	0.0	0.0	0.0	1891.3
IMPORT3		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IMPORT4		666.2	137.0	1143.9	573.7	1871.4	2154.4	1550.4	1552.5	2359.0	93.7
TR.BAL.		-272.9	-88.7	-505.9	-340.1	-5220.2	-7052.9	-115.6	164.3	-65.5	19.4
INCOME	53373.1	1300.3	286.4	1989.8	1621.3	15450.1	18760.8	2525.5	2525.5	3862.5	5051.0
TRPOUT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRPIN		5.67	1.33	9.0	7.66	69.3	92.0	11.3	10.0	19.67	27.3
TRG		420.8	105.0	385.9	350.7	4870.8	5496.67	385.6	0.0	32.53	0.0

CHAPTER 7: A SUMMARY OF THE FINDINGS.

7.1 Introduction:

This final chapter is devoted to a summary of the results obtained in this study, a listing of some of the special assumptions made regarding the data used and the specification of constraints and how these affect the workings of the optimisation results. Section 7.2 describes some of the critical assumptions made in this study. In the concluding section of this chapter (7.3) the debate is summarised and the manner in which this work is a complement to and an extension of earlier work in regional economics is also put forward.

The discussion there runs on two or three distinct fronts. First, the manner in which conventional studies on regional and interregional economic dependence could be extended is discussed. Second, the weaknesses and shortcomings of the conventional models and a selected set of improvements incorporated in this study are noted. Third, the discussion highlights what may be considered "unexpected" results -, results that imply rather unconventional policy prescriptions. The major part of this discussion in 7.3 is in response to the widespread disparities in living standards between various areas inside a nation discussed in Chapter 2 above.

It is advisable here, though, to mention that the results of this study have to be treated with caution, because the results are based on a number of special assumptions, each of which may not be applicable in certain specific situations and so may prevent similar conclusions from holding elsewhere. Similarly, this study is designed to look into and answer only a part of the questions that arise in the context of regional disparities and regional development. Most significant among the omissions is the fact that this study is not a dynamic optimisation exercise. Furthermore, this study does not go into how interregional linkages are established, and what makes some regions better sources of supply of raw materials and others better centers of production of output for export etc. Rather, these linkages are taken as given, and the study focuses on what implications emerge if this pattern of interdependence forms the basis of an optimisation. Finally, a word of caution is also warranted because of the data set used in the study, this being a mixture of statistics that are available on a regular basis, statistics that are published only once and so may not be consistent with all the yearly components of those published annually, and some statistics that had to be derived on the basis of particular assumptions. As a result of all these complexities, the data values used here may not reflect the true picture in Canada, with the implication that

the results may not reflect the position in any economy modelled on the Canadian experience. The emphasis here is modest: to concentrate on how the regional allocation of resources would change if the optimality criteria described above were adopted. Since the stress is not too much on predictive ability, the year chosen for the exercise is 1966, the choice of this year being justified on account of the availability of the DREE Input-Output Table (Zucker 1976) for this year.

7.2 Some Limitations of the Study

The limitations of this study include both limitations of the data and the assumptions used, and those of the framework of the optimisation (the linear program LP). The latter are analysed first, followed by the former.

7.2.1 Limitations of Linear Programming

The discussion in Section 2.5 above has tended to draw a rather sharp distinction between parameter values derived by econometric estimation and values used in optimisation exercises. In reality, the parameters used in an optimisation could be those derived from actual estimates, so that this dichotomy no longer holds. Most often the parameters used in a LP exercise are "plausible" or

approximate values, not the actual estimates (the idea being to use LP as an alternative to econometric estimation in the first place). As a result, the conclusions that can be drawn from most LP studies are only as accurate as the parameter values used. In this study, some parameters were obtained from published sources (the I-O coefficients for one), but others (e. g. the consumption coefficients or the factor/output ratios) were derived as averages of the relevant variables over a five year period. To the extent that these values differ from what would be obtained through an econometric study, the accuracy of the results obtained here is reduced.

In addition, the LP framework (obviously) assumes that all the relations are linear, and if in reality these are non-linear, the constraints used in the model here can only be taken as approximations of the true picture. A more serious limitation, however, is the one that can be classified as the "all or nothing" nature of LP. In such an optimisation, if an activity is found to be feasible, it may be used or run to its maximum potential. Thus if any sector's output in any region should be produced, all factor resources are transferred to this sector in the region, until some bound is hit. Such a complete neglect of all other sectors and regions, in addition to leading to a very extreme concentration of activity, is not an adequate representation

of the current diversity that characterises the real world. It is to be acknowledged here that this feature of LP is unrealistic. While some extremes of this nature can be avoided by imposing upper and lower bounds on the value each variable can take (e. g. $\pm$ 20, 40 or 50% of the plausible values), the presence of too many such bounds has its drawbacks too. In such a case the exercise does not yield the maximum possible value of the OF but the highest value obtainable within a very narrow band of values of endogenous variables.

Again the LP framework used is a one period, static model. Hence the model is unable to yield indications of how the adjustments leading to a final outcome are obtained. What are seen are snapshots of the economy before and after all adjustments have been made. In addition, in the LP solution it is very easy to determine what targets are attained, but no indication is given as to what instruments are to be used to arrive at this solution.

7.2.2 Data and Other Limitations

The most obvious limitation forced on the model by data availability concerns transport costs. These are assumed to be incorporated in the values on interregional trade coefficients. Thus the fact that regions separated by a large

land mass are seen to trade very small amounts with each other is taken to imply high transport costs.

Another assumption that has a significant impact on the results is that of a steady state. Equations (4.11 - 4.16) above were seen to incorporate both levels and changes in levels of various asset holdings. The steady state assumption is believed to be more relevant for a one-period, static model because changes in assets in a one-period model imply different solutions for subsequent periods, a feature that this model cannot account for. Again, the steady state assumption is used to highlight the fact that the study attempts to find the optimal regional allocation of resources. This can best be done in an equilibrium framework, when all adjustments between any (policy) injection and the final outcome have taken place. If a steady state is not allowed for, the full impact of any action cannot be determined. This assumption also reduces the number of variables from (an unfeasible) 280 to 160, a number that does not exceed available memory space on many computers.

While the use of this (steady state) assumption considerably simplifies the form of the financial equations (the right hand side of 4.14 becoming zero to represent zero additions to the capital stock), it creates some problems for the overall model. As these equations are derived by assuming

savings are zero, the sum of consumption coefficients over all sectors and regions equals unity - so that income equals consumption. However, in the commodity balance equations there has to be some investment (at least equal to replacement investment). This, along with the fact that the coefficients used here are derived by rounding off the Zuker values to 5 decimal places leads to a state in which the commodity balances, income equations and the government budget constraint do not imply exactly the same constraint on output as the financial equations dictate.

The data values in the I-O table also include no housing sector, no internationally traded inputs and define income as wages and salaries, interest income and the profit income of unincorporated businesses. Even though it is unreasonable to do so in the Canadian case, this study is forced to assume that the value of input supplies and demands of the housing sector and the proportion of internationally traded inputs is minor enough to be negligible. However, as the model generates less value added per sectoral output than is true in reality (as the data ignores corporate profit and rental income), a correction is made in the values used. Value added per sector per region is calculated as the residual from sectoral output after intermediate inputs used and indirect taxes on output are subtracted away, and the resulting numbers are used in the income definition

equations.

7.3 An Overall Analysis of the Study:

This thesis has been devoted to the developing and testing of a linear programming optimisation model whose main aim is to study ways of making the spatial pattern of economic activity more efficient than it has been. Chapter 2 above documents the existence of and the factors responsible for widespread disparities in living conditions and standards of material welfare across nations, and between regions of the same nation. Because of equity considerations, it is essential that these obvious disparities be removed, or at least efforts be made to speed up the pace of development in the areas that are characterised by hunger and poverty. However, it is felt, and the results of the study itself show that this observation is not unfounded, that a speeding up of a rate of growth is more easily accomplished if scarce resources are allocated to activities where they yield a maximum return. The notion of maximum is exployed across sectors as well as across regions, therefore the policy prescriptions that emerge from this model ensure the highest rate of growth across the entire national economy. In any situation where resources are scarce and some optimisation is undertaken, the policy maker has to take into account the following points:

i) the productivity (or utility) of the resources (or commodities) used in all possible uses;

ii) potentials and possibilities of each area, a factor that includes considerations like the availability of support and service facilities for industry, the existence of enough aggregate demand to justify locating any industry there, and problems like overcrowding and congestion in certain regions;

iii) the utility or usefulness of the activity where the investment is being contemplated, both by way of the activity's contribution to any objectives and the demands it makes on scarce resources per unit of output.

To fully account for all these factors it was felt that a fairly detailed model of the economic system was essential, a model that accounts for most of the linakges between demands and supplies of various commodities, assets and resources so that any emerging scarcities could be seen within the context of their impact on the overall economic picture. Even though the demand for and supply of any commodity reveals the relative scarcity that may exist in the particular market where excess demand (supply) is likely to push prices up (down), this picture reveals only the partial equilibrium that prevails for this one commodity alone. Even

a very high degree of scarcity for any one commodity may not mean too high a shadow price for the commodity in the national economy because of either a relatively higher scarcity of other commodities or a lower contribution to the objective function per unit of output by this commodity relative to others. A general equilibrium system is what enables a policy maker to account for these linkages that are implied but not made explicit in a single market analysis. As an example, the creation of any investment is likely to result in a demand for finances to pay for the expenditure, and this may mean that once all adjustments are over, it is the market for financial assets and not that for goods that reveals the largest excess demand. This is true even though the policy maker by encouraging investment may desire only to create a larger aggregate demand for goods. This idea has been linked in the model above to the notion of the "most binding constraint" - the constraint whose relaxation would yield the highest increase in the value of the objective function.

The usefulness of any resource to the national economy can vary across regions just as it does across sectors because of:

i) differences in demand for the goods

ii) variations in resource/output ratios across regions.

Factors that make for a relatively high productivity in the core regions of the nation include availability of complementary goods and services alongside repair and service facilities. Also essential are a labour force with the relevant degree and type of know how and sufficient aggregate demand to make large scale operations profitable. However, the core regions may not be the ones where investment is profitable if there exist supply bottlenecks say due to overcrowding, or if it is felt that there will be no future growth in aggregate demand in these regions because a threshold level of demand has been met. Transport cost savings can also be obtained by locating in a region somewhat removed from the centers but along a well established transport route. To be truly comprehensive, a model should incorporate both an allowance for all factors that can make for a given pattern of costs, returns, demands and supplies and not others, as well as covering the entire range of commodities, resources, assets and types of finance that exist in the economy. In reality this high degree of interdependence is not possible to account for both because of the existence of data and computational limitations and because the effects of quite a few forces are not easy to quantify. Thus in any study only a segment of the facets

described here are stressed, and in case of the present study this means making an allowance for the given pattern of interdependence among as large a variety of assets, goods and resources as is possible. Thus the results obtained are based upon linkages between only these categories of commodities and resources.

This study has been based on the assumption that there is a scope for improvement in the current pattern of resource allocation across space and among various sectors within each spatial unit. It it observed that it is possible to produce a greater output of all goods and services, and for all regions to attain a better standard of living than at present if all resources are put to their most efficient uses. This conclusion is independent of what forces lead to the currently observed patterns of costs and prices, and of what factors made some areas suppliers of raw materials while others became centers of production and growth. This is quite apart from the cost savings that would emerge if the best production techniques were adopted or if the production structure of the economy was redirected to make an optimal use of current and future transport methods. The concept of efficiency used here hinges on the ability of each resource to help relax the most binding constraint on the economy, and to this end the model makes use of a thorough linking of the commodity, asset and resource markets. The commodity market

linkages observed in the DREE table are assumed to be based on the least cost source of supply for any input, and these equations are complemented by constraints representing the asset and factor markets. Thus the emergence of say a shortfall in commodity demand implying savings out of income (and a demand for assets) is linked to the supply of various assets that could be held as wealth in place of the expenditure on goods and services. The presence of interregional trading opportunities represents another link between the asset and commodity markets of various regions, creating another avenue by which expenditures in one market (in one region) can create demands for other assets elsewhere. The constraints that the optimisation now is performed under cover not only the maximum amounts available of various commodities as a result of factor supplies and resource endowments, but also include the interlinks between various markets (which create what could be called the indirect demand effects). Hence the resulting shadow prices reveal a productivity or a utility of the resource in question that is based on its aggregate scarcity in the economy. This can now be used to arrive at a reallocation of resources that accomplishes any required ends with a lower use of inputs than the current pattern, even within the present price and cost structure.

At a theoretical level the model used would represent

an extension of most of the earlier work on regional and interregional systems. Most of these studies, whether theoretical or empirical, are based on the demand-supply balance of commodities alone. Even when this work is extended beyond these input output relations, most often the tool used is the input output relations between the commodity sector and the "rest of the economy" (e.g. Carter and Ireri 1970). Again, it was noted above (Chapter 3.3) that most of the efforts of various government agencies in Canada are also restricted to analysing the impact of easing a demand or a supply bottleneck in the commodity market in various regions. This is accomplished either by helping provide supply (subsidy and tax benefits) or by creating demand via (income) transfers to the depressed regions. It is not to be denied that the commodity demand-supply nexus is the mainstay of any economy with the other asset and resource markets being complements of the picture, so that efforts aimed at removing inefficiencies here would go a long way towards making resource allocation more productive. However, it is felt here that the obvious interlinks between this and other sectors of the economy are important enough to warrant consideration. Unless all potential scarcities are recognised and efforts made to remove these shortages, any effort at generating a larger demand or a larger supply in the commodity market are liable to fail. This is just the same as saying that if income growth is to be encouraged, and so a

demand creation policy is followed, it will not succeed unless the supply of output that is needed is also forthcoming. The simultaneous relation of the commodity and asset markets via the trade balance in the financial constraints ensures that the creation of any aggregate demand for goods does not lead to any other bottlenecks elsewhere that are not recognised. The results that are obtained from this model are likely to be better indicators of scarcity than those seen elsewhere because the former are based on the impact of a larger variety of constraints.

On looking at the results obtained from various exercises in this study it is seen that on a few occassions the results do support the conventional wisdom that income growth in depressed regions is best accomplished by locating industry and transferring jobs to the poor area. The feasible level of output to produce in these regions in these cases is as high as is allowed by factor supplies, and also carries high enough shadow prices for further increases to be justified if a larger endowment of the most constraining factor was available. In each of these cases a higher income level can be generated by producing more output (than by providing transfers, for instance), whether the output is produced for local use or for exports. However, in several irstances it is seen that this is an incomplete picture because the most stringent constraint on the regional system

is not the limited availability of goods but some other supply limitation. Thus, at times the creation of aggregate supply via the location of productive facilities in the region leads to such a large increase in the demand for financial assets that the financial constraints on the economy become strictly binding. In other cases it is observed that these financial limitations are binding because of the regional economic structure, with its heavy dependence on imports for intermediate and/or final use. As a trade deficit is the result of an excess of spending over income generated locally, it can be financed by running down the level of holding of any assets that can be used as a payment, and so the supply of these assets becomes a severe bound on the growth of regional income. In still other cases when national output of any sector is seen to reach a factor supply limit, it represents a case where factor supplies to produce the output are not available, independent of any shortages of aggregate demand or of profit making opportunities for investment in the regions.

This rather wide variation in the results shows that there is a lot to be learned by extending conventional works in both the directions that are the focus here. To begin with, it is seen that by linking various sets of constraints in a general equilibrium system, some new insight is provided into why and how the most binding constraint on the economy

may not be the one relating to commodity markets alone. In most cases it is seen that the given supply of financial assets is not sufficient to justify any large increments in spending unless the supply of financial assets can be raised without cost, so that financial constraints are a bind on the growth of income. In most cases this picture is revealed by the existence of links between the commodity demand and supply equations and the asset market. The task of finding the best allocation of scarce resources is made easier because it is now possible to locate the most binding constraint as a result of this explicit interdependence.

Second, it is seen that the extension of the analysis to incorporate an asset market equality adds to the model's predictive power. Not only are these constraints felt to be relevant at a theoretical level in a full explanation of various economic relations, these constraints are found to be binding in more instances than one, quite often severely binding. Hence if income levels and the standard of living across regions is to be raised, this can be accomplished by relaxing these limitaions on regional growth. In all these instances central government equalisation payments to and tax revenues generated in various provinces attain fairly significant shadow prices because these are among the variables that help relax these constraints.

As has been stressed above in Chapter 2, the degree of disparity in living standards between today's poor and rich regions is vast, and the gap shows no real signs of narrowing. As a result, economists have devoted an immense amount of effort to the question of how to remove the various bottlenecks to growth in the poor nations. Among the questions that are important are those related to how best to ensure a faster rate of growth, how to best redistribute the fruits of this progress, whether a higher current output is better or worse than a lower current output if the latter entails quicker growth than the former etc. In all of these issues, the central theme is an optimal allocation of scarce resources, with the definition of optimality ranging from the highest rate of growth, to the highest current output to the smallest feasible gap between the rich and poor segments of society. Using one of these definitions of an optimum here - "the highest productivity of all resources when viewed in the context of the impact on the whole economy" - it has been shown that there are many instances where conventional wisdom stands vindicated and the most efficient alternative is the one that can be seen by looking at isolated market demand and supply conditions alone. But there are also instances where, if these direct effects are supplemented by indirect effects through the financial constraints, the final answer can be quite a different policy prescription or plan of action. One of the contributions of this thesis thus lies in its

providing a fairly comprehensive tool to investigate the optimal pattern of regional economic activity.

Some avenues for further research that arise from this thesis have been mentioned earlier. These relate to the fact that in this model, equity across regions is attained by operating the economies of all regions at the level of the region with the lowest potential for increasing income. Avenues for further income growth (both regional and national) are limited by the explicit lack of more transfers to Prince Edward Island in most of the results described in Chapter 6 above. Two ways by which this limit can be removed are

i) to remove the bounds on individual transfer variables and impose an overall national limit;

ii) to replace individual financial constraints by one national financial constraint.

Both of these cases can be taken to imply financial mobility across regions, within the limits defined by national availability. Thus the question of whether income growth can be accomplished by transfers of output, factors or finances can be answered. These financial mobility cases are not analysed here to stress the partial nature of results derived

by ignoring this constraint. Also with various specifications of trade constraints, factor supply availabilities and financial mobility, the number of permutations and combinations of the results becomes very large. It may not be possible to analyse in depth the results of any experiment if the number of cases is too great.

Another avenue for further research involves removing the import bias of the model - and this can be accomplished by allowing the government budget constraint to be an inequality. Although this is not really consistent with a steady state (Section 6.5 above), it may be assumed that the excess of funds that the government sector accumulates is used for the payment of international debts, and so does not re-enter the nation's income stream. Conversely, a deficit in the government's budget could mean borrowing from the rest of the world.

Finally, the assumption of a constant ratio of population to labour force can be dropped. This case is of special significance in all the mobility experiments described above. The level of population in a region can be made a function of local labour and the inflow (outflow) from other regions. A correction should also be made in the data values used so these can correctly reflect transport costs as these are much more important now than they were in 1966.

BIBLIOGRAPHY.

Abouchar, A. "Regional Welfare and Measured Income Differentials in Canada", Review of Income and Wealth, p363-69, Dec. 1971. Reprinted in N.H.Lithwick ed. Regional Economic Policy; the Canadian Experience, p37-45, 1978.

Adams. F.G., C. G. Brookings, and N. J. Glickman, "On the specification and simulation of a Regional econometric Model: A Model of Mississippi", Review of Economics and Statistics, LVII, p286-98, 1975.

Arrow, K. J., and L. Hurwicz, "Decentralisation and computation in resource allocation", in R. Pfouts ed. Essays in Economics and Econometrics in Honour of Harold Hotelling, Chapell Hill, University of North Carolina Press, p34-104, 1960.

Boudeville, J. L'espace et les Poles de Croissance, Paris, 1968.

Brewis, T.N. Regional Economic Policies in Canada. McMillan of Canada, 1969.

----------. "Regional Economic Disparities and Policies" in L.H.Officer and L.B.Smith eds. Canadian Economic Problems and Policies, McGraw Hill of Canada, Toronto, p335-51, 1970.

Carter, H. O. and D. Ireri, "Linkages of California-Arizona Input-Output Models to analyse water transfer patterns", in A. P. Carter and A. Brody eds. Applications of Input-Output analysis, North-Holland, Amsterdam, 1970.

Chenery, H.B., P.G.Clark, and V. Cao Pinna, The Structure and Growth of the Italian Economy, Rome, US Mutual Security Agency, 1953.

----------. "Interregional and International Input-Output analysis", in T.Barna ed. The Structural Interdependence of the Economy, John Wiley and Son, New York, p341-56, 1955.

Christaller, W. Central Places in Southern Germany, (Translated from German), Prentice Hall, 1966.

Courbis, R. "The REGINA Model; A Regional National Model of the French Economy", Economics of Planning, Vol. 12, p133-52, 1972.

----------. "Urban Analysis in the Regional National Model - REGINA of the French Economy", Environment and Planning, Vol. 7, No. 7, p863-78, 1975.

----------. "The REGINA Model - a Regional National Model for French Planning", Regional Science and Urban Economics, Vol. 9, No. 2/3, p117-39, 1979.

Crow, R.T. "A Nationally linked Regional Econometric Model", Journal of Regional Science, Vol. 13, No. 2, p187-204, 1973.

Czamanski, S., and E.Malizia, "Applicability and Limitations in the use of National Input-Output tables for Regional Studies", Regional Science Association Papers and Proceedings, Vol. 23, p65-77, 1969.

----------. Regional and Interregional Social Accounting, Lexington, Mass., Lexington Books, 1973.

van Duijn, J.J. An Interregional Model of Economic Fluctuations, Lexington, Mass., 1972.

Economic Council of Canada, "Regional Growth and Disparities", Third Annual Review, Towards Sustained and Balanced Economic Growth, Ottawa, Queen's Printers, p97-135, 1965.

----------. "Recent trends in Regional Differentials in Canada", XIIth Annual Review, Options for Growth, Ottawa, Information Canada, p21-41, 1975.

Fishkind, R.H. "The Regional Impact of Monetary Policy: An Economic Simulation study of Indiana, 1958-73", Journal of Regional Science, Vol. 17, No. 1, p77-88, 1977.

Friedman, J. Regional Development Policy: A Case Study of Venezuela, MIT Press, 1966.

Funck, R., and G. Rembold, "A Multiregion Multisectoral Forecasting Model for the Federal Republic of Germany", Regional Science Association Papers and Proceedings, Vol. 34, p69-82, 1975.

Garnick, D. H. "Differential Regional Multiplier Models", Journal of Regional Science, Vol. 10, No. 1, p35-47, 1970.

Glickman, N.J. Econometric Analysis of Regional Systems, Academic Press, New York, 1977.

Graham, J.F, "Fiscal Adjustment in a Federal country", in J. F. Graham, A. Johnson, and J. M. Andrews Intergovernmental Fiscal Relationships, Canadian Tax Papers No. 40, Reprinted p188-205 of Lithwick (1978).

Green, A. Regional Aspects of Canada's Economic Growth, University of Toronto Press, 1971.

Greytak, D. "Regional impact of Interregional trade in Input-Output Analysis", Regional Science Association Papers and Proceedings, No. 25, p203-17, 1970.

Griffin, K. B., and J. L. Enos, Planning Development, Addison-Wesley Publishing Co., 1970.

Hartwick, J.M. "Notes on the Isard and Chenery-Moses Interregional Input-Output Models", Journal of Regional Science, Vol. 11, p73-86, 1971.

Heal, G.M. The Theory of Economic Planning, North-Holland, Amsterdam, 1973.

Hirschman, A.O. The Strategy of Economic Planning, New Haven, Conn., 1958.

Isard, W. "Interregional and Regional Input-Output analysis: a Model of a Space Economy", Review of Economics and Statistics, XXXIII, p318-28, 1951.

--------. Methods of Regional Analysis: An Introduction to Regional Science, MIT Press and John Wiley & Son, New York, 1960.

----------, and R. F. Kuenne, "The impact of steel in the greater New York-Philadelphia Industrial Region", Review of Economics and Statistics, XXXIII, p318-28, 1951.

Judge, G.G. and T.Takayama, Studies in Economic Planning over Space and Time, North-Holland, Amsterdam, 1973.

Kendrick, D. "Mathematical Models for Regional Planning", Regional and Urban Economics, Vol. 1, p247-87, 1971.

Klein, L.R. and N.J.Glickman "Econometric Model building at a Regional level", Regional Science and Urban Economics, Vol. 7, No. 1/2, p3-23, 1977.

Kuklinski, A. Growth Poles and Growth Centers in Regional Planning, UN Research Institute for Social Development, Geneva, 1972.

Lange, O. "On the Economic Theory of Socialism", Review of Economic Studies, Vol. 4, No. 1/2, p123-44, 1936-37.

Lee, T. H., J. R. Moore, and D. P. Lewis, Regional and Interregional Intersectoral Flow Analysis, Knoxville, University of Tennessee Press, 1973.

Leontief, W.W. The Structure of the American Economy, 1919-39, New York, Oxford University Press, 1951.

----------. "Interregional trade", in W. Leontief ed. Studies in the structure of the American Economy, New York, Oxford University Press, p93-115, 1953.

----------, in collaboration with A.Strout, "Multiregional Input- Output Analysis", in T. Barna ed. Structural Interdependence and Economic Development, London, St. Martin's Press, 1963.

Lithwick, N.H. Regional Economic Policy: The Canadian Experience, McGraw Hill Ryerson Ltd., 1978.

Little, I.M.D. and J.A.Mirrlees, Manual of Industrial Project Evaluation in Developing Countries, Development Center of the Organisation for Economic Co-operation and Development, Paris, 1969. Second ed. as Project Appraisal and Planning for Developing Countries, New York, Basic Books, 1974.

Losch, A. The Economics of Location, (translated from German by W.F. Stopler), New Haven, Yale University Press, 1954.

Malinvaud, E. "Decentralised procedures for planning", in Malinvaud E., and Bacharach, M. ed. Activity Analysis in the Theory of Growth and Planning, McMillan and Co., London, 1967.

Mennes, L.B., J. Tinbergen and J.G. Waardenburg, The Elements of Space in Development Planning, North-Holland, Amsterdam, 1969.

Miernyk, W. H. "Regional and Interregional Input-Output Models", in M. Perlman, C.J.Leven and B. Chinitz, eds. Spatial, Regional and Population Economics, Gordon and Breach, New York, p263-92, 1972.

Miller, R.E. "Interregional feedback effects in Input-Output Models: some preliminary results", Regional Science

Association Papers and Proceedings, Vol. 17, p105-25, 1966.

----------. "Interregional feedback in Input-Output Models: some experimental results", Western Economic Journal, VII, p41-50, 1969.

Mishan, E. Cost Benefit Analysis, New York, Praeger, 1971.

Moore, F. T. and J. W. Peterson, "Regional Analysis: An Interindustry Model of Utah", Review of Economics and Statistics, XXXVII, p368-83, 1955.

Morgan, R. and J. Alden, Regional Planning: A Comprehensive View, John Wiley and Son, New York, 1974.

Morrison, W.I. "The Development of an Urban Interindustry Model: Building The Input-Output Accounts", Environment and Planning, Vol. 5, p369-83, 1973.

----------. "The Development of an Urban Interindustry Model: The Structure of the Peterborough economy in 1968", Environment and Planning, Vol. 5, p433-60, 1973.

----------. "The Development of an Urban Interindustry Model: Input-Output Multipliers for Peterborough", Environment and Planning, p545-54, 1973.

Moses, L.N. Regional Input-Output: a method of analysing regional interdependence, Ph.D. Dissertation, Cambridge, Harvard University, 1952.

--------. "The Stability of Interregional Trading Patterns and Input- Output Analysis", American Economic Review, XLV, p803-32, 1955.

Myrdal, G. Economic Theory and Underdeveloped Regions, London, G. Duckworth, 1957.

Perroux, F. "Note sur la notion de Pole de Croissance", Economie Applique, Vol. 8, 1955.

---------. "La firme motrice dans la region et la region motrice", Cahiers de L'INSEE, Series 1, No. 9, 1961.

Polenske, K. "An Empirical test of Interregional Input-Output Models: Estimation of 1963 Japanese Production", American Economic Association Papers and Proceedings, Vol LX, No. 2, p76-82, 1970a.

----------. "A Multiregion Input-Output Model for the U.S.", Economic Development Administration Report No. 21, US Deptt. of Commerce, 1970b.

----------. "Empirical Implementation of a Multi-Region Input-Output Gravity Trade Model", in A.P.Carter and A. Brody eds. Applications of Input-Output Analysis, North-Holland, Amsterdam, 1971.

Prebisch, R. "Development Problems of the Peripheral Countries and the Terms of Trade", Chap I. Towards a Dynamic Development Policy for Latin America, UN, New York, 1963.

Prest, A.R. and R.A.Turvey "Cost Benefit Analysis- A Survey", Economic Journal, Vol. 75, p683-735, 1965.

Richardson, H.W. Input-Output and Regional Economics, John Wiley and Son, New York, 1972.

----------. Regional and Urban Economics, Penguin, 1978.

----------. "The State of Regional Science: A Survey", International Regional Science Review, Vol. 3, No. 1, p1-48, Fall 1978.

Riefler, R. F. and C. M. Tiebout, "Interregional Input-Output: An empirical California-Washington Model", Journal of Regional Science, Vol. 10, No. 2, p135-52, 1970.

----------. "Interregional Input-Output: A state of the arts Survey", in Judge and Takayama op. cit. p133-62, 1973.

Statistics Canada Provincial Economic Accounts - the Annual Estimates 1963-78, Ottawa, Cat. No. 13-213, (Annual).

----------. Fixed Capital Stocks and Flows, Ottawa, Cat. No. 13-211, (Annual).

----------. Public and Private Investment in Canada, -Outlook, Cat. No. 61-205, (Annual).

----------. Historical Labour Force Statistics, Annual data, Seasonal Factors and Seasonally Adjusted data, Ottawa, Cat. No. 71-201, (Annual).

----------. Labour Force - Annual Averages, Ottawa, Cat. No. 71-529, (Occasional).

Thompson, F. P. Report of the Royal Commission on the Third London Airport, Vol. 7, H. M. Stationary Office, 1970.

Tiebout, C. M. "Regional and Interregional Input-Output Models: An Appraisal", Southern Economic Journal, Vol. 24, p140-47, 1957.

----------. "An Empirical Regional Input-Output Projection Model: the state of Washington", Review of Economics and Statistics, LI, p334-40, 1969.

UNIDO Industrial Location and Regional Economic Development, Seminar at Minsk, 1968.

U.S. Deptt. of Commerce, Industrial Location as a factor in Regional Economic Development, 1955.

Usher, D. "Some Questions about the Regional Development Incentives Act", Canadian Public Policy, Vol. 1/4, p557-575, Autumn 1975. Reprinted p283-302 of Lithwick op. cit.

Winch, D.M. Analytical Welfare Economics, Penguin, 1971, Reprinted 1973.

Zuker, R.C. An Interprovincial Input-Output Model: Version III, Economic Development Analysis Division, Deptt. Of Regional Economic Expansion, Ottawa, May 1976.

----------. Employment and Occupational Impact using the Version III Interprovincial Input-Output Model, Economic Development Analysis Division, Deptt. Of Regional Economic Expansion, Ottawa, May 1977.