MINING EXPORT-DEPENDENCY AND REGIONAL DEVELOPMENT: A PRELIMINARY ANALYSIS

BY

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A Thesis submitted to The Faculty of Graduate Studies in Partial Fulfillment of The Requirements for the Degree of Master of Arts.

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PREFACE

Throughout history mining industry has had a useful influence on the evolution of societies and civilisation. In fact, few industries have imposed, and experienced, such economic and political shocks as the mining industry, especially since the oil crisis of the 1970s. It can be said that mining activity is a reflection of the way in which industry, government power and society as a whole is organized, and it is a reflection of the way in which the mining industry is perceived. Minerals are seen as being vital to the economic growth and future well-being of a mature manufacturing nation or region and as such the exploitation of those resources is deemed to be of paramount importance, and this has intensified the interest in research of resources. Unfortunately, the renaissance in mineral exploitation in most parts of the world during the last decade has only served to arouse very considerable interest in potential benefits to national economies and in environmental impacts, and much less in the consequences for regional development. Awareness of this neglect provided the initial stimulus for this thesis.

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ABSTRACT

Societal achievement in the world is dependent to a great extent on the development of mineral resources. A rapid economic growth in any country must have access to plentiful supplies of minerals at the lowest cost. Typically, mining export-dependent activity can provide the start for many production sequences and prepares the region for achievement of the "take-off" point in the early stage. The importance of resources exports can remain preponderant even longer. Indeed, the advaced-industrial countries are deeply involved in the changeover from a "products" economy to a "processing and service" economy. But this transition does not mean that mineral resources have become less vital, rather, it suggests that mining activity will remain important for regional development in the later stages not only because of its uneven spatial distribution, disproportionately benefiting some localities and not others, but also owing to its contribution to the development of a "centre-periphery" structure.

This thesis represents preliminary research work to analyse the relative positive role of mining activity in regional development, examining the interaction between mining and other industrial activities on the one hand and the role of mining during different stages of the proces of economic growth on the other. Examination of the contemporary role of mining industry in regional development seemed to lead naturally to an analysis of its role in Canada, one of the world's leading mining countries. Export-base theory and input-output analysis are treated as a conceptual underpinning and a powerful tool to expose the significance of the mining industry.

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CHAPTER I: MINING AS AN INSTRUMENT OF DEVELOPMENT

INTRODUCTION

In the classic division of factors of production into land, labour and capital, it has been customary to place mineral resources in the land category. As is true with so many simple classifications, this allocation of mineral resources into a single, homogeneous group breaks down when confronted with the complexities of real situations. Thus, while undiscovered minerals or mineral deposits lying untapped can be classified as being part of land resources, their exploitation ushers into use totally different production systems from those obtaining in agriculture. Minerals that are undertapped, therefore, come closer to being regarded as a part of the stock of capital goods in a region or country than a facet of the land factor. This is particularly true in developing areas where capital, both in terms of money and goods, is relatively scarce.

Social achievement within any country, whether advanced or relatively backward, is dependent to a great extent on the development of mineral resources in that country or by that progress brought about through international trade. It becomes apparent that if a country is to enjoy rapid economic growth it must have access to plentiful supplies of mineral materials at the lowest possible cost. Adequate supplies of mineral resources have always been among the most important determinants of a nation's survival and prosperity. Indeed, the world nowadays is deeply involved in the changeover from a "products" economy to a "processing and service" economy. But this transition does not mean that resources have become less vital; rather, it suggests that the magnitude and diversity of activities now demanding resources are greater than was ever the case in the past. Such activities include manufacturing, transportation, marketing, government, education, national defence, the arts, and many other aspects of modern society.

Regional development typically is promoted by the ability of a region to produce goods or services demanded by the national economy and to export them at a competitive advantage with respect to other regions. Once a region (for whatever reason) gains an initial advantage over others, various forces tend to speed the growth process by "circular and cumulative causation" and lead to the development of a "centre-periphery" or "heartland-hinterland" structure. This is well illustrated by Thompson (1965), who suggests a model on which the following synthesis is based. In short, spatial development is related to stages in the evolution of a regional economy.

1. In Export Specialization, the local economy is the lengthened shadow of a single dominant industry or even a single firm.

2. In the Export Complex, local production broadens to other products and/or deepens by extending forwards or backwards in the stages of production, by adding local suppliers and/or consumers of intermediate products.

3. In Economic Maturation (Local Service Sector Puberty), the principal expansion of local activity is in the direction of replacing imports with new "own use" production; the local economy fills out in range and quality of both business and consumer services.

4. In the Regional Metropolis, the local economy becomes a node connecting and controlling neighbouring cities, once rivals and now satellites, and the export of services becomes a major economic function.

5. In Technical-Professional Virtuosity, national eminence in some

specialized skill or economic function is achieved.

In relation to this model, the content of exports changes in regional development. Mining export-dependent activity can provide the start for many production sequences and prepares the region for achievement of the "take-off" point. The importance of resources exports remains preponderant even during the second and subsequent stages. As a region or a country becomes more industrialized, the proportion of mineral products in the structures of exports, total industrial output and employment gradually reduces as a result of the development of manufacturing and service activities and advancing skill in producing the minerals. It could be argued that mining will remain important for regional development in the later stages not only because of its uneven spatial distribution, disproportionately locating in some areas as opposed to others, but also owing to its contribution to the development of a "centre-periphery" structure. At any rate, mining activity remains important through its influences on the spatial patterns of population and industrial distribution in hinterland areas.

The aim of this chapter is to review the relatively positive role of mining activity in regional development, and this intention is met by examining the interaction between mining and other industrial activities on the one hand and the role of mining during different stages of the process of economic growth on the other. The review is divided into four sections; namely, preliminary appraisals referring to mining as primary industry; its direct impacts; indirect impacts; transition of impacts from direct to indirect; and culminates with a synopsis of the remainder of the thesis.

A PRIMARY INDUSTRY: Some Basic Characteristics

Each industry has its ways of contributing to regional development; therefore, before examining the impacts of the mining industry on a regional economy, it is useful to determine some essential characteristics of the industry. For the sake of convenience, they may be examined under the following headings.

Time value. Evaluation of the potential supply of minerals available for exploitation in any region as a basis for development is a complex matter, particularly as the perception of any resource does not rely only on physical properties, such as quantity, quality, geological and geographical conditions, and transportability, but also on a range of 'cultural' factors, such as marketing conditions, technology of processing and conveyance, substitutional possibility, interests of local communities and environmental protection policy. Indeed, there is a constantly changing preference for the use of certain mineral commodities which depends on the stage of technology. For example, coal, as a major energy resource, replaced firewood and water energy in the steam engine era, and oil and natural gas substituted for coal in the automobile era (Fig 1-1, p.27). The life span of mineral usage in the industrial economy has induced great changes both in the structure of mineral consumption and the spatial pattern of mining. With the discovery and development of the vast oil reserves of the Middle East and North Africa, Western European countries and Japan began to follow the U.S. postwar example of switching rapidly from coal in the 1950s and 1960s to oil and natural gas as their major energy resource, and this shift occasioned a massive development of oil exploitation in the world thereafter. In counterbalance, the local industry, once the leading fuel industry, suffered serious decline in many parts of the world, especially in economically advanced countries. In this case, the term 'resource' does not apply to a material or an object, but to a value placed upon a material. "Resources are not, they become" (Zimmerman, 1951). They expand and contract in response to human wants and needs and to technological, economic and political conditions. Thus, minerals have time value (Peters,1978). Some minerals (like flint) become ex-resources, reverting to "neutral stuff", made obsolete by technological change (Spooner, 1982).

Place value. It would be reasonable to maintain that mineral resources rejoicing in a time value would also have a place value. Place value, as a variable affected by the interplays of demand and supply, as well as distance and transport costs, is an elementary factor helping to determine the location of mining activity. It is especially important in understanding the role of different minerals in regional development in the context of mining and economic growth.

There is no doubt that minerals cannot be extracted where they are absent. But it must be recognized that the multiplicity of deposits of variable size, quality and location choice are latent resources whose value is complicated by the possibilities of substitution between alternative mineral products. For the mining industry itself, two variables are of basic importance in deciding which deposits are exploited; namely, the quality of the deposits and the location of the market. According to McCarty and Lindberg (1966), there is a relationship between the value to weight ratio of a mineral and the distance from the market of the location at which exploitation will occur. Value to weight ratio, or unit value, is crucially affected by the extent of opportunities for product substitution; opportunities which influence the elasticity of demand for a particular mineral product. Thus products like sand and gravel command a low unit value. Such minerals are easily substitutable and have high demand elasticity; their market price is strongly affected by distance and transport costs. They are said to have high place value--their value is highly dependent upon the place in which they are located. Unit value and place value tend to be inversely related, but other factors such as transportability must also be considered: for example, liquid products, like oil, which can be easily conveyed by pipeline or sea-tanker tend to be exploited further from markets than unit values might suggest. Then there is the cyclical nature of mineral exploitation. This aspect is critical in regional development because of the varying intensity of investment and employment requirements at different stages of mining production. To the resource manager and the regional planner, the fleeting nature of mineral exploitation poses fundamental dilemmas--when shall development take place? And at what rate shall the resource be depleted?

Mineral extraction, either at the level of the individual mine or in the context of the entire industry, is subject to the discovery-depletion cycle (Fig 1-2, p.27), which may be said to consist of six stages: discovery, development, expansion, mature production, decline and exhaustion. The passage of the cycle may be extremely erratic. Here, generalizations are very difficult because the length of the normal life cycle is highly uncertain, depending on the place-spacific variety of minerals and the methods utilized in their extraction. Although advanced technology can help some mines to persist successfully for longer periods than first anticipated, the overwhelming trend is for modern extraction technology to diminish the length of the normal life of a mine.

In new resource frontier regions, mining operations may require heavy infrastructural investment, especially of the economic overhead capital type such as water supply, transport facilities and power sources; but also possibly in the area of social overhead capital--education, health, housing and other community services. In such circumstances, the total labour requirement for exploitation of a mineral deposit may peak well before the maximum production phase is reached. Generally, the second phase--manufacturing plus some temporary construction for each field,--is the most labour-intensive and lasts three to seven years; employment levels fall in the third phase, which may last from 20 to 30 years, and is the most capital intensive. At this juncture, we are merely highlighting the process stages; subsequent sections of this chapter, however, will address these issues in greater detail.

DIRECT IMPACTS: Stimulative and Stable Effects

Direct impacts are the contribution to regional development made by mining industry itself, and induce those repercussions which involve particular industries and businesses whose output directly serves mining project construction needs and overhead expenditures. These direct impacts can be desegregated into stimulative and stable effects.

Stimulative effects. As a forerunner of regional industrialization, mineral exploitation, in theory at least, can lead to great structural changes in both the local economy and spatial pattern and, in so doing, lay down a solid foundation for the development of other subsequent economic activities; for example, manufac-turing and services. A prevalent viewpoint of the stimulative effects of mining industry holds that this activity can contribute to regional development in three major aspects; that is to say, through its impacts on land, capital and labour. Let us take each in turn, beginning with land. Establishment of an integrated infrastructural system to bring land into increasingly intensive use by the utilisation of otherwise dormant resources of the region is absolutely fundamental to development. The effects on capital occur in two manifestations; first, through attracting outside investment capital into the region and, secondly, through increasing the regional income so that some new money can be used for local investment. In respect of labour, the effects are registered through drawing population into the region, upgrading local skills and implanting concepts of enterprise and entrepreneurship. The rise in income, production and employment in the mining industry combines to impact on the region in a manner analogous to a breeder reactor (Nordhaus, 1974). In short, it stimulates the expansion of other activities though the multiplier process. As a result, under one scenario, mining can be conceived of as a step towards a more broadly based industrialization--a step which makes other steps easier (McDiviff and Jeffery, 1976). In California, for instance, the gold rush of 1849 led to the influx of labour not only to work the mines, but also to serve the needs of those who worked them by opening up large crop and livestock areas which eventually became independent of the mining industry (Warren, 1973). Even though the Cornish metal-mining industries declined and remained depressed throughout the inter-war years, many ancillary enterprises set up to supply mining equipment, explosives and safety fuses have been maintained and now supply world-wide markets.

More significant and spectacular examples of the propensity of mining to sustain growth are encapsulated in the history of many of the British coal fields. Coal ´had an original and dominating role as a source of energy´ an was also ´a big enough activity in itself for its distribution to have direct economic significance' (Brown, 1972). The coalfields were able to draw in a huge labour force and, at a time when transport cost were comparatively greater, exercised a powerful pull on other industries. Hall (1973) has estimated that in 1900 over 50 per cent of British towns were situated on or near coalfields, and presumably there was an element of causal interaction between the two phenomena. He also stressed that each coalfield ultimately sustained 'a host of varied crafts and trades and that its pull was only reduced by the development in the mid-1930s of a national electricity power grid. Even in the light of such waning influence, the desire to utilise the social and economic fabric resulting from the existence of the coalfield has been recognised in the influx of non-coal related industry. Though frequently aided and abetted by government grants and other local incentive, the propensity of mining activity is to do more than merely create direct employment during the whole process of mineral exploitation.

There is, however, an obvious qualification to the aforementioned prescriptive viewpoint and that concerns its generality . Elsewhere examples may be found of the tendency of mining developments to stimulate local supportive activities which may be limited or not outlast the disappearance of the original stimulus to regional economic expansion. According to Odell (1973), for example, the Maracaibo oilfields in Venezuela could be seen as isolated high-technology enclaves in a region of subsistence agriculture throughout the 1940s and 1950s. The oil was piped away, resulting in little or no local impact since the international oil companies undertaking the exploitation of the oil were totally self-sufficient. Baldwin (1966) and McDivitt and Jeffery (1976) argue that all regions and countries do not have the same capacity to engender the stimulatory processes, and that most impose serious limitations on their development.

Of course, there is another perspective concerning the contribution of the mining industry. For example, Harry Caudill (1962) in his study of the Cumberland mountains of Kentucky pointed out, that "Coal has always cursed the land in which it lies .... It is an extractive industry which takes away all and restores nothing". Also from the experience of Appalachia in the U.S.A. and parts of Venezuela, mining companies are frequently regarded as environmental vandals. These images always encourage conflict between economic and environmental objectives, especially in the case of Western Europe and North America. Cameron (1986) found that the mining of a copper deposit at Ladysmith in Wisconsin was delayed on two occasions since it was discovered in 1968. The Department of Natural Resources were still requesting more information on the effects of mining on water conditions in December 1983 although an environmental-impact statement had been submitted to the department well before this date. It meant that a further public hearing and review of permit applications as well as a final decision on the mining permit could not be made before May 1985. There are thus institutional obstacles added to the normal risks of mineral exploration. Consequently, marginal deposits are less likely in the future to be considered for development. There is evidence also that the role of smaller mining organizations in mineral development in the United States is being diminished, since such organizations are less able to bear the costs of environmental studies and the protracted regulatory procedures.

If the mining industries have evoked a poor image in regional development terms, this has been doubly true in the context of environmental impact and resource management. It follows, then, that discussion of the contribution of mineral exploitation to regional development cannot be divorced from a consideration of the environmental problems posed by that exploitation. But it is equally true to say that development of these economic activities should not be debated only in environmental terms. Here, a basic concept of cost-benefit analysis may allow us to assess the wider implications of mining activity in respect of social costs and benefits. In considering whether, or to what extent, mineral works should be permitted, it is very important to bear in mind that the mining industries are fundamental to the national economy and that many other industries of the country are to a greater or less degree dependent on them. The essential concern of planning policy, therefore, must be to ensure a free flow of mineral products at economic cost. This is borne out in the real world. The exploitation of North Sea oil and gas by the U.K. is a case in point. Balance of payments problems, intensified by reliance on imported minerals, have led the UK government to react favourably towards indigenous developments, particularly in the fuel sector. This moved them to introduce an incentive oil and gas exploitation scheme. As a result, the North Sea oil project not only contributes to the country with 3.5 billion pounds of revenues from royalties, petroleum tax and corporation tax per year, but also contributes to job creation: providing 64,000 new jobs (multiplier of 1.4 on the estimated total employment).

In fact, mining is not an only destroyer of the environment. According to Cameron (1986), the principal dispoiler of lands in the United States is agriculture. Other forces for disturbance are urban development and transportation and communication construction. Mining is a despoiler of relatively minor proportions (see Table 1-1, pp.12). If people are truly concerned about the impacts of civilization on the environment, attention should be directed primarily to soil conservation, the consequences of urban and sub-urban sprawl, and the extravagant use of land for transportation and communication systems. The old image, which regarded mining as an environmental vandal, dies hard, although only a very small fraction of the country has been affected by mining, and a substantial part of the disturbed land has already been restored to agricultural, forest, or other uses (although, to be sure, the pervasive effects of acid rain may reinforce the prejudice against mining).

Table 1-1 Land Use in the United States in 1980

	Millions of Acres
Agriculture	1589.0
Wildlife refuge system	88.7
National park system	77.7
Urban and built-up areas	68.7
Transportation and Communication system (1978)	28.5
Highways (1978)	21.5
Airports (1978)	4.0
Railroads (1978)	3.0
Forest service wilderness	25.1
Mining	5.7
Other	388.1
Total,all use	2270.8

Source: U.S. Bureau of Mines, 1982. Cameron.E.N. (1986) AT THE CROSSROAD--THE MINERAL PROBLEMS OF THE UNITED STATES.

Stable effects. In 1969, the U.S. Senate approved a Bill to establish a National Mining and Mineral Policy aimed at avoiding critical dependence on foreign supply rather than attaining complete self-sufficiency. This philosophy of national security relative to mining development began to mature in the 1970s. In practice, as an important part of national development strategy, this philosophy has been fully considered by almost all countries. Another notable example is the exploitation of the offshore North Sea oil and gas deposits by the UK. When British economic development turned from coal as a major energy resource to oil and gas in the 1950s, its mining industry had not been prepared for such a shift. Until the 1970s, when North Sea oil and gas began to come on stream, Britain suffered from inflationary prices and the effects of political conflict through its reliance on the import of oil and gas. Elimination of political animosity was a factor favouring the use of offshore resources. While, in truth, no country is currently self-sufficient in all mineral commodities, the simple fact remains that the more kinds and the greater quantities of mineral resources that a country has access to, then the more stable is the course of economic--and frequently, political--development.

Another stable effect arises in the context of spatial interaction. A change in the location pattern of resource frontiers not only supports the growth of marketing and manufacturing centres, but it also amends the spatial economic system of a country as a whole. For example, in 1800 London with a population of 900,000 was already easily the largest city in Britain. Yet it would be hard to imagine London's growth without coal exploitation. According to Wrigley (1969), about one-sixth of the whole output of British coal mining was shipped down the east coast of England to London in the eighteenth century. The effect was reciprocal : London stimulated coal-mining expansion and the growth of the regions while access to coal for domestic and industrial consumption helped to sustain London's survival and growth. In effect, the expansion of manufacturing activities in many seaport cities of Western Europe and Japan in the last century can be imputed to the ready import of mineral commodities from other countries. Gealy and Kimbell (1968) estimated that the value of mineral commodities moving in international trade represents over one-fourth of the total value of all commodities traded in world commerce, and mineral fuels accounted for nearly half of the total value of the mineral commodities. These figures have remained relatively constant in recent years. In 1983, for example, North America and Europe produced just over 800 million metric tons of crude oil, 30 percent of the total production of the world, but both areas consumed nearly 1300 million metric tons of the substance or fully half of the total consumption of the world. In this case, the centre-periphery relationship was already firmly in place. The central areas of the world are formed by North America, Europe, the western part of the USSR and Japan (see Table 1-2, pp.14). Asia, Africa, S.America and the eastern part of the USSR remain as the peripheral areas. These facts suggest that, first, the outward orientation of infrastructure in the mining areas, with emphasis on transport links to ports for export and coastwise shipment, is to likely prove a disadvantage once the emphasis on the home market for goods becomes of key importance (Caesar, 1964). Secondly, development of the mining frontiers can, in some ways, keep the national centre-periphery structure stable. In any country, either of the marketing or command economic type, the growth of centre-periphery structure depends on the medium of spatial organization: in a word, it hinges on interaction. The various kinds of movements, flows and

Table 1-2 Production and Consumption of Crude Oil

Area	Production(%)	Consumption(%)	Net export(+) or import(-)
World	100.0	100.0	(million metric tons)
Africa	8.2	3.2	+ 116.0
N.America	24.2	28.6	- 143.0
S.America	6.3	5.5	+ 18.0
Asia	30.4	21.8	+ 215.0
(Japan)	(-)	(6.6)	(-177.0)
Europe	6.9	21.4	- 395.0
OCEANIA	0.7	1.2	- 13.0
USSR	23.3	18.3	+ 130.0

Source: Energy Statistics Yearbook, United Nations, 1983.

transactions between regions and cities are the expressions of input-output linkages, relationships, and all interdependencies within the spatial economic system of a country as a whole (see Fig 1-3, pp.28). In the context of mining exploitation, the mineral-export-orientated relationship is to the manufacturing and service heartlands or centres, supplying them with resource inputs. By way of contrast, growth of the heartlands or centres is incumbent on supply to the peripheral regions of technology, equipment, information, capital and other inputs of the business and personal services kind. In other words, developments of both regions are mutually reinforcing, providing a latent market from which all can benefit. Thus, what goes on in the peripheral or central region of the system almost invariably affects what goes on in other parts of the system. In the 1970s the oil crises intensified this viewpoint.

INDIRECT IMPACTS : Forward and Backward Linkages

Indirect impacts occur in those industries that supply inputs to the industries directly stimulated and also embrace the subsequent impacts of supplying these industries.

There are broad relationships between mining and other industries through which mining activity can make its contribution to regional development. Since considerable variation in such relationship occurs depending on the geographical scale of enquiry, it is preferable to emphasize the indirect impacts over the direct concept in examining the relationships between mining activity and regional development. The following discussion sets out the basic elements of a framework provided by linkage analysis.

Forward Linkage. A forward linkage is that proportion of an industry's output which is used as an input by other industries. Thompson (1965) suggests a model of linkages lines for regional development. In this model, a forward linkage can emerge when some other firms use a raw material or a by-product produced by a local producer. If these firms locate nearby, they can save transportation costs on their chief raw material and make their products at a competitive advantage in comparison with firms denied such easy material linkages.

Generally speaking, the forward linkage of mining is to smelting and refining. However, when the output of smelting and refining is used by a number of metal products' industries, the output from these industries may, in turn, be used at higher stages of processing in different manufacturing industries. Little by little, according to Thompson's model, such additional business and manufacturing operations are added to the local economy, as the growing local market affords ever more economies of scale.

In practice, the generation of forward linkages is often beset by obstacles. These difficulties arise not only as a result of the great number of minerals and the possibilities of substitution between alternative mineral exploitation, but are also occasioned by differences in technology, manufacturing location theories, policies and behaviour of mining managements. Generally speaking, the magnitude of the effect of forward linkage at a large scale of resolution (nation or country) depends upon which stage of industrialization the society finds itself within. The sizes of forward-linkage impacts at an intermediate scale within nations are very different because of various internal and external development conditions obtaining within each region, such as the types, qualities and configuration of resources, to say nothing of economic and natural environments. In Venezuela in the 1940s and 1950s, for example, the Maracaibo oil fields functioned merely as isolated high-technology enclaves in a region of subsistence agriculture. The oil was piped away with little or no local impact since the international oil companies undertaking the exploitation of the oil were totally self-sufficient and had no reason to set up a regional processing base. However, taxation revenues were expended on the development of the capital, Caracas, where the oil companies also had their local headquarters. By the 1960s, apart from the misspending of such revenues on non-essential buildings in that city, such policies had resulted in a severe imbalance of the population within the country with some 25 percent of the Venezuelan people clustered in the Caracas metropolitan area (Odell, 1973). Similarly, in Venezuela, Ciudad Guayana, founded in 1961, had reached a population of 130,000 by 1975. This new industrial complex is based on a variety of minerals combined with hydroelectric power source, among which rich iron deposits are outstanding, and is centred on a new city. According to Friedmann (1973), the experiment could already be counted a success; Ciudad Guayana had become Venezuela's principal centre for heavy industry, including steel, and an important exporter of intermediate products. Forward linkages had thus developed in the way demanded by growth pole theory.

In regional development terms, the ubiquitous types of mineral, which are largely used in the construction industry and include sand and gravel, limestone, igneous and metamorphic rock and brick clays, can be considered as region-serving rather than region-forming because of their low unit values and high place values. In contrast, the localized types which include most of the metallic minerals used in the metallurgical industries and the raw materials for chemical and the fertilizer industry, together with china clay (used in ceramics) and fluorspar (used in the steel industry), may play some part in region-forming, initiating new pattern of urbanization and attracting processing industries. They effect these changes because their exploitation requires resort to a relatively large scale of operations and their final products can withstand greater transport cost to more distant markets. Unlike the localized and ubiquitous materials, mineral fuels (oil and gas) are not incorporated in the final product, but rather are consumed to provide energy for direct industrial and domestic consumption as well as for electricity generation. Coalfields remain attractive for the location of a power station, which may give advantage to the intensive consumer who locates hard by, such as an aluminium smelter. In regional development, the significance of these fuels has been immense. Spooner (1981) argues that, in the modern world, the direct localized forward linkages of oil extraction and refining with other economic activities are more limited than was ever the case with coal simply because crude oil and liquefied gas can be easily conveyed by pipeline or sea transport to market regions and this ability thus obviates the need to establish local plants to utilize the field's output. He also claims that, in both the USA and UK, over 50 per cent of coal output goes to the electricity generating industry. But the rush of power stations constructed since the war in the UK's 'central' coalfield has not provided any significant local or regional attractions to industrial consumers. The potential advantages of the coalfields in providing cheap power have been negated by the development of the grid, pricing policies, and the construction of nuclear and oil-fired power stations in coal-deficient areas. For much manufacturing industry, a localized primary fuel source, coal, has been replaced by a ubiquitous secondary source, electricity.

Backward Linkage. A backward linkage exists when an industry purchases intermediate inputs from suppliers. According to Thompson (1965), once an industry which originates outside the locality is set up in a region, it always attracts some ancillary equipment suppliers, such as tool factories. This integration of sequential operations indirectly can add to local exports, by increasing the proportion of the export product's earnings that remains within the region. In other words, as vertical integration in the local export industries proceeds, local value-added and income generated can together constitute a higher proportion of sales.

In the context of mineral exploitation, the mining industry buys machinery and equipment, business services (including administrative and higher level functions--research and development, operations research, personnel and industrial relations), chemical products, and the like from other industries.

All these inputs might be internalized within the local operation, bought locally, or--more likely--be provided by a head office of a national or multi-national mining corporation spatially divorced from the local mining operation. It is obviously the case that the more of these backward linkage that can be developed locally, the fewer are the 'leakages' and the more diverse is the indigenous economy and the mining industry itself. But many empirical instances of regional development based on resource exports have shown that the backward linkages fail to save themselves from reliance on the mining industry and tend to decline in tandem with the expiry of the mines. Nickel (1978) noticed that the size of the backward linkages associated with mining is relatively smaller than that of other industries because a large part of the inputs is imported from outside the defined locality. He found, for example, that approximately 49.9 percent of the industrial machinery and equipment inputs of the mining industry in British Columbia was imported in

1976. This phenomenon can be used to substantiate the leakage effect. It is usually defined as money (derived from local production) which is not available for respending locally, and thus reduces the size of the multiplier. In the export-based, intermediate or small-area economy, the multiplier is again the reciprocal of the rate at which income leaks out of the internal circular flow of income and expenditure. In this case, however, the multiplier is largely determined by the reciprocal of the marginal processing to import; for local imports, not savings, are now the important income leakage (Thompson,1965). For mining industry, there are three reasons for the limitation imposed on the backward linkages. First, mining is a capital-intensive industry. Large mines involve huge capital outlays running to a billion dollars or more. Raymond (1976) estimated that the preliminary capital costs associated with mining fall into three categories; namely, costs incurred in exploration, building (including facilities) and the procuring of machinery and equipment. By one estimate, expenditures of capital for machinery and equipment equal nearly 40 percent of the total, while mineral exploration accounts for over 25 percent, and building for nearly 22 percent. Among the three categories, only the building phase can be expected to develop a local backward linkage. At this stage limits are especially important in the case of mines located in mountains, deserts, or jungles and away from developed areas. Secondly, it should be recognized that the outward orientation of infrastructure typically found in mining areas presents the mining industry with easy access to its markets--the developed areas. And in the meantime, it also serves to enforce a dependence of the mining areas on service inputs from the developed areas. This input-output relationship of reciprocity between the mining and developed areas may remain relatively stable once it is set up, especially once a spatial structure of the centre-periphery kind is established. Thirdly, the mineral exploration and mining machinery and equipment manufacturing industries are relatively advanced technologically and highly specialized. Mineral exploration, in particular, is an extremely risky business and requires highly advanced technology to fultil its object of amassing sufficient geological information to determine the feasibility of any subsequent mining industry. The location of such industries tends to be in the developed areas because their development is contingent upon the ready co-operation of other manufacturing sectors, scientific and educational institutes as well as special business services. The limitations issuing from backward linkages based on these industries at an intermediate scale, therefore, are eminently understandable, although industries reliant on them play an important role in determining the effectiveness of the mining industry and render the regions based on mineral exports a competitive advantage with respect to other regions.

In fact, as a factor in regional development patterns, the emphasis on increasing scale of operation is of considerable importance. Regional concentration and specialization of production is encouraged and might be seen as a movement towards region-forming rather than region-serving activity. The ability of mining industry to initiate new patterns may be enhanced and the impact of a discrete new mine is potentially great. However, such arguments must be treated cautiously. Mining is for the most part highly capital-intensive and volunteers only a very limited benign effect on regional development. Furthermore, the organizational characteristics of the industry remain highly centralized. The existence of centre-periphery structure may mean that large scale exploitation of new mineral resources acts largely to sustain the growth of the centre by providing resource inputs and high technology outputs.

IMPACTS TRANSITION : From Direct to Indirect

Economic Structure Change. Regional development is a long process of accumulation and redistribution of natural endowments and social wealth. The forces that push the process forward come from the transformation of the economic structure. Mining activity can only play a dominant role at the early stage of regional development when the society changes from an agricultural base to one rooted in industry. For the successive stages, the push power of the structural change should be handed over from mining to manufacturing and service industries. Such changes are inevitable, even for the mining industry itself. An expansion of mining industry is determined not only by an increasing demand for mineral consumption, but also by a successful supply of advanced technologies, good services and sufficiently skilled workers. Bosson and Varon (1977) calculated, for example, that in 1970 some 65-70 per cent of all minerals mined in the world came from open pits. It could be impossible to achieve such a figure without the development of open-pit mining technology, application of advanced rock mechanics and on-site processing techniques expressly geared to low-grade mineral deposits. A successful application of advanced technology and a good service network invariably results in the decline of direct employment in the mining industry. Spengler (1967) estimated that, whereas less than 40 years ago nearly 30 per cent of the labour in the U.S.A. needed to be located close to natural resources, only 7 per cent were still resource-bound in the 1960s. To take the comparison further, by 1970 mining's share of the total direct employment in the U.S.A. had fallen below one percent, and its contribution to national income had stabilised at just over one per cent.

Mining and the change of economic structure. We can see that in most developed countries a growing independence of economic activity from specific localized resource bases has occurred as the ends of economic activity become increasingly non-material, and as the quantity of natural resource inputs declines relative to total input (Adler,1961).

Perloff and Wingo (1961) delineate a number of periods in American development in a procedure which has a bearing on our theme. After the early agriculture period, based on the utilisation of land accessible to the eastern seaboard, came the "mineral-dominant" phase. From 1840 the expansion of railroads and manufacturing stimulated demand for mining products. In the period between 1870 and 1920, a broadening of the industrial structure emerged from the growth of the mineral economy. Its effects shifted rapidly among regions, triggering, intensifying or transforming the nature of regional growth patterns. Resources remained important, however, through their influence on the inherited patterns of population and industrial distribution. Finally, from mid-century, an "amenity resource" era set in, with shifts in population and economic activity moving towards Florida, the Southwest and the Pacific coast. In time, the internal structure change (steadily augmenting the proportion of employment in manufacturing and services) led to expansion of local markets and changes in the export-import structure. After World War II, America become the biggest mineral-importing country in the world, and occupied a leading position both in the promulgation of extraction technology and the export of mining equipment.

The impact transition usually occurs in those regions with location advantages, most notably where an export base of manufactured products and business services has been developed. Yet this transition is not a necessary stage for the sustained growth of all regions.

Obstacles to conversion. In the Twentieth Century the success of mining areas has often proved illusory, and many have slipped into a downward spiral of cumulative causation. The very scale of past mining activity has ultimately proved a burden, as a huge and specialized work-force has been deposited onto the labour market at colossal speed. Between 1955 and 1968 approximately one million coal-mining jobs were lost in the major Western producing countries (Brown and Burrows, 1977).

Why have so many mining regions failed to sustain their growth as mineral production declined ? And what are the obstacles to 'conversion' of mineral economies ?

A major problem has often been the low rate of labour demand throughout the national economy. For example, the buoyant labour demand in West Germany in the 1960s clearly assisted the conversion of the Ruhr; but its absence in the UK converted coalfield economies into peripheral depressed regions.

Secondly, industrial conversion in depressed mining areas may be hindered by social and economic 'rigidities', which preclude the adaptation of existing resources to the needs of expanding sectors. The labour force may not only be specialized but also conservative and opposed to change, while union strength may deter potential investors. The fixed capital of the mining industry is also inflexible; it is not easy to find new uses for the redundant plant of mining. Derelict mining land can be reclaimed for a variety of purposes, from agriculture and forestry to industrial estates, but such treatment is costly.

Thirdly, the legacy of mining has often been inimical to the development of other activities. Spoliation of the environment has become increasingly significant, as there is now considerable evidence that regional environmental quality is a potent influence on the location of manufacturing plants, particularly in the developed countries. In accordance with the traditional prejudice directed against mining, Keeble's (1976) analysis of industrial change in the UK supported the hypothesis that the image of particular localities as attractive residential environments functioned as a factor of major importance in manufacturing growth, strongly influencing the locational decisions of both workers and industrialists. The survey of management in the Northern Planning Region by House et al (1968) showed that this negative image of the North did exist in the minds of managers and their wives--one of 'regional isolation, an unpleasant climate and most of all with an unfavourable urban, and industrial landscape,' Negative images of 'Northern' coal fields in the UK have undoubtedly hindered the attraction of new firms from southern England.

CONCLUSION

Considering mining and its capacity not only to stimulate regional development but also to sustain its growth in the long term after the original mining activity has ceased, Spooner (1981) postulated four main measures that will influence mining's ability to sustain regional economic expansion.

First, the supply of the products of the mining industry within the region must be maintained and the demand for these sustained elsewhere, both nationally and internationally, in the long run. Mining areas which must operate in a competitive market but cannot of themselves remain cost-effective, or which rapidly exhaust their richer deposits, are not likely to be of value in the promotion of regional development. In other words, comple-mentarity, in a spatial interaction sense, must be assured over the long run.

Secondly, the large scale of the operation to exploit the resource in question is a key factor and frequently allied to a large labour force. This was the advantage of coal, but it is also occasionally the case with other minerals.

Thirdly, the development by the mining industry of both forward and backward linkages may also be significant aspects of its capacity to create and sustain regional growth. Integration of this nature should have complementarity with other activities (Richardson,1976) in terms of economic growth in the peripheral areas.

Finally, if it is to play a key role in regional development, a mining industry must not be characterised by a high level of 'leakage'. A substantial proportion of the returns from mineral 'exports' must find their way into the region, and stimulate demand for regionally-produced goods and services. Additionally, the region must become attractive to migrants.

In order to maximize the benefits of mining activity, therefore, a suitable regional policy should be implemented at an early stage of mining activity. The major reasons for so advocating are that the effectiveness of the export base in stimulating regional development may depend considerably upon the ability of the region to organize itself for economic growth, and the size of the multiplier effect may depend upon community capacity for social develoment. If there is a will to persist with regonal development, a suitable regional policy, including a rational tax policy, can help the region to organize itself in this way and thereby lubricate its growth.

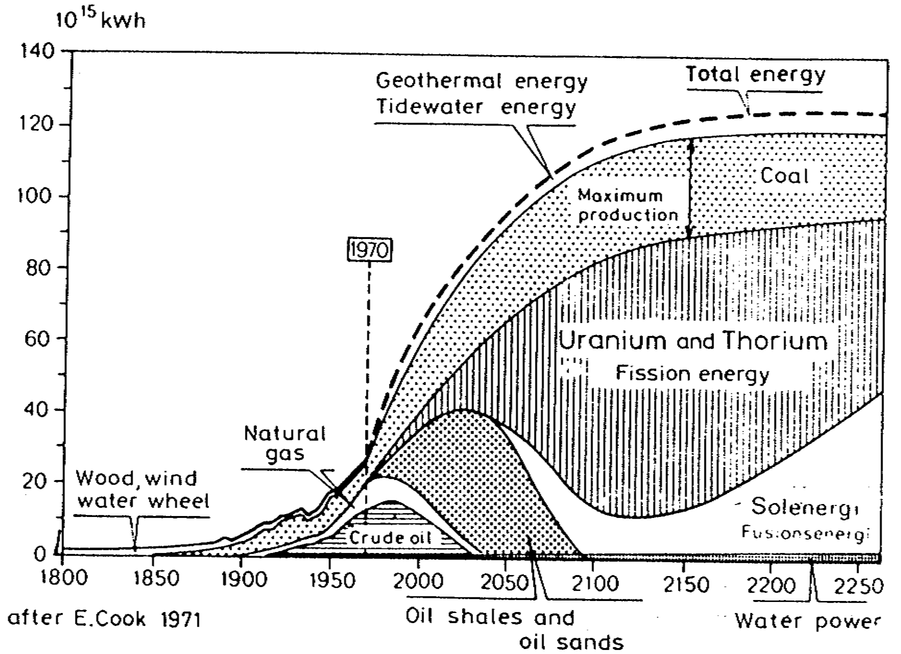

Fig. 1-1 Possible Future Energy Consumption

Source: ***Alexandersson,G. & Klevebring,B.I*** (1978) <u>*World Resources*</u> pp.18

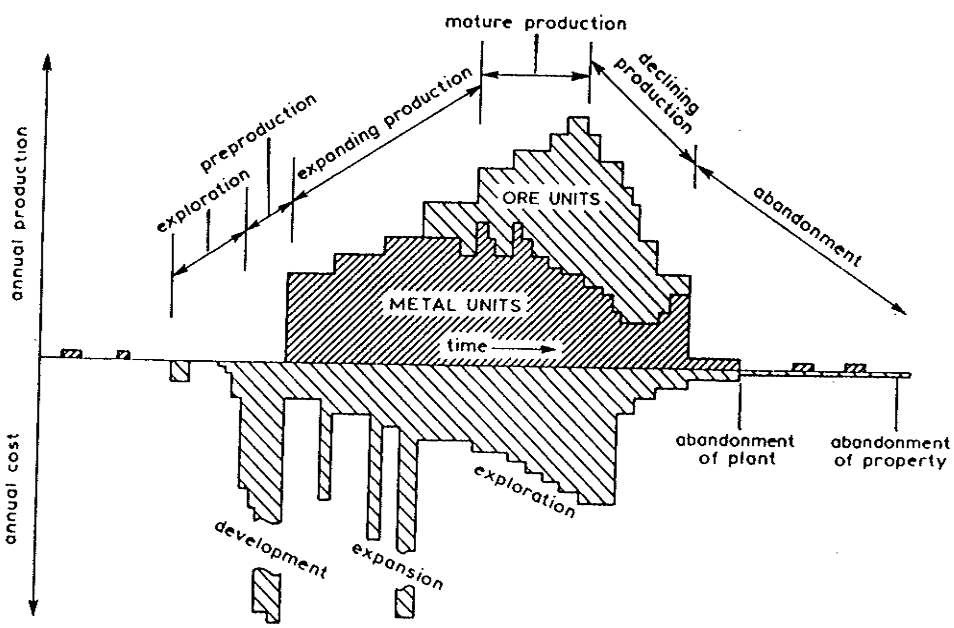

Fig. 1-2 The Life Cycle of a Metal Mine

Source: **Peters,W.C.** *(1978)* <u>*Exploration and Mining Geology*</u> *pp.82*

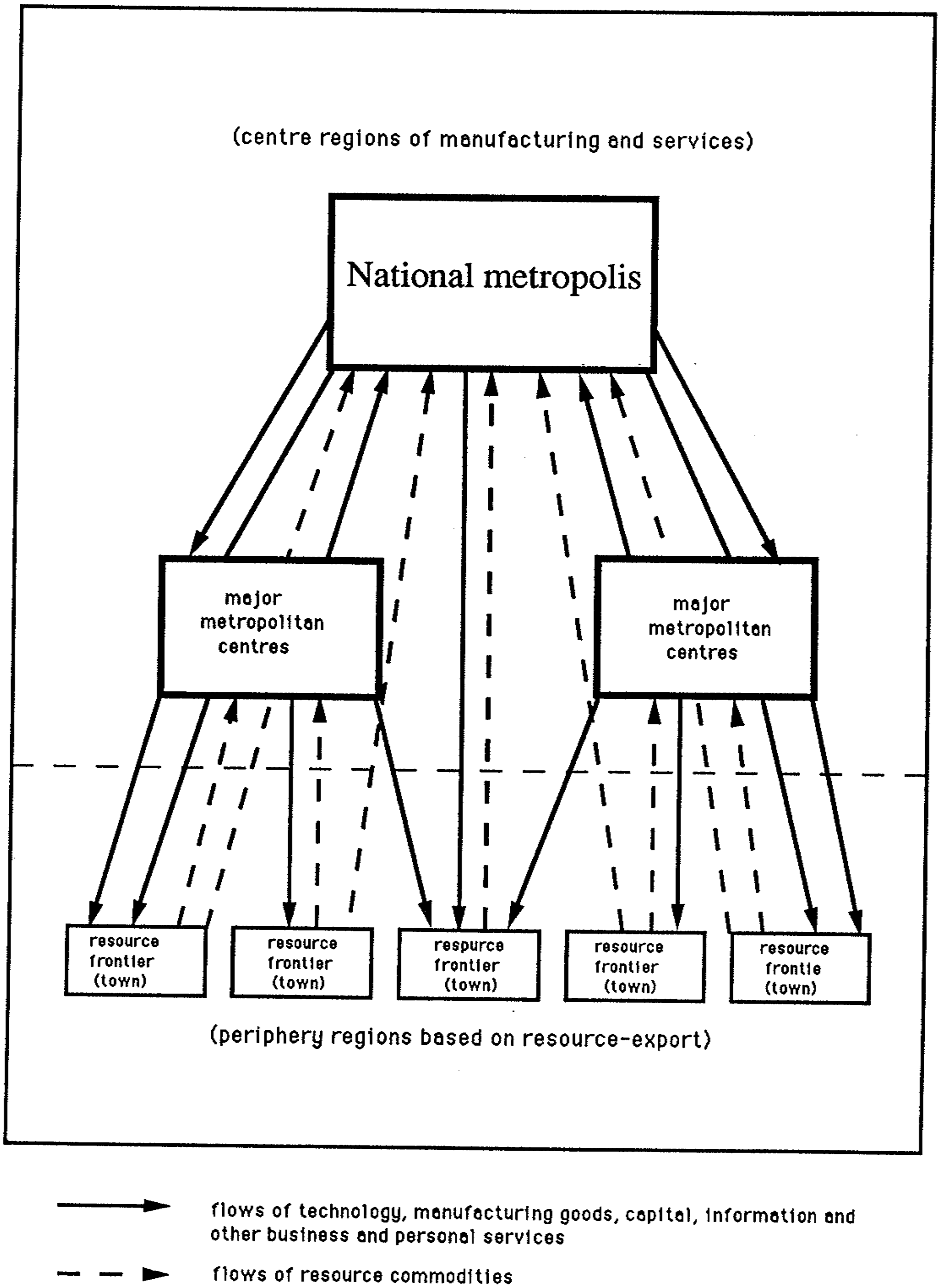

Fig. 1-3 Centre-Periphery Structure Within a Country

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CHAPTER II Mining in a Canadian Regional Context

INTRODUCTION

Canada is one of the world's leading mining countries. For years, it has been the world's leading producer of nickel, zinc, and potash; and it is among the top four producers for a host of other commodities including asbestos, uranium, gold, silver, copper and lead. In the light of that stature, it is not surprising that mineral exploitation has loomed large in the country's evolution. Indeed, in its history, mining has been closely tied to national growth and economic development. The search for minerals brought many of the early explorers to Canada, played a major role in opening up new regions, and has underwritten the costs of some of Canada's major transportation links. Early gold rushes brought settlers into remote areas, and while some mining communities faded away, others survived and prospered. According to Miller (1982), there were 80 mining communities dotted across Canada in 1982, and 1.1 million people, or 4.5 percent of the Canadian population, were resident in them. Since World War II, iron ore, base metal and uranium developments have been the major cause of northern population growth, and together have helped to establish a Canadian foothold in the Arctic. Almost all of the railway lines constructed since the late 1940s were built to service mineral deposits. The St Lawrence Seaway could not have been justified economically without the promise of iron ore traffic from the Labrador Trough to Ontario and the U.S. Midwest. At the present time, coal is the force behind the major transportation and community developments in British Columbia's northeast. Mining activities are scattered all across Canada; every province and territory except Prince Edward Island has active producing mines (see Fig. 2-1, p. 67), although the level of the activity and the commodities produced vary from province to province. It is apparent than much of the mining activity occurs in regions inhabited by native people. Furthermore, new discoveries have tended to carry operations into more and more remote areas, and can be expected to continue to do so in the future. Consequently, opportunities for the participation of native peoples will , if currently pursued, increase as well (Nickel, 1978).

The purpose of this chapter is to examine mining industry as a basis for regional development in the context of Canada. It is devided into several parts; namely, national impacts, regional impacts, income and employment effects and, finally, residual problems.

NATIONAL IMPACTS

What is the nature of the mining industry's impact upon, and link to, the Canadian national economy? Answering this question requires three issues to be addressed. First, the direct economic significance of the mining industry is expressed in terms of principal industry statistics. Historical tendencies are presented, as well as statistics which allow interindustry comparisons. Second, the linkages (one of the indirect impacts, see Chapter I) from the mining industry are identified and discussed. Thereafter, the concept of 'resource-dependent industries' is developed. Third, the backward linkages (another of the indirect impacts) are identified. Finally, some attempts directed to increasing the national economic impacts of mining are reviewed for all these three issues.

Direct impacts. The direct impacts of Canada's mining industry are usually expressed in terms of such indicators as value of production, employment, wages and salaries, capital expenditure and capital formation, value added and the value of exports. A number of these indicators are presented in Table 2-1 (pp.32). These data represent the extraction, milling and concentrating activities.

The gross value of Canadian mineral production in 1985 was $44.7 billions, an increase in current dollar terms of 1,100 percent from 1965. In 1984 the industry employed directly 81,700 workers or 0.74 per cent of the national labour force. Historically, the proportion of the Canadian work-force engaged in mining activities has been declining, likely in response to technical advances.

Table 2-1 Selected Principal Statistics of the Canadian Mining Industry; 1961, 1973, 1984

Indicator	1961		1973		1984	
	Value for mining ($ million)	Mining as percentage of total economy	Value for mining ($ million)	Mining as percentage of total economy	Value for mining ($ million)	Mining as percentage of total economy
Value of production	$ 1,941.0	4.9	$ 8,369.5	6.8	$ 43,789.0	10.4
Employees (person)	92,149	1.5	111,443	1.3	115,790	1.1
Wage & salaries	$ 436.0	9.2	$ 1,214.9	1.8	$ 4,106.1	2.8
Capital expenditure	$ 471.0	4.2	$ 2,362.3	6.9	$ 12,129.4	12.0
Merchandise exports	$ 786.5	13.7	$ 2,577.7	10.4	$ 17,350.6	15.4

Source: Statistics Canada, General Review of the Mineral Industries (26-201)

Although mining in 1984 employed fewer than one percent of the labour force, it accounted for 2.8 percent of wages and salaries paid. Wage levels in mining are among the highest of any industrial group. For example, in 1982, the average weekly wage of a Canadian worker was $390.75, compared with $ 608.26 for a worker in the mining industry.

A particularly significant feature of mining is the major role played by the industry in Canada's export markets. In 1983 Canada exported $ 14.4

billion worth of crude minerals, about 16.3 percent of total domestic exports, and most of these minerals (63 per cent) went to the United States. Fabricated mineral exports accounted for a further $ 17.7 billion. Briefly, crude and fabricated mineral products accounted for about 38.3 percent of total Canadian exports, contributing to an overall foreign merchandise trade surplus of $18.3 billion; up from $7.4 billion in 1981.

Another important aspect of mining, and one that has attracted a considerable amount of discussion in recent years, is the industry's level of capital investment. As Table 2-1 shows, mining accounts for a relatively large share of capital expenditure (12.8 percent in 1983) given the size of its labour force. Beigie and Shaffner (1974) argued that if projections of a world capital shortage in the near future were accurate, the relatively high proportion of capital flowing into mining may not be maintained. Furthermore, the desirability of allocating scarce investment to capital-intensive resource industries was questioned. An opposing viewpoint, of course, is that mining generates needed investment in regions which would otherwise not attract it (Blain and Norcliffe, 1988). In the long run, the second viewpoint is very worthwhile, not only for mining industry itself but also for the whole country. Canada's abundant mineral resource endowment, its small but highly urbanized labour force, and its relative indigenous capital shortage provide a high degree of complementarity, and the geographical location of Canada renders it accessible to the United States, Japan and Western Europe which are the central areas of the world's industrial capital. This complementarity fostered foreign investment in Canada's mineral-extracting industries in the past and, in all probability, will continue to attract capital well into the future.

An economic impact often discussed is the tax revenue generated by mining. The total contribution of the industry is difficult to estimate, since it consists of federal and provincial corporate taxes, municipal taxes, mining taxes, royalties, and claims and lease payments (some authors also include personal taxes paid by recipients of wages, salaries, dividends, etc.). In 1976 the mining industry paid $ 5.63 billion directly in federal and provincial taxes. The distribution of these revenues was at the heart of federal-provincial conflict over mining (Burns, 1975).

Much of the industry's growth coincided with an increasing demand for base metals just prior to the Second World War, and during the early 1950s as a result of the Korean war. Canada, owing to its geographical proximity and political stability, attracted large amounts of development capital from the United States during this period. The findings of the Raley Report (Washington: Government Printing Office, 1952) with respect to the United States' mineral requirements, coupled with foreign investment incentives on the part of the American government, resulted in increased investment in Canadian mining from this source. Further incentives for growth of the industry came in the 1955 Canadian federal budget which made permanent special tax concessions designed to promote expansion of mining. The OPEC-inspired oil crisis of 1973 played an important role in encouraging the government and the energy firms to diversify and expand the industry's production. The cumulative effect of these circumstances was that the gross value of mineral production increased at an average annual rate of 11.3 percent in the period 1950-84, a growth trend not characteristic of other primary resource activities. In that period, minerals accounted for a constant proportion of gross domestic product (GDP) while other resource industries accounted for decreasing proportions.

Thus a comparison of GDP for three primary resource activities shows that, within the primary resource sector, fisheries and forestry accounted for a constant proportion of about 13 percent in the years extending from 1939 to 1981, while agriculture declined from 60 percent to about 32 percent. In the same period, minerals increased from 30 percent to 55 percent of primary resource GDP. The performance of the minerals industry relative to other industries in the primary resource sector may have been based in large part on the change in the mining industry's product structure, particularly the increase of fuel mineral products (crude petroleum and gas and coal) since the 1970s. Prior to that time, the fuel mineral products in the mining industry accounted for about 20 percent of the total production. The share of fuel minerals rose to account for half of the total mining GDP in the 1970s and 1980: a reaction to the uneasy situation in the Middle East, hitherto the major supply of crude petroleum and gas for developed countries.

Forward linkage. Nickel (1978) suggested that the mining industry's forward linkages can be measured by:

i the number of other industries to which it sells;

ii the share of the total output of mining which is used by other industries; and

iii the importance of mining products among all the inputs used by the purchased industry.

Such measures of forward linkage from the mining industry to other industries in the Canadian economy can be constructed from input-output tables. Forward linkage coefficients of the mining industry, expressed in percentage form, are set out in Table 2-2 (see pp.38) for metallic ores and concentrates, for mineral fuels and for nonmetallic minerals. Two features of the construction of the linkage coefficients should be kept in mind when interpreting this table. They are recounted below.

In the first place, linkage coefficients would ideally be derived for policy purposes by tracing the interindustry flows of mineral commodities of domestic origin only. However, this is not possible in practice because the input-output tables do not distinguish between domestic and foreign sources of commodity inputs. We are therefore forced to base all distribution measures on a single aggregate supply. Secondly, the size and number of forward linkages will be affected by the level of industry and commodity aggregation utilized in the input-output tables. The higher the level of aggregation, the larger will be the size and the fewer the number of linkages (Nickel, 1978). The 1981 input-output tables provide three levels of aggregation: S, M and L. Aggregation M, consisting of 43 industry and 92 commodity groupings, is used for constructing the forward linkage coefficients.

When we use the 1981 input-output tables to analyze the coefficients of the forward linkages, we find that there are relatively few forward linkages from metal mining to other Canadian industries. While 64.8 percent of the total supply of metallic ores and concentrates is used by domestics industries, some 52.5 percent is absorbed by the primary metals group of industries alone. By way of contrast,the forward linkages from non-metallic minerals are more numerous but weaker. Again, the largest coefficients are in those industries where further processing occurs. In primary metals industries, some 33.0 percent of the value of intermediate inputs is made up of metallic ores and concentrates. Conversely, for the nonmetal mineral products industries, nonmetallic minerals comprise only 16.1 percent of all intermediate inputs used. The forward linkages of other industries are small by comparison. Bucovetsky (1973) has stipulated that mining be considered linked forwardly to an industry only if the latter receives one-third or more of its intermediate inputs from mining. On this criterion there are only two significant forward linkages from Canadian mining; namely, the mining of metallic ores and concentrates in connection with the

Table 2-2 Forward Linkages from the Mining Industry: Canada, 1981

Industrial group	Metal Mines: Percentage of total metallic production supply used by industrial group	Metal Mines: Metallic PROD purchased as a percentage of total commodity purchased by industrial group	Mineral Fuel: Percentage of total mineral fuel supply used by industrial group	Mineral Fuel: Mineral fuels purchased as a percentage of total commodity purchased by industrial group	Non-metallic Mineral: Percentage of total nonmetallic mineral supply used by industrial group	Non-metallic Mineral: Non-metallic purchased as a percentage of total commodity purchased by industrial group
Agriculture			0.1	0.1	1.0	0.2
Fishing,hunting & trapping					0.1	0.1
Metal mines	0.4	1.1	0.5	0.3	2.4	1.4
Mineral fuels			0.1	0.2	0.2	-
Non-metal mines & quarries			0.2	0.3	0.5	0.1
Services incidental to mining			-	-	1.0	1.1
Food & beverage industries			0.4	0.3	0.9	0.1
Rubber & plastic production			0.1	0.4	0.5	0.3
Textile industries			0.1	0.5	0.4	0.1
Wood			0.1	0.4		
Paper & allied industries	-	-	0.6	1.2	3.2	0.6
Primary metal industries	52.5	33.0	3.8	5.8	3.8	0.6
Metal fabricating industries	6.1	6.5	0.2	0.4	0.2	-
Machinery industries			0.1	0.2	0.7	0.2
Transportation equipment INDs.			0.2	0.2	0.1	-
Electrical products industries	-	0.1	0.1	0.3	0.1	-
Non-metallic mineral PROD.INDs.	0.7	2.1	0.5	3.9	16.1	10.7
Petroleum & coal PROD. INDs.	-	-	84.9	79.4	0.3	-
Chemical & chemical PROD. INDs.	1.9	0.2	1.4	3.1	13.9	2.7
Miscellaneous MFR.INDs.	3.2	9.8	-	0.2	0.1	0.1
Construction industries			1.1	1.6	9.7	0.6
Total industry	64.8	na	94.5	na	55.2	na
Exports	34.6	na			19.7	na
Other final demand	0.6	na	5.5	na	25.1	na
Total	100.0	na	100.0	na	100.0	na

Source: Statistics Canada, The Input-Output Structure of the Canadian Economy 1981-1984 (15-201). Aggregation-M.

Notes: na= not applicable. -= less than 0.05 percent.

primary metals industries and the mining of mineral fuels in association with petroleum and coal products industries.

Industrial production is a sequential value-added process. In this process, each sector has its own particular function responding to the whole production system. For example, the cotton textile industry is basically organized by the processing procedures: washing--drying--kempting--primary spinning--fine yarning--weaving--dyeing. Therefore, when we analyze the forward linkages of raw cotton, we could not define it only relation to the process of washing or kempting. By the same token, the chain of forward linkages from mining should be extended to succeeding rounds, although after a few rounds the linkages may be extremely weak. Bennett (1973) takes an approach similar to Bucovetsky's, but extends the analysis to the third round of the linkage. Resource-dependent industries are then defined as those which use minerals or mineral products for at least half of their commodity inputs. Thus the smelting and refining industry is directly linked to mining because it draws over-half of its intermediate input from mining. The iron and steel industry is linked to the mining industry in the second round because it draws over one-half of its intermediate input either directly from mining or, indirectly, through smelting and refining. Similarly, the steel pipe and tube industries are linked in the third round because over half of their intermediate input comes from mining, smelting and refining and the iron and steel industry. Table 2-3 (see pp.42) presents selected indicators for the group of industries thus identified. A comparison of the values given in the table with equivalent values for mining abstracted from Table 2-2 reveals that for most indicators the direct impact of ´mining-dependent´ industries is greater than that of mining itself. Yet another way of measuring forward linkage is to by pass interindustry connections and to evaluate linkage in the aggregate. This has been done by EMR (Department of Energy, Mines and Resources) investigation. Using the 1961 input-output tables, Stahl (1973) found a forward linkage coefficient of only 0.65 for metal-mine products (that is, 65 percent of the domestic output of that commodity is used as an intermediate input by domestic industries) and 0.58 for nonmetallic minerals. In a similar study, but using a larger number of industry groupings, McCulla and Stahl (1977) calculate forward linkage coefficients from the 1966 input-output tables. The results indicate a coefficient of 0.76 for metal ores and concentrates, 0.37 for nonmetallic minerals, and 0.28 for iron ores and concentrates.

Backward linkage. Estimates of backward linkages from metal mining, minerals fuels quarrying and non-metal mines are derived from the 1981 input-output tables and are presented in Table 2-4. The procedure for constructing the backward linkage coefficients duplicates that for forward linkages--except that it focuses on the supply side--but the interpretation of the backward linkages is slightly different. The first and third columns identify all commodity inputs used by the respective mining industries and show their percentage distribution. The second and fourth columns indicate the percentage share of the total supply (domestic production plus imports) of each commodity that the mining industries use. For example, the use of services incidental to mining accounts for 13.5 percent of the total value of intermediate inputs absorbed by metal mining, and the metal-mining industry purchases 10.8 percent of the total supply of those services. As is the case with Table 2-3, this table illustrates both the number and size of the linkage. The metal-mining industry has a greater number of backward than forward linkages. After analyzing input-output tables of 1971, Nickel (1978) concluded that the mining industry in general has fewer backward linkages than other industries. Similarly, Stahl (1973) points out that the primary extraction group average 21 backward links compared with 31 for the metal fabricating group. Both of them argue that the size of the backward linkages, as measured by the percentage of intermediate inputs purchased from other domestic industries, is also relatively small for mining. According to Stahl (1973), among 15 commodity groups examined in this study, metal mines and nonmetal mines ranked lowest and third lowest, respectively.

Increasing the degree of integration of mining activity into the economy of the country is a lengthy process best accomplished by gradual exposure over time. This process must begin with the implantation of scientific concepts at an early age and then across the full society. On this fundamental level, the country in which mineral development takes place must be prepared to undertake more fundamental industrialization based on its strong and diversified mining foundations. In fact, there is evidence to suggest that the Canadian situation has followed such a course since 1971. The number and magnitude of the industry's linkages have increased significantly, and particularly in respect of the latter (see Table 2-5, p.45). While the information elicited from the Table 2-4 (p.44) is limited owing to the vertical orientation of the linkages, examination of the horizontal bias in the linkages displayed in Table 2-5 is much more revealing. Both the number and the size of the backward linkages, as measured by the percentage of intermediate goods and services inputs purchased from domestic industries, are relatively large for mining. Among 24 commodity groups examined in Table 2-5, mining industries ranked 11 in number and 5 in size respectively. These results indicate not only that

Table 2-3 Selected Principal Statistics for Canadian 'Resource-dependent' Industry, 1981

industry	Value of product ($ million)	Value-Added ($ million)	Employees (person)	Wages and salaries (& million)
Primary Metal Industries	**15,743.2**	**5,836.6**	**125,168**	**3,058.8**
Iron and steel mills	7,110.8	2,750.9	56,543	1,407.3
Pipe and tube mills	1,363.3	378.3	7,531	174.6
Iron foundries	552.4	266.0	8,358	166.7
Smelting & refining	4,298.6	1,808.9	38,011	1,002.7
Aluminum rolling & casting	1,178.0	292.8	6,512	144.6
Copper & alloy rolling	598.1	129.3	3,031	64.8
Metal rolling, Castings	642.0	210.4	5,182	98.2
Metal Fabricating Industries	**13,493.9**	**6,137.8**	**158,832**	**3,143.3**
Boiler & plate works	829.0	385.8	11,215	271.4
FAB structural metal IND.	1,576.1	829.1	18,445	407.9
Ornamental,architectural MTL.	1,341.8	622.7	17,603	322.5
Metal door,window metal MFRS.	691.1	317.5	9,434	169.6
Ornamental,architectural NES.	650.7	305.2	8,169	152.9
Stamping,pressing & Coating.	4,012.3	1,447.1	32,459	648.2
Metal Coating industry	359.8	204.7	5,636	100.4
Stamping & pressing IND.	3,652.5	1,242.4	26,823	547.8
Wire & wire products MFRS.	1,677.3	671.7	17,309	336.2
Fastener manufacture	373.4	164.7	4,189	86.3
Wire & wire products MFRS.NES.	1,303.9	506.9	13,120	249.9
Hardware,tool & cutlery MFRS.	1,172.1	714.0	19,575	379.1
Heating equipment MFRS	479.5	206.8	5,806	103.0
Machine shops	719.9	449.9	14,297	269.9
MISC. metal fabricating INDs.	1,686.0	810.6	22,123	405.4
Non-metallic mineral PRODs. INDs.	**5,308.9**	**2,510.5**	**55,269**	**1,188.5**
Clay products manufacturers	221.5	132.9	4,145	76.0
Clay products MFRS(domestic clays)	130.1	82.0	2,238	44.1
Clay products MFRS(imported clays)	91.4	50.9	1,907	32.0
Cement manufacturers	779.7	421.4	4,726	126.7
Stones products manufacturers	68.9	40.9	1,410	22.4
Concrete products MFRS.	691.1	378.5	9,121	191.3
Concrete pipe manufacturers	182.2	96.8	2,214	48.5
MFRS. structural concrete PROD.	237.9	145.1	3,241	75.2
Concrete products MFRS. NES.	271.0	136.6	3,666	67.6
Ready-mix concrete MFRS.	1,151.1	430.2	10,053	227.0
Glass & glass products MFRS.	938.3	505.6	12,003	246.1
Glass manufacturers	652.6	364.6	8,476	179.4
Glass products MFRS.	285.7	141.0	3,527	66.7
Abrasives manufacturers	247.2	95.9	2,571	51.6
Lime manufacturers	132.4	62.8	968	22.8
MISC. nonmetallic mineral PRODs.	1,078.9	442.5	10,272	224.6
Refractories manufacturers	164.2	54.5	1,489	32.6
MISC. nonmetallic mineral PRODs.	914.7	387.0	8,783	192.0
Chemical & chemical products INDs.	**2,093.8**	**442.8**	**7,522**	**185.6**
Manufacturers of mixed fertilizers	329.6	67.9	1,017	185.6
MFRS of plastics& synthetic resins	1,664.2	374.9	6,505	167.2

Table 2-3 (continued)

Petroleum & coal products INDs.	**21,575.9**	**2,722.9**	**22,638**	**686.5**
Petroleum refineries	21,429.7	2,683.6	22,054	637.6
MFRS. lubricating oil & greases	211.8	42.1	729	16.1
MISC. petroleum & coal PRODs.INDs.	146.2	39.3	584	12.9
Total	**58,215.7**	**17,650.6**	**369,429**	**8,262.8**

Source: Industries of Canada: National and Provincial Areas, 1981 (31-203).

the mining industry buys a wide variety of commodity inputs from other domestic industries, but also—and more importantly—that the links represent a large proportion of the output of the supplying industry; that is to say, the commodity purchased by mining industry has a stronger influence on the domestic economy. In order to confirm this finding, we compare the nature of the backward linkages of Canadian industries with that the U.S.A.. As a result, we discover that there is a similar tendency at work in both the U.S.A. and Canadian economies in spite of the fact that the former operates on a larger economic scale and a higher level of structural diversification.

It should be said that the Canadian mining-equipment sector has not developed enough to meet the needs of the local mining industry. As Table 2-6 (p.46) evinces, the mining industry purchases a wide variety of equipment, totalling over $2 billion in 1984. These equipment purchases are made from a broad cross-section of both general and mining-specific equipment suppliers. There were about 120 firms, largely concentrated in Ontario and Quebec, employing 6,000 people directly in the production of mining equipment in 1982. Annual shipments amounted to approximately $342 million, of which about 60 percent was exported, mainly to the United States. Growth in the sector registered about 12.2 percent between 1965 and 1985, slightly ahead of both the machinery industry as a whole and total manufacturing (both 11 percent).

Table 2-4 Backward Linkages from Mining Industries, 1981

Commodity groups	Metal Mining: Distribution of commodity purchased by metal mining (%)	Metal Mining: Total country supply used by metal mining (%)	Mineral Fuel: Distribution of commodity purchased by mineral fuels (%)	Mineral Fuel: Total country supply used by mineral fuels (%)	Non-metal Mines: Distribution of commodity purchased by nonmetal mines (%)	Non-metal Mines: Total country supply used by nonmetal mines (%)
Iron ores & concentrates	0.1	0.4	-	-	-	-
Other metal ores & CONT.	1.0	0.7	-	-	-	-
Natural gas	0.3	0.6	0.2	1.2	2.9	2.0
Nonmetal minerals	1.4	4.3	-	-	1.0	0.9
Service incidental to mining	13.5	10.8	7.0	14.8	2.7	0.7
Other textile products	0.1	0.4	-	-	0.1	-
Plastic fabricated products	-	-	-	-	0.7	0.3
Other fabricated products	-	-	-	-	0.1	-
Paper products	-	-	-	-	2.1	0.6
Iron & steel products	3.3	1.2	0.6	0.1	-	-
Other nonmetal metal PRODs.	0.1	0.2	-	-	-	-
Fabricated structural metal PROD.	0.2	0.2	0.1	-	-	-
Other metal fabricated PRODs.	0.3	0.1	0.1	-	-	-
Other industrial machinery	7.4	4.1	1.8	2.7	8.3	1.5
Motor vehicle parts	4.2	1.4	0.4	10.3	2.6	0.3
Other transportation machinery	0.4	0.8	-	-	-	-
Other nonmetallic mineral PRODs.	0.6	0.8	-	-	0.3	0.1
Gasoline and fuel oil	7.4	2.5	1.0	0.9	6.7	0.7
Other petroleum & coal PRODs.	1.3	1.2	0.1	-	1.3	0.4
Industrial chemicals	2.8	1.2	0.4	0.5	1.1	0.1
Other chemical products	4.3	3.4	0.3	0.6	2.6	0.6
Repair construction	4.8	1.9	6.3	6.8	1.7	0.2
Pipeline transport	0.2	-	0.1	-	1.7	1.2
Transportation & storage	3.0	0.5	0.3	0.1	1.7	0.1
Telephone & telegraph	0.3	0.3	0.3	0.6	0.4	0.1
Postal services	-	-	0.1	-	0.1	-
Electric power	6.7	4.7	2.1	3.9	5.6	1.2
Other utilities	0.2	-	0.2	2.6	0.8	1.1
Wholesale margins	6.3	1.7	1.0	0.8	5.4	0.5
Retail margins	0.1	0.3	-	-	0.2	0.1
Other finance, insurance and real estate	7.1	2.1	63.9	24.8	30.3	1.4
Business services	5.3	1.4	5.3	3.7	2.6	0.2
Other personal & miscellaneous services	1.8	0.7	0.3	0.3	3.2	0.4
Transportation margins	1.8	1.1	0.2	0.3	1.3	0.2
Operating, office, lab & food	13.2	2.8	6.8	0.7	11.0	0.7
Travel, advertising & promotion	0.5	0.2	1.0	0.9	1.3	0.1

Source: Statistics Canada. The Input-Output Structure of the Canadian Economy 1981-1984 (15-201): Aggregation-M.
Note: - = less than 0.05 percent

Table 2-5 Backward Linkages of Selected Industries

Industrial group	The number		The size	
	Canada (1981)	U.S.A. (1984)	Canada (1981)	U.S.A. (1984)
Mining industries	41	58	4.8	2.9
Metal mines	35	50	1.1	0.1
Mineral fuels	30	54	2.8	2.6
Nonmetal mines	34	50	0.3	0.2
Services	15	-	0.6	-
Agriculture	40	48	2.9	1.4
Forestry	27		0.8	
Fishing, hunting & trapping	30 }	52	0.1 }	0.1
Food & beverage industries	55	58	8.0	4.3
Tobacco products industries	32	47	0.3	0.3
Rubber & plastic products industries	42	60	0.1	1.5
Leather industries	47	49	0.3	0.1
Textile industries	39	55	1.1	0.8
Knitting mills	32	39	0.2	0.2
Clothing industries	37	54	0.2	0.8
Wood	45	57	0.8	0.7
Furniture fixture industries	48	53	0.5	0.4
Paper & allied industries	47	49	3.3	1.4
Printing & publishing	37	67	1.1	1.5
Primary metal industries	44	67	4.3	1.8
Metal fabricating industries	54	60	2.5	1.8
Machinery industries	44	61	1.8	1.9
Transport equipment industries	52	66	5.7	4.0
Electrical products industries	51	62	1.8	4.0
Non-metal mineral products industries	54	65	0.9	0.8
Petroleum & coal products industries	33	50	7.1	2.8
Chemical & chemical products industries	60	66	3.1	2.3
Miscellaneous manufacturing industries	59	65	10.6	1.1

Source: 1. Statistics Canada. The Input-Output Structure of the Canadian Economy 1981-1984 (15-201): Aggregation-M.
2. Annual Input-Output Accounts of the U.S. Economy, 1984. SURVEY OF CURRENT BUSINESS, Vol. 69-11, 1989.
Note: The size = percentage of total commodity purchased by industrial group.

Even so, imports of mining machinery in 1984 still captured 44 percent of the Canadian market share.

According to a study conducted by the Federal Department of Industry, Trade and Commerce, most of the Canadian-owned manufacturers are small, with sales of less than $10 million annually. They face considerable disadvantages compared with large firms in terms of scale economies, distribution facilities, and access to technology. More importantly, since mining firms tend to be conservative purchasers of equipment, these small firms are at an additional disadvantage because they are generally perceived to be less stable, and unable to match the service offered by the large firms.

Unlike the mining-equipment sector, the Canadian mining exploration equipment industry has been particularly successful, and rates special mention. In mid-1985 the sector consisted of about 15 companies which develop, manufacture and sell geophysical and geochemical instruments. Some of these manufacturers also provide contract services such as airborne and ground surveys. These 15 firms carry out most of the R & D and technological innovation for the exploration industry in Canada, and are world leaders as well: a fact demonstrated since the 1960s through exports, principally to the Third World.

Table 2-6 Mining Equipment Related Expenditure and Imports, Selected Years

Year	Total equipment expenditure (million dollars)	Imports (million dollars)	Imports as a percentage of total expenditures
1965	270.8	140.8	52.0
1984	2,188.0	960.5	43.9

source: Statistic Canada (61-206); Statistic Canada, Imports by Commodity, Bulletin (65-007).

Table 2-7 Mining-Related University Programmes and Degree Granted, 1984

	Number of university participants	Undergraduate degrees	Graduate degrees
Geology: Arts and Science	32	887	332
Geological Engineering	9	281	5
Geophysics	16	116	45
Mining Engineering	8	136	39
Mineral Processing	6	20	11
Metallurgical Engineering	10	136	95
Metallurgical: Art and Science	2	25	3

Source: Wojciechowski, M.J. "Innovation in the Mineral Industry: Opportunities and Strategies for Canada" 1987.

Wojciechowwski (1987) argues that Canadian mining industry is served by a very large number and wide variety of organizations, especially those based in universities. Indeed, Canadian universities play an important role in the backward linkages of the industry. First, they provide the industry with skilled manpower resources, turning out a steady stream of undergraduates and graduates with a broad range of skills, both managerial and technical (see Table 2-7, pp.46). Secondly, universities are generally considered to be the principal agencies for performing basic research and long-term applied research and development in all fields. Thirdly, universities have an important role to play in technology transfer from the laboratory to the industry, extending from the application of so-called ´emerging´ technologies, such as biotechnology and information technology; to the transferring of technology into commercial applications in the private sector. Unfortunately, these discernible contributions of universities to mining industry are difficult to estimate in any financial sense.

REGIONAL IMPACTS OF MINING: The Provincial Level

It is often suggested that the real importance of mining to Canada lies in its regional effects, both in opening up new settlements in remote regions and in providing stability to the already settled areas and core-peripheral settlement structure. There are two problems that we should discuss before we analyze regional economic impacts of the mining industry. First, we should establish precise terms of reference. Mining regions often share several basic attributes, including homogeneity of physical features and resources, economic activity, and social and cultural features. The mine operation itself is of course easily identifiable; it is normally site-specific and the actual geographical areas are small (130,000 acres in Canada as a whole). However, the economic impacts of the mining industry are identifiable at several levels. Here we only choose to discuss these impacts under one regional heading: provincial. While supra-provincial, and sub-provincial local data are of some interest, they are of limited value because economic data are not easily collected within such frameworks. For example, as with potash in Saskatchewan or coal in Nova Scotia, the relevant region for our analysis is clearly not the prairies or Atlantic region, but the province hosting those mining activities. Secondly, there are problems about how to measure regional impacts and linkages. The major problem is to obtain input-output data for regions. It is correspondingly difficult to describe the nature of the regional economic structure (and, as a corollary, the impact of mining within that structure). In spite of two types of input-output models for analyzing regional economic impacts; namely, interregional models (e.g. the Ontario, Quebec, Alberta and Manitoba models) and sub-provincial regional models resting on the same computational basis as interregional models (but emerging in 1975-1976), neither of them are extensively used. Inadequate data on provincial ´impacts´ and ´exports´, perhaps, is the most serious drawback encountered when constructing regional or interregional input-output tables; additional disclosure problems may be posed in a region if only one or two firms locate for a given industry. The result is that regional data are often highly aggregated, reducing the possibility of detailed industry impact analysis. The significance attached to a given provincial mining industry may vary, depending upon one´s perspective. Two broad perspectives are identified: a ´national´ one that weighs the significance of a province´s mining industry in the light of its contribution to mining nationally; and a

´provincial´ one that looks at the impact of mining relative to other sectors of the provincial economy. The distribution between a ´national´ and a

Table 2-8 Selected Mining Industry Indicators, by Province, Canada, 1981

	Value added		Employment		Wage & Salareis	
Province	($ million)	Provincial value at national level (%)	(number)	Provincial value at national level (%)	($ million)	Provincial value at national level (%)
NFLD.	560	2.4	5,373	4.2	155	4.5
P.E.I.	-	-	-	-	-	-
N.S.	155	0.7	4,909	3.8	103	3.0
N.B.	150	0.7	3,093	2.4	70	2.0
QUE.	1,236	5.4	22,295	17.2	583	17.0
ONT.	2,200	9.5	31,499	24.4	780	22.7
MAN.	356	1.5	5,220	4.0	121	3.5
SASK.	1,984	8.6	8,278	6.4	217	6.3
ALTA.	14,603	63.2	29,399	22.7	812	23.6
B.C.	1,628	7.1	14,893	11.5	441	12.8
Yukon & NWT.	219	0.9	4,195	3.3	154	4.6

Source: Canada Mineral Yearbook 1985.

Table 2-9 Provincial Significance of the Mining Industry by Selected Industry, Canada,1984

	Value-added		Employment		Wages & Salaries	
Province	($ million)	As percentage of provincial GDP	Number	As percentage of provincial total	($ million)	AS percentage of provincial total
NFLD.	560	13.4	5,373	3.1	155	6.4
P.E.I.	-	-	-	-	-	-
N.S.	155	2.1	4,909	1.5	103	2.4
N.B.	150	2.4	3,093	1.3	70	2.1
QUE.	1,236	1.5	22,295	0.9	583	1.4
ONT.	2,200	1.7	31,499	0.8	780	1.1
MAN.	356	2.8	5,220	1.1	121	1.9
SASK.	1,986	13.3	8,278	2.0	217	4.2
ALTA.	14,603	31.6	29.399	2.7	812	4.5
B.C.	1,628	3.8	14,893	1.2	441	2.1
Yukon & NWT.	219	20.0	4,195	-	154	22.4

Source: Canada Mineral Yearbook 1985.

´provincial´ perspective may therefore be of some importance in the evaluation of data on mining.

The distribution by province of some direct effects of mining (value added, employment, and wages and salaries; see Table 2-8, p.48) reflects the ´national´ perspective of the mining industry. We can see from this table that, regardless of the chosen indicator, Alberta is consistently the most significant mining province; followed by Ontario, Saskatchewan and Quebec. A quite different pattern emerges, however, when we look at the major indicators with a ´provincial´ perspective. Table 2-9 (see p.49) gives a rough idea of the relative importance of mining to each provincial economy. It is interesting to note the changes in ranking that emerge from a comparison of Table 2-9 by value-added. On the count of ´selected mining industry indicators´, the order is: Alberta, Ontario, Saskatchewan, British Columbia, Quebec, Newfoundland, Manitoba, NorthWest Territories (including Yukon), Nova Scotia and New Brunswick. In contrast, ranking by importance of mining to the individual provincial economy (mining value-added as a percentage of provincial gross domestic product) in Table 2-9, yields a sharply altered ordering: Alberta, Yukon & North West Territories, Newfoundland, Saskatchewan, British Columbia, Manitoba, New Brunswick, Nova Scotia, Ontario and Quebec.

While the direct impacts in Table 2-9 are useful as an approximation of mining´s importance to a province, an additional, but less easily captured, factor that should be considered is the degree to which mining is integrated into the provincial economy. To render some perspective to our discussion thus far, Table 2-10 (see pp.51) gives an idea of the absolute levels of mineral production´s value in each province standardized by population. The highest levels occur in Alberta, followed by Saskatchewan, Newfoundland and British

Table 2-10 Per Capita Mineral Production Value by Province, Canada, 1956-1981 (dollar)

growth	1956	1961	1966	1971	1976	1981	% growth 1956-1981	Population (%) 1956-1981
Newfoundland	203.2	202.4	494.6	657.6	1,336.0	1,788.7	780.3	36.9
Nova Scotia	95.1	80.8	113.2	76.2	154.0	313.3	229.4	21.8
NEw Brunswick	32.9	29.9	146.2	168.8	352.0	753.1	2,189.1	25.4
Quebec	91.3	85.1	133.4	127.7	240.0	371.5	336.6	39.1
Ontario	120.4	152.1	137.6	201.8	328.0	472.5	292.4	59.6
Manitoba	79.9	107.6	186.2	333.0	501.0	614.5	669.1	20.5
Saskatchewan	139.4	235.9	364.8	441.4	1,058.0	2,313.4	1,559.5	9.8
Alberta	366.1	348.1	580.0	1,00.8	3,773.0	7,488.1	1,945.4	99.3
British Columbia	145.4	118.1	176.6	248.9	651.0	976.6	571.2	96.8
Rank correlation between 1956 and 1981 per capita				r_s = 0.924	$\bar{X}$ = 1,168.7			

Source: Canada Mineral Yearbooks 1956, 1961, 1966, 1971, 1981. Canada Yearbooks 1958, 1966, 1973, 1985.

Table 2-11 Correlation of Mineral Production Value and GDP by Province, 1966-1981: Per Capita (dollar)

Province		1966	1976	1976	1981	Correlation coefficient(r_s)	Rank
Newfoundland	(1)	495	658	1,336	1,789	0.979	3
	(2)	1,753	2,479	4,546	7,354		
Prince Edward	(1)	10	9	14	13	0.016	9
Island	(2)	1,581	2,295	4,423	7,167		
Nova Scotia	(1)	113	76	154	313	0.931	7
	(2)	1,973	2,995	5,597	8,683		
New Brunswick	(1)	146	169	352	753	0.912	8
	(2)	1,919	2,810	5,413	8,928		
Quebec	(1)	133	128	240	372	0.990	5
	(2)	2,818	3,918	7,475	12,165		
Ontario	(1)	138	202	328	473	0.992	2
	(2)	4,104	5,171	9,280	14,769		
Manitoba	(1)	186	334	501	615	0.961	6
	(2)	2,730	3,995	7,759	12,461		
Saskatchewan	(1)	365	441	1,058	2,313	0.994	1
	(2)	3,121	3,788	8,587	15,042		
Alberta	(1)	580	1,008	3,773	7,488	0.994	1
	(2)	3,424	4,884	11,634	20,647		
British	(1)	177	249	651	977	0.975	4
Columbia	(2)	3,422	6,320	9,217	15,480		

Source: Canada Yearbook 1973, 1980-1981, 1985.
Note: (1)= per capita mineral production's value.
(2)= per capita GDP.

Columbia. Notably, the level of mineral production's value per capita (measured in constant dollars) has risen steadily in almost every province—— the exceptions being a small 1956-61 reversal in Newfoundland, Nova Scotia, New Branswick and Quebec and a small 1961-66 reversal in Ontaria. Indeed, the overall growth column would seem to argue well for New Branswick in that it underscores its high rate of growth relative to the small number obtaining for the accounting base of 1956. However, lest one becomes too optimistic, the low population growth rates in these provinces, for example in Saskatchewan and Manitoba, imply that their increasing per capital mineral production values have less to do with mining expansion and more to do with slower population increases. Also, the stability of provincial per capita mineral production value ranks over time is impressive and undeniable, with the 1965 and 1981 distributions being correlated at 0.924 using Spearman's coefficient.

Further insight into the issue of the mining impacts on provincial per capita GDP figures is gained from an analysis of Table 2-11 (see p.51). Here, provincial observed per capita mineral production value is correlated with the GDP indicator in a given year. A general tendency concerning the correlation coefficients is clear, with the 1966 and 1981 distribution between two sets of paired values in each province being correlated at a high level of $r_s > 0.910$, except for the case of Prince Edward Island ($r_s = 0.016$). However, the differences of the coefficients, although relatively insignificant, indicate that mining's impacts on provincial economies vary. Obviously, the mining activities in Alberta and Saskatchewan play more important roles in both of their host provincial economies than do the mining industries resident in other provinces, and the value of $r_s = 0.992$ for Ontario (ranking in the second place) might be attributed to its share of added value, employment and wages and salaries in the national mining as a whole (see Table 2-8, p.49). To the extent that mining activity is a function of the abundance of capital investment in production (see the introduction of Chapter I), provincial shares of Canada's capital stock can attest to a strong and continuing inertia in the geography of economic property in Canada. Table 2-12, pp.53) shows the regional dynamics of Canada's capital stock in 1956 and 1981 respectively. We can elicit from this table the fact that the absolute dominant region in capital stock is Ontario, with a share consistently greater than one-third. However, this share has been gradually eroded by the rising

Table 2-12 Regional Dynamics of National Capital Stock, Canada, 1956-1981

		NFLD.	N.S.	N.B.	QUE.	ONT.	MAN.	SASK.	ALTA.	B.C.
1956	Actual share	0.9	2.2	1.9	21.0	39.1	4.8	7.2	12.8	9.8
	Expected share	2.6	4.3	3.5	28.8	33.7	5.3	5.5	7.0	8.7
	Surplus (deficit)	(1.7)	(2.1)	(1.6)	(7.8)	5.4	(0.5)	1.7	5.8	1.1
1981	Actual share	1.7	2.5	2.0	18.6	33.9	3.6	5.3	20.4	11.8
	Expected share	2.4	3.5	2.9	26.5	35.5	4.2	4.0	9.2	11.3
	Surplus (deficit)	(0.7)	(1.0)	(0.9)	(7.9)	(1.6)	(0.6)	1.3	11.2	0.5

Note: Expected share represents provincial share of national population in 1951 and 1981 respectively.
Source: **Gertler,M.S.** "Regional Dynamics of Manufacturing and Non-manufacturing Investment in Canada", Regional Studies. Vol.20:6 (1987) p.523-34.

Table 2-13 Mining Purchases and Sales of Intermediate Goods Compared with those of all Industries

	Mining purchases within the province		Mining sales within the province	
Province	Rank among industries	As a proportion of all-industrial purchase (%)	Rank among industries	As a proportion of all-industrial sales (%)
Alberta	18 (31)	0.8	13 (31)	2.3
Manitoba	16 (36)	1.8	16 (36)	1.7
Ontario	15 (49)	1.7	10 (49)	3.0

Source: Derived from: **Wright,R.W.** The Alberta Economy: An Input-Output Analysis; Manitoba Economic Consultative Board; Manitoba Input-Output Table; **Frank,R.H., Batik,S.M. and Haronitis,D.** The Input-Output Structure of the Ontario Economy prominence of Alberta, particularly from 1975 on, along with a modest increase in British Columbia's proportion (see Fig.2-3, p.69). In the case of primary activity (see Fig.2-4, p.69), Alberta, according to Gertler (1988), rises head-and-shoulders above all other provinces from 1960 on, and of course, its share of secondary and tertiary fixed capital also exhibits definite upswings (see Fig.2-5 & 2-6, p.70). It should be said that the exploitation of crude oil and natural gas on a large scale since the 1960s has played a leading role in this aspect of Alberta's evolution. Ontario's primary share has dropped further and further behind that of Alberta since the 1960s, but its secondary and tertiary shares hover consistently in the high range of percentages.

Nickel (1978) tries to establish that a relatively small mining industry has significant effects on the provincial economy through its indirect effects (backward or forward linkages to other industries sectors). He analyses three selected province input-output tables and attempts to show that the linkages vary in importance between provinces. In other words, he argues that mining purchases and sales of intermediate goods, as compared to those of all other mining industry, is not well linked to the rest of the provincial economies as might be expected. For example, mining in Manitoba, in Nickel's analysis, accounted for only 1.7 per cent of total provincial sales of intermediate inputs in 1973, although the mining industry was much more significant in a direct sense to Manitoba's economy at that time (holding a share amounting to 5.2 percent of the GDP of Manitoba). Similarly, its performance as a purchaser of intermediate inputs within the province, while somewhat better than Alberta, offered only a slight improvement over that of Ontario (Table 2-

13, p.53). Obviously backward linkages of the mining industry at the provincial level are not easily developed because of the relatively small size of industrial production systems and the less diversified industrial structure applying at provincial level. Conversely, the case of forward linkages of mining industry at the provincial level seems to be different. We find that the impact of the forward linkages between provinces is greater than of the backward linkages. The development of forward linkages in the 'core areas' of Canada (Ontario, and Quebec) appears to be much better than that occurring in the 'peripheral area' (see Table 2-14, p.55).

It is interesting to note that mining activity stimulates growth of national centre-periphery structure in economic disequilibrium on the one

Table 2-14 The Forward Linkages of Mining Industry in Canada, by Selected Provinces, 1984

	Gross Domestic Product			Employment		
	Mining industry ($ million)	Forward industry ($ million)	Multiplier	Mining industry (person)	Forward industry (person)	Multiplier
Quebec	779.0	2,225.5	3.9	16,428	30,060	2.8
Ontario	2,211.0	10,397.6	5.7	26,352	98,558	4.7
Manitoba	424.1	172.3	1.4	4,180	3,350	1.8
Saskatchewan	2,437.6	44.8	1.0	7,357	1,011	1.1
Alberta	16,55.4	1,534.0	1.1	34,118	10,600	1.3
British Columbia	1,701.2	1,576.0	1.9	13,206	12,237	1.9

Source: Canada Mineral Yearbook 1988; Canada Yearbook 1988; General Review of the Mineral Industries (26-201); Statistics Canada, 1988.

Table 2-15 Average Household Income: Regional Level by Selected Year

	NFLD.	N.S.	N.B.	QUE.	ONT.	MAN.	SASK.	ALTA.	B.C.	Canada
1951 ($)	1,625	1,753	2,148	2,171	2,303	2,088	2,103	2,146	2,283	2,213
weight (%)	73.4	79.2	97.1	98.1	104.1	94.4	95.0	97.0	103.2	100.0
1986 ($)	28,068	31,505	30,057	32,870	39,519	32,381	31,728	37,273	35,254	35,673
weight (%)	78.7	88.3	84.3	92.1	110.8	90.8	88.9	104.5	98.8	100.0

Source: Canada Yearbooks 1954,1988.

Table 2-16 Percentage of Urban Population, by Province, Selected Year

	NFLD.	N.S.	N.B.	QUE.	ONT.	MAN.	SASK.	ALTA.	B.C.	Canada
1956 (%)	43	55	43	67	73	56	30	48	69	62
1986 (%)	59	54	50	78	82	62	61	79	79	76

Source: Statistics Canada, Census of Canada, 1986.

hand, and it also fosters development of decentralized tendencies in urbanization on the other hand. Comparing the average household income of 1951 with that of 1986 (see Table 2-15, p.55), we note that the situation of income disequilibrium still tends to be serious, although it has changed a little for the better. In comparison, the local urbanization level has converged quite perceptibly (see Table 2-16, p.56), and a more significant tendency in urbanization is the change in the Canadian central place hierarchy (see Table 2-17, p.57), especially the increasing urban population of Edmonton, the provincial capital of Alberta. Edmonton witnessed the highest rate of population growth, to reach 785,000 in 1986; an increase of 3.6 times the figure of 1956, and its rank, in the national urban system, was up to 5 in 1986 from 9 in 1956. Of course, such a change does not mean that the economic development in Alberta, a major mineral-production province of Canada, has surpassed that of the core areas overall. Conversely, the characteristics of Alberta's economy, for example, a less diversified industrial structure, a small multiplier emanating from mining's linkages and a quite simple structure of local urban hierarchy (see Fig. 2-5, p.67), continues to indicate that there is still a strong stamp of peripheral economy on its development.

INCOME AND EMPLOYMENT EFFECTS——A Remaining Problem

It should be said that no single indicator can be used to suggest the importance of mining at national and regional levels. The perspective--´national´ or ´provincial´--with the former weighing the significance of a province´s mining industry in the light of its contribution to mining nationally and the latter regarding the impact of mining relative to other sectors of the provincial economy, may be a determining factor. Furthermore, the nature of linkage to other sectors may qualify the initial impression given by indicators of mining´s effect. An additional factor which must be considered is the variation in indirect effects to nation and provinces. This is discussed in the two following sections.

Income effects. When we ask what impact a given industry has on the economy, the indicator generally considered most important is the effect discernable on national and provincial income. Income can be defined as the payment made to productive factors. These payments include salaries, wages, net income of unincorporated businesses, and surpluses. A commonly-used measure for total income which includes these elements is gross domestic product (GDP) at factor cost. Nickel (1978) argues that the method of calculating mining´s impact on income varies considerably even though there is general consensus on the appropriate definition of income. As we shall see,

Table 2-17 Population in Ten Census Metropolitan Areas by Selected Year

		Toronto	Montreal	Vancouver	Ottawa-Hull	Edmonton	Calgary	Winnipeg	Quebec	Hamilton	Saskatoon
1956	population (000's)	1,572	1,830	694	368	171	201	413	328	342	73
	Rank	2	1	3	5	9	8	4	7	6	20
1986	population (000's)	3,427	2,921	1,381	819	786	671	625	603	557	201
	Rank	1	2	3	4	5	6	7	8	9	17

Source: Statistics Canada, Census of Canada 1986.

Table 2-18 Summary of National Income Multipliers, by Industries

Investigator	Mining Industries Industry Mutiplier		Other Industries industry Multiplier	
Type A multiplier: Dollar of GDP generated per dollar of industry output				
Stahl & McCulla	Crude minerals:		Semi-fabricated	
	range	1.45-1.52	minerals: range	1.38-1.58
			Oil & natural gas	1.25
			Other industrial: range	1.50-1.73
			Average	1.66
Mckinley	Mining & petroleum	1.45	Other industries: range	1.26-1.56
Bennett	Mineral products	1.41	Oil & gas PRODs.	1.27
			Other Industries: ramge	1.31-1.44
- **Type B multiplier: Dollar of GDP generated per dollar of Value in an industry**				
Bucovetsky	Non-fuel	1.50	Crude petroleum &	
			natural gas	2.50
			Forestry	3.00
			Manufacturing: range	2.96-8.46
			Average	2.80
McCulla	Mining range:		Fabricated minerals	
	Metal o/c	1.93	Range:	2.96-8.46
	Iron o/c	3.28	Average	5.26
			Non-mineral industries	
			Range:	2.79-4.41
			Average	3.67

Source: **McCulla,D.J.** and **Stahl,J.F.** Quantitative Impact of Minerals on Canadian Economic Development: A Partial Analysis, 1977; **Mckinley,D.** Employment and Income Effects, 1973; **Bennett,W.D.** Science Expenditures, 1973; **Bucovetsky,M.W.** Role of the Resource Industries, 1973; **McCulla,D.J.** Input-Output Impact and Multiplier Analysis, 1974.

Notes; Averages reported in this table are unweighted.
o/c = ores and concentrates.

the choice of methodology may have some differential effects on the apparent relative significance of mining to the economy.

i. Income multipliers: national level. In common understanding, a concept of the multiplier relates the change in the GDP generated by an expenditure to the initial increase in demand for the output of a given industry. An important part of this approach is synthesized by McCulla and Stahl (1976), and Nickel (1978) refers to it as a type A multiplier (see Table 2-18, p.58). Using the 1966 input-output tables, the former pair analyzed income impacts with a model which is closed to households, and which allows for indirect import leakages (i.e. the import of the import of intermediate inputs). The model is used to compare impacts at different stages in the mining industry's development, from extraction to manufacturing, and also to provide comparisons with other commodity groups. For the extractive phase of mining, a rather narrow range of multipliers was found, from 1.45 for ores and concentrates to 1.52 for non-metallic minerals. Similarly, at the semi-fabricated level, multipliers do not vary widely, from 1.38 for zinc and alloys to 1.58 for asbestos. By comparison, the multipliers for non-mineral groups are slightly higher, with the exception of oil and natural gas at 1.25. These other groups range from 1.58 (for food products and tobacco) to 1.73 (for printing and publishing), with an unweighted average of 1.66. In sum, while the multipliers for mining are somewhat lower, the differential is not substantial.

McCulla uses another multiplier concept, the type B, to analyze the impact of the mining industry. It purports to relate the increase in total GDP to an increase in income or value-added within a particular industry group. Its application necessarily yields a large value since the denominator of this type of multiplier is only that portion of the initial expenditure which constitutes payments itself, although this construct uses the same numerator as the type A multiplier. Within the mining sector, therefore, the iron ores and concentrates group has a relatively high type B multiplier (3.28), but has the least impact of all mineral groups under type A analysis (1.52).

ii. Income multiplier: Provincial Studies. One measure of the mining's impact by provinces can be drawn from the interprovincial input-output model developed by the now-defunct federal Department of Regional Economic Expansion

(DREE). The DREE model traces various income impacts for 34 sectors in each of the provinces. This study produces a set of multipliers where each reflect the change in total provincial income to an initial increase in the output of an industry located within the province. Some of these multipliers, which we also refer to as type A, are given in Table 2-19 (p.60) for selected industries. It can be seen therein that the industries in the primary sector--mining and

Table 2-19 Provincial Income Multipliers for Selected Industries: Type A (Dollars of Provincial Income Per Dollar of Industry Output)

Province	Mining(a)	Agriculture	Textile	Metal Fabricating	Machinery
Newfoundland	1.00	1.12	0.75	0.76	0.92
Prince Edward Island	1.11	0.99	0.32	0.60	0.71
Nova Scotia	1.09	1.03	0.74	0.81	1.10
New Brunswick	1.06	1.01	0.72	0.85	1.07
Quebec	1.20	1.29	0.97	1.03	1.01
Ontario	1.29	1.41	1.02	1.21	1.16
Manitoba	1.17	1.23	0.58	0.86	0.74
Saskatchewan	1.02	1.36	0.72	0.68	0.84
Alberta	1.14	1.33	0.78	0.84	0.87
British Columbia	1.14	1.29	0.83	0.98	0.93

Source: Department of Regional Economic Expansion, Canada: An Interprovincial Input-output Model. Version 1976
(a): Excluding coal.

Table 2-20 Provincial Income Multipliers for Selected Industries: Type B (Dollars of Provincial Income Per Dollar of Value Added Within an Industry)

Province	Mining(a)	Agriculture	Textile	Metal Fabricating	Machinery
Newfoundland	2.00	1.63	1.68	1.95	1.75
Prince Edward Island	1.53	1.98	1.99	2.31	1.75
Nova Scotia	1.59	2.01	1.68	2.02	1.93
New Brunswick	1.43	2.14	1.71	1.76	1.90
Quebec	1.83	2.65	2.59	2.29	2.39
Ontario	1.86	2.62	2.85	2.78	2.57
Manitoba	1.48	1.89	2.52	2.00	2.21
Saskachewan	1.42	1.76	1.96	1.79	1.87
Alberta	1.85	1.92	2.08	2.00	2.05
British Columbia	1.58	2.25	2.14	2.14	2.26

Source: **NIckel,P.E., Gillies,I.R., Henley,T.J.** and **Saunders,J.D.** Economic Impacts and Linkages of the Candian Mining Industry. pp.69 (1978).

agriculture--substantially outperform industries in the manufacturing sector; only in Quebec and Ontario do the manufacturing industries come close to generating impacts equivalent to mining. Nickel and Gillies (1978) develop an alternative measure of impact which can also be derived from the DREE model; that is to say, a multiplier relating total provincial income generated by a given change in output to the payments to primary factors required for that change in output (type B, see Table 2-20, p.60). These multipliers are necessarily higher than those yielded by type A analysis because of a smaller denominator. The change in the performance of different sectors between Table 2-19 and Table 2-20 is a good evident; using type B analysis, mining now performs relatively poorly compared with other sectors in all provinces except Newfoundland. The improved relative position of the Newfoundland mining industry might be expected in that iron ore (which is the mainstay of Newfoundland mining) performs relatively better with the equivalent of a type B than a type A multiplier, while mining generally does not perform as well. The results of both analyses are consistent with an important fact about the nature of provincial industrial structures. The relatively well-integrated economies of Ontario and Quebec would be expected to have higher multipliers on account of the existence there of more goods-producing industries and a concomitantly lesser reliance on imports (i.e. fewer ˊleakagesˊ).

Comparing the results of the various income multiplier analyses (type A and type B) at both national and provincial levels, we find a different importance attached to mining, depending upon the multiplier chosen. Type A multiplier address the policy question: if demand for minerals were increased by $1 million, how would this affect the total of incomes generated in the economy? By comparison, with type B analyses, we ask what would be the total income impact if the primary factors engaged in mining earned an additional $1 million? From the economic growth point of view, using type A and type B analyses has undoubtedly different influences on evaluating either the mining industry or the whole system. This is also true not only of specific industry multipliers but also of more general multipliers designed for analyzing the effectiveness of regional development policy. Unfortunately, when we discuss the impact of the mining industry on employment, similar problems of discriminating among meanings surface.

Employment Effects. The effectiveness of mining in generating employment, both in absolute terms and relative to other industries, is a focus of debate. Mining is often said to be a capital-intensive industry, and it has a high level of capital expenditure relative both to its output and its direct employment. The use of labour intensity as a measure of employment effects may, of course, be misleading; application of other indicators embracing indirect and induced effects to measure the more significant impact on employment may also be confusing sometimes.

i. Employment effects: national studies. Bucovetsky (1973) measured the employment impacts of a number of resource and manufacturing industries. The results indicated a relatively low employment ratio (calculated as total jobs divided by direct jobs) of two for mining. By comparison, the ratio for manufacturing appeared to exhibit slightly stronger employment impacts than mining; for example, 3.08 for clothing (although the difference is not substantial). McCulla and Stahl (1977) calculated impacts that include the employment effects induced by consumer spending. Employment ratios at the extractive stage were again somewhat low; from 2.46 for both metallic and non-metallic minerals to 3.28 for iron. At the primary metal and semi-fabricating stage, the rates were generally higher; between 1.96 (for aluminium and alloys) and 7.93 (for iron and other steel mill products). The ratios declined slightly at the metal fabricating stage, registering between 2.49 (for aircraft and equipment) and 5.87 (for passenger automobiles and chassis). Mining tends to generate somewhat lower employment ratios than other sectors, especially when compared with further stages in the mineral system. On the whole, though, the difference between mining and manufacturing is not as great as might be expected.

An alternative approach is to calculate the total employment generated by a given increase in demand for a commodity. McCulla has done this for a number of commodity groups, assuming an increase in demand to vary substantially among minerals, from 25.6 man-years for iron ores and concentrates to 156.7 man-years for gold and platinum. The impacts for fabricated forms are generally larger, although the range is not as great; from 50.4 man-years for nickel products to 112.3 man-years for tin and all fabricated materials. The results of Mckinley's study, using very broad definitions of industry groups, differ somewhat from those we have reviewed above. Of the five industry groups analyzed, mining and petroleum yields the lowest impact, in terms of both total employment generated and the employment ratio. In response to $1 million of increased exports, mining and petroleum generate 94 man-years of employment with an employment ratio of 2.8. By comparison, fabricated products generates 130 man-years of employment with a ratio of 4.3. An analysis of the impact of investment on employment has been conducted by McCulla and Stahl for two sectors; namely, mines, quarries and oil wells on the one hand and manufacturing on the other. The results conform to what might be expected: in the construction phase, for equivalent investments amounting to $20 million, 3,600 man-years of employment are generated by mining, compared to 1,800 man-years by manufacturing. When the employment generated over the productive life of the mine or plant is included, the results are reversed (see Table 2-21, p.64). Table 2-21 presents a summary of employment impacts. Because of varying methodologies and assumptions, one must be guarded in attempting comparisons between studies. Nevertheless, it is possible to make a few general observations.

ii. Employment ratios: Regional studies. The DREE interprovincial input-output model has been linked to employment-output coefficients to yield

Table 2-21 Summary of National Employment Impacts, by Industry

investigator	Mining Industries: Industry	Mining Industries: Measure of impact	Other Industries: Industry	Other Industries: Measure of impact
Employment Ratios: total jobs created in the economy per job in the industry				
Bucovetsky	Non-fuel	2.00	Forestry	2.44
	Coal	2.44	Manufacturing:	1.77-3.08
	Oil & gas	10.88	Average	2.32
Stahl & McCulla	Metals	2.64	Primary metals & semi-fabricating:	1.96-7.93
			Average	3.78
			Other industries:	2.32-5.64
			Average	3.89
Employment per unit output: man-years of employment per $1 million of product demand				
McCulla	Mining range:	25.60-156.70	Fabricated mineral:	50.40-112.30
	Average	77.60	Average	93.60
			Nonmineral industries Average	76.10
Mckinley	Mining & petroleum	94.00	Fabricated products	130.00
			Motor vehicles	102.00
Employment per unit investment: man-years of employment per $ 20 million of investment				
Stahl & McCulla	Mine, quarries & oil wells:		Manufacturing:	
	Constructin phase	3,600	Construction phase	1,800
	Operating phase	18,000	Operating phase	69,000

Source: see Table 2-18
Note: Averages reported in this table are unweighted.

Table 2-22 Provincial Employment Ratios for Selected Industries (Total provincial Jobs Created Per Provincial Job in an Industry)

Province	Mining(a)	Agriculture	Textiles	Metal fabricating	Machinery
Newfoundland	3.35	1.39	1.41	1.86	1.64
Prince Edward Island	1.34	1.49	1.65	1.74	1.55
Nova Scotia	2.47	1.44	1.80	1.84	1.54
New Brunswick	2.25	1.48	1.44	1.76	1.63
Quebec	2.57	1.71	2.21	2.11	2.21
Ontario	2.41	1.98	2.45	2.61	2.68
Manitoba	1.93	1.76	1.81	1.81	1.94
Saskatchewan	2.30	1.92	1.49	1.63	1.61
Alberta	2.20	1.72	1.80	1.87	1.81
British Columbia	2.24	1.54	1.65	2.04	2.13

Source: see Table 2-19. (a) = excluding coal.

Table 2-23 Provincial Employment Impact of Selected Industries Per Unit of Industrial Output (Man-years of Employment Induced by $1 Million Increase in Industry Output)

Province	Mining(a)	Agriculture	Textiles	Metal Fabricating	Machinery
Newfoundland	38.09	93.11	65.19	47.20	59.52
Prince Edward Island	97.43	104.33	26.91	54.58	58.04
Nova Scotia	40.22	109.18	40.55	50.61	87.66
New Brunswick	32.12	103.36	57.92	50.70	74.73
Quebec	45.66	111.11	61.31	58.15	57.81
Ontario	50.42	91.35	59.37	62.45	57.27
Manitoba	39.63	67.01	43.02	48.92	44.64
Saskatchewan	25.32	54.76	50.55	37.37	51.68
Alberta	41.18	64.59	39.58	40.72	45.16
British Columbia	33.12	95.18	53.05	45.21	44.29

Source: see Table 2-20. (a) = excluding coal.

employment impacts by industry and province. Provincial employment ratios for mining and other selected industries are given in Table 2-22 (p.65). With a few exceptions--Newfoundland which seems high, and Manitoba and Prince Edward Island which seem somewhat low--the ratios do not vary widely among provinces. It is interesting to note that the provincial employment ratios for mining tend to be higher than for most other industries; this is in contrast to the relatively lower ratios found for mining at the national level.

The man-years of employment associated with a million-dollar increase in output is calculated for a number of industries by Nickel (1978). The impression yielded by the results (see Table 2-23, p.66) varies considerably from that in Table 2-21. Mining generally performs rather poorly using this measure of impact. Moreover, the importance of mining by province varies, depending upon the indicator chosen. Thus, while Newfoundland has by far the highest employment ratio, it ranks relatively low in terms of jobs created by an increase in output; similarly Prince Edward Island with the lowest employment ratio for mining generates by far the greatest number of jobs per unit increase in output.

Once again the national and provincial impacts of the mining industry can be described in terms of a small number of indicators such as income and employment. Estimates of direct impacts for these indicators are easily obtained. However, the true impacts of an industry can be captured only by looking beyond the direct impacts to effects generated in backward-linked activities and to effects induced by round by round of consumer spending (indirect effects and induced effects of an industry respectively). It is at this point that most difficulties arise. Because of different research methods and underlying assumptions, studies analyzing the economic impact of mining are often difficult to compare and this remains still an unsolved problem.

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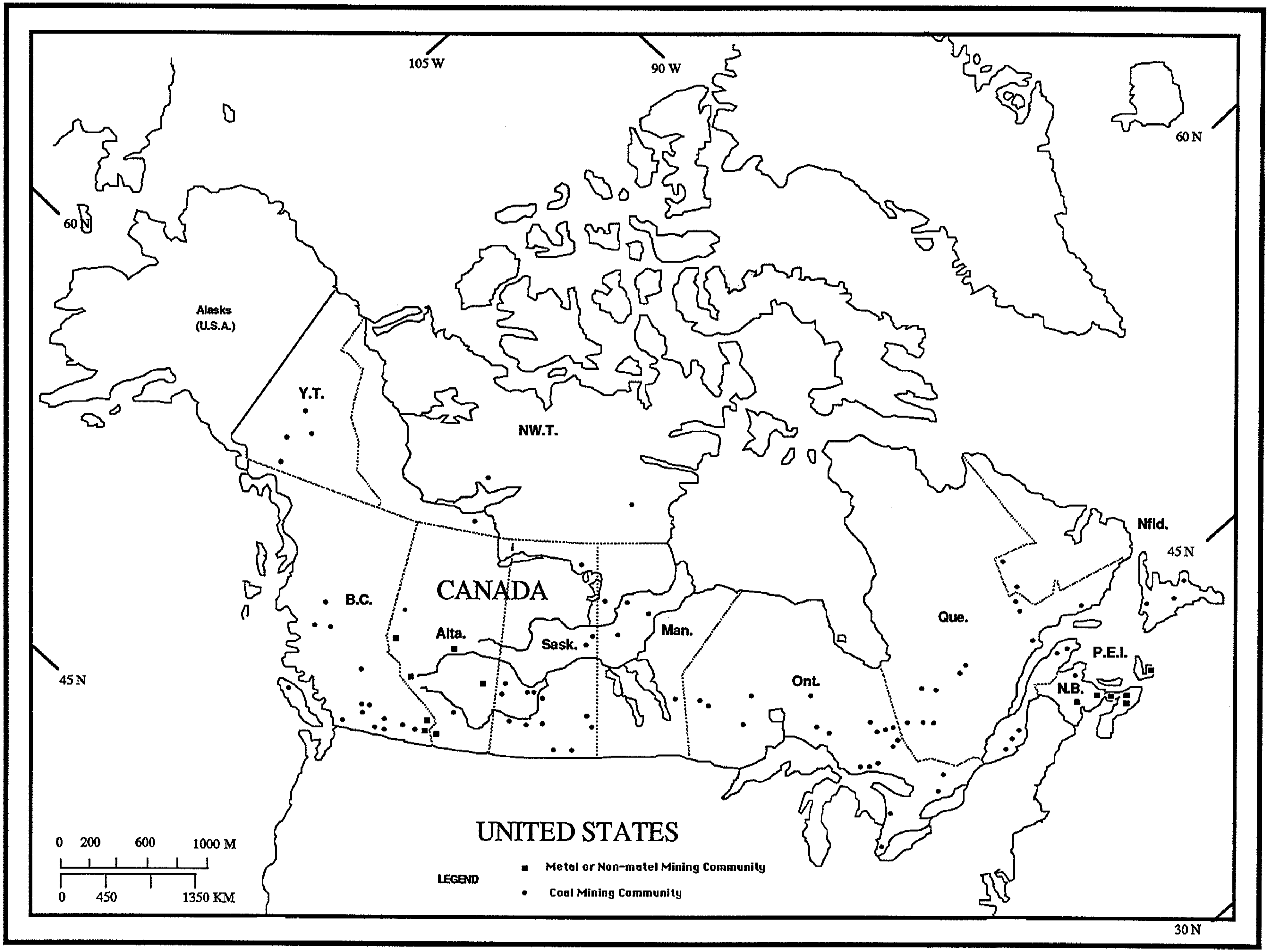

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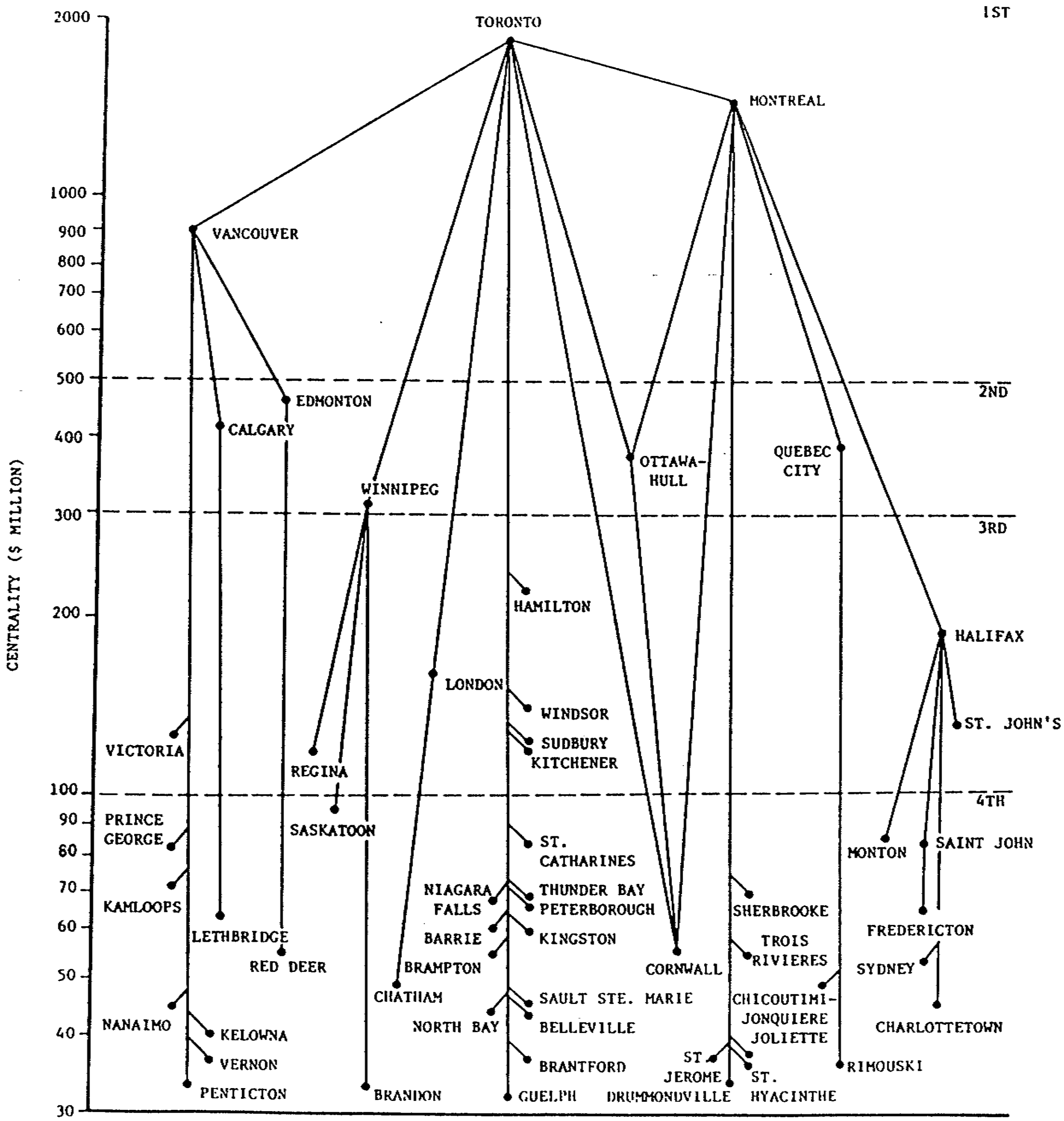

Fig. 2-2 Canada: National Cental Place Hierarchy

Souece: **Preston,R.E.** (1984) "The Canadian Central Place System" **Helleiner,F.M.** (ed.) <u>Cultural Dimensions of Canada's Geography</u>, *University of Waterloo*

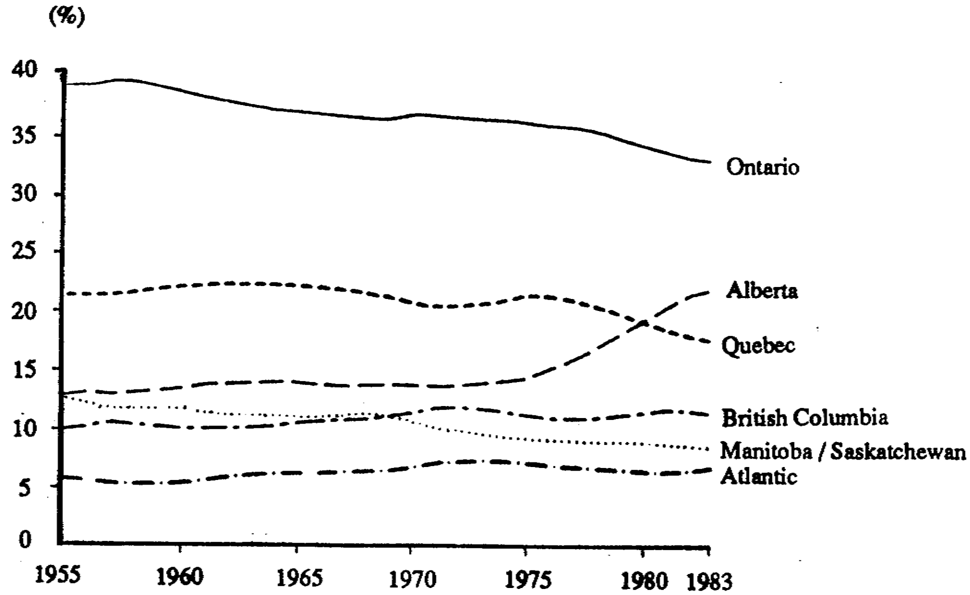

Fig. 2-3 Regional Share of National Capital Stock: total private

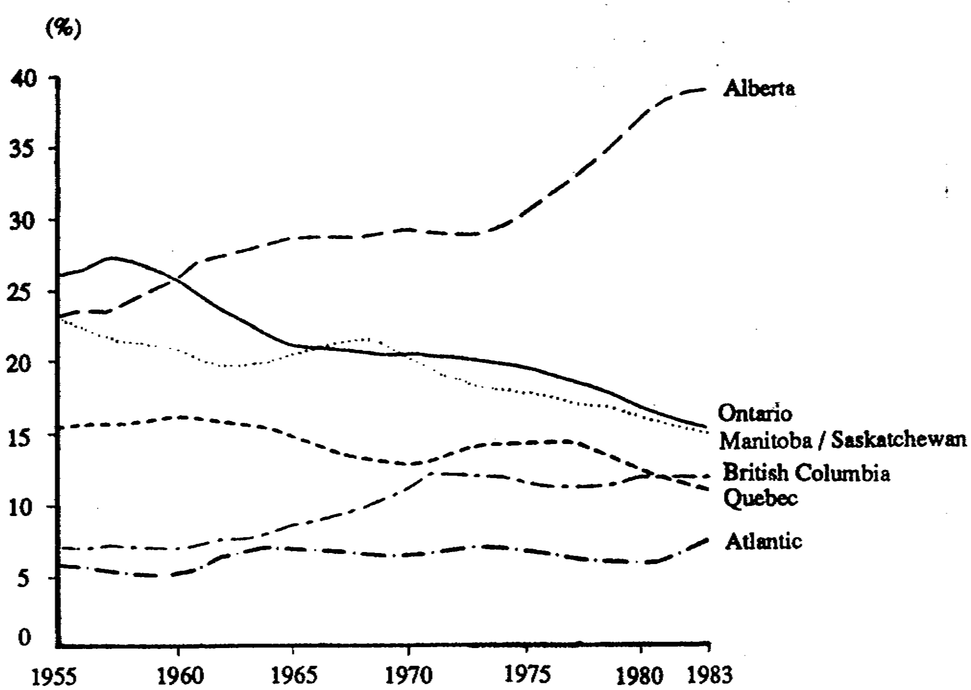

Fig. 2-4 Regional Share of National Capital Stock: primary

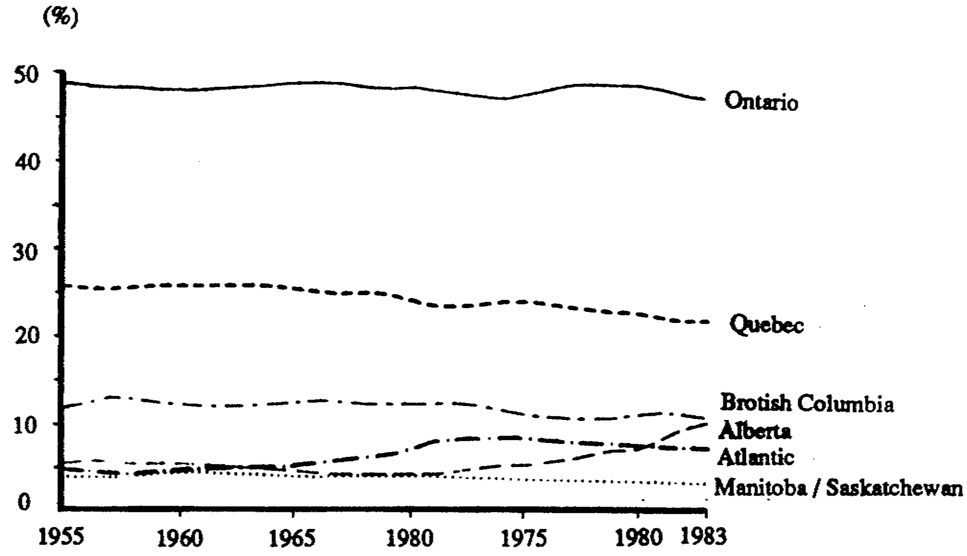

Fig. 2-5 Regional Share of National Capital Stock: secondary

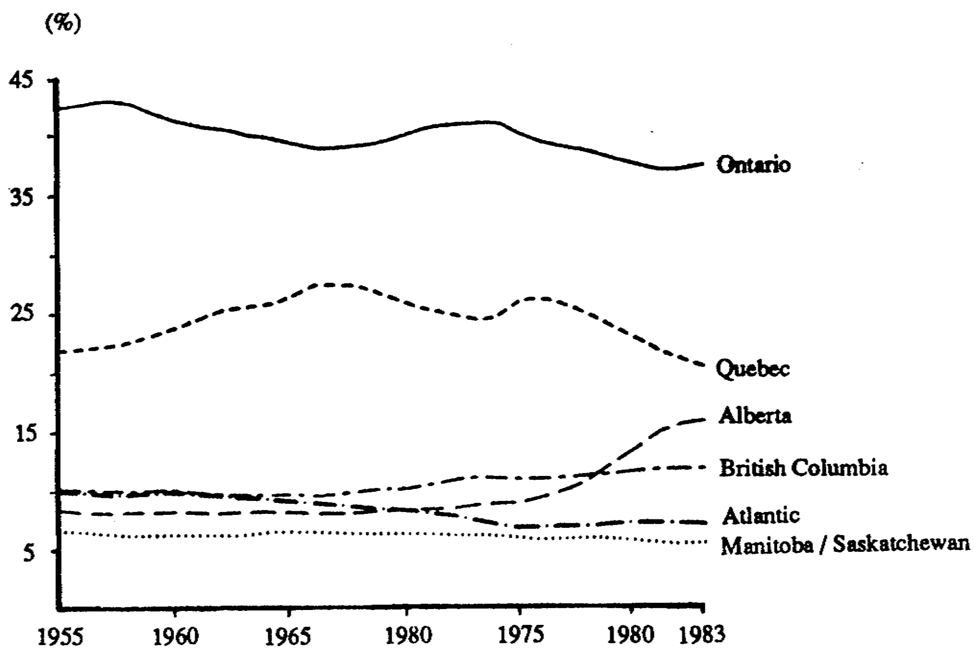

Fig. 2-6 Regional Share of National Capital Stock: tertiary

Sources (Fig. 2-3, 4, 5 and 6): **Gertler, W.S.** "Regional Dynamics of Manufacturing and Non-manufacturing Investment in Canada" Regional Studies Vol.20, No. 6, pp. 528-531.

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Chapter III: Export-Base Theory As A Conceptual Underpinning

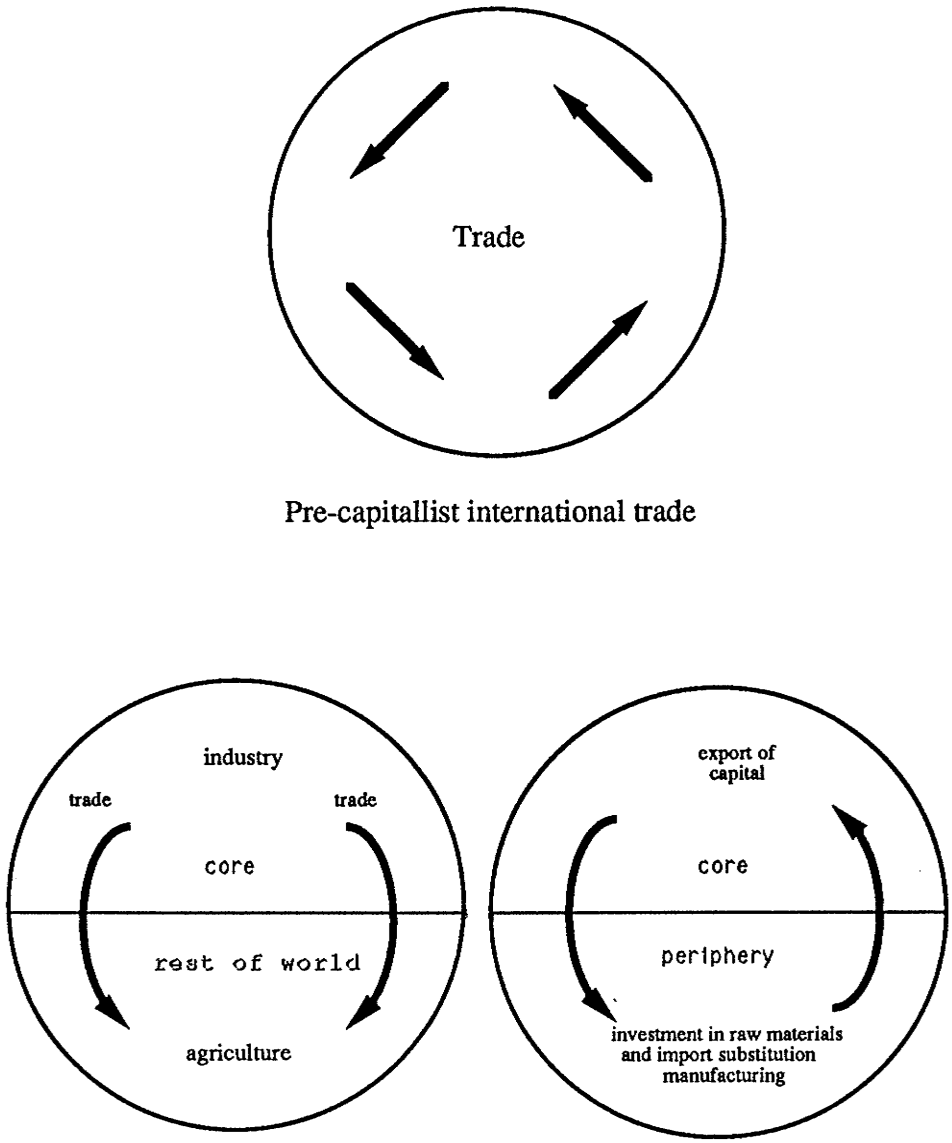
INTRODUCTION

While interest in the theoretical aspects of the location of economic activity dates back approximately one hundred and seventy years to the work of Johann Heinrich von Thünen, attempts to construct a theory that would explain the process of regional development are of much more recent origin. In part, the process was delayed owing to confusion about the roots of the concept; that is, development and/or growth has been taken to mean: (1) a rise in regional per capita income, (2) an expansion in the volume of regional output, or (3) both of these. In the 1950s and 1960s the question of quantitative and qualitative change through time received increasing attention at all levels, although attention was largely riveted on fairly simplistic notions of growth. Nevertheless, those interested in regional development have had at least three sources from which to draw inspiration. One was the well-developed body of location theory; another derived from international trade theory; while yet another owed its inspiration to the empirical studies and observations of structural change facilitated and partially caused by technological progress. As a result, two distinct theoretical frameworks have emerged. The first, largely attributed to the work of Edgar M. Hoover and frequently referred to as the ˊstagesˊ theory, is an extension of location theory combined with generalization derived from observed structural changes following the introduction of improved technology. The alternative approach, known as the ˊexport baseˊ theory, is the result of work initiated by Douglass C. North and is also an extension of location theory combined with aspects of international trade theory that are useful for regional analysis. Stages theory, while germane to structural change, really focuses on manufacturing systems and, therefore, is not directly relevant to the scope of this thesis. The second, by way of contrast, is pivotal to my work, and will be amplified in the pages that follow.

Export-base theory speaks in terms of a region's comparative advantage which leads to the sale of goods that, in turn, directly or indirectly provide resources to the commodity-exporting region. The inflow of resources, for its part, makes possible further development to the end that multiple gains are attributable ultimately to the original export (North, 1955). This export base theory has origins in the trade theories of Ricardo and Mill, and the location theories of Hoyt. The stock of resources, both natural to the region as well as those obtained by it from trade, serves as a base for its economic growth. The purpose of this chapter is to analyse the theoretical significance of the export base and evaluate the development policies which relate to it. It turns on the process of exports and regional economic growth, stresses the return to the classics in regional economic development theory, and highlights some problems which are thrown up in consequence.

A TEMPORAL PROCESS: Exports and Regional Economic Development

Mindful of contemporary experience, Marshall (1920) declared that 'the causes which determine the economic progress of nations belong to the study of international trade'. During the formative years 1460-1600 (Wallarstein, 1974), the growth of world trade first produced a spatially undifferentiated pattern (Fig.3-1, p.74) but, beginning with the emergence of Dutch 'hegemony' in the 17th century (Wallarstein, 1980) and more strongly following the 'Industrial Revolution', a new international trade pattern



Pre-capitallist international trade

Internationalalization of trade

Internationalization of capital

Fig. 3-1 The Changing World Trade Space

appeared. Contemporary with this period of internationlization of commodity trade (Palloix, 1977), the industrialising regions of Europe specialized in manufacturing while the colonies and other parts of the world specialized in agricultural production which was destined for markets in the industrializing regions. In the 19th century, the pattern of ´growth through trade ´affected particularly the new countries or the ´regions of recent settlement´ in the world´s temperate latitudes: Canada, Argentina, Uruguay, South Africa, Australia and New Zealand. No doubt the United States, too, belongs substantially to this group. These regions had certain essential characteristics in common, but in the present context what matters is their high, though varying, dependence on growth through primary commodity exports and on the private foreign investment which, derictly or indirectly, was thereby induced.

The historical process of international trade began entering a new phase in the 20th century and particularly since the mid-1960s (Forbes, 1981). The world economy has expanded greatly. Production processes are more and more internationalized (Grunwald & Flamm, 1985) and all kinds of international economic flows have increased in volume and importance. Virtually every national economy in the world is to some extent integrated in the international economy, and is thus affected in one way or another by decisions, processes and developments outside its borders. In this interconnected or even interdependent world, international economic co-operation is, by definition, of vital importance in regional development. It rests, in fact, on one type of international economic co-operation; namely, international trade. Although the economic relevance of other types of co-operation, such as labour migration and tourism, has increased, trade still is the single most important form of international economic co-operation. It represents a major portion of the monetary flows in circulation and it has immense direct impact on the local economies (level of employment, income etc.) involved. Most national economies have become increasingly open over the past few decades. Between 1965 and 1975, for example, the trade/GNP ratio of 96 out of the total of 116 countries increased, rising from an average of 48.1 in 1965 to 55.4 in 1975 (Taylar & Jodice, 1983). Of note, economic policies entailing appropriate investment incentives for exports appeared to take on a central importance in the economic growth occurring in developing countries, while some other countries which neglected their export sectors through discriminatory economic policies had to settle for lower rates of economic growth as a result (Tyler, 1981). During the last century, and especially since the last world war, the density of the network of international trade relations has increased. As a result of the fast development of communications and transport technologies, more and more of the potential trade links were actually made effective (Nierop & De Vos, 1988).

More recently, academic attention has focused on the role of the very large global corporations as agents of industrial location change at the international scale (Taylor & Thrift, 1982b; Peet, 1983). The rapidity of such changes has prompted reference to the hypermobility of capital as corporations seeking to maximize returns engage 'in a continual process of locational reselection and rationalization' (Taylor & Thrift, 1983). The major consideration in this process seems to have been the cost and control of labour, and most explanations of the redistribution of many basic manufacturing industries towards the Newly-Industrializing Countries have exflicitly linked the organizational capabilities of the global corporation to the product-cycle hypothesis in accounting for the emergence of a 'new international division of labour' (Hymer, 1972; Frobel, Heinrichs, and Dreye, 1980). Because of the widely acknowledged significance of the labour factor, the influence of spatial variations in the cost and availability of raw materials upon the location of industry is generally considered to have declined in importance as a consequence of changes in the structure of manufacturing and in the economics of transportation (Estall & Buchanan, 1980; Smith, 1981). However, this conclusion is usually based on the results of analyses couched at meso- or national scales (Hoare, 1983) and is not necessarly appropriate at the international level (Chapman, 1985). The desire to gain access to key resources has frequently been identified in studies of corporate growth as a motivation factor in the transition from national to multinational operations (Mckern, 1976; Taylor and Thrift, 1982a). Sharp increases in the cost of oil since 1973 have adversely affected industries such as iron and steel, chemicals, and glass, in which energy costs typically account for more than 10 per cent of total production cost. In these circumstances, it is not surprising to find that energy and resource costs have become a more important consideration in the international investment strategies of such corporations as British chemicals giant, ICI, (Clarke, 1982) and that one consequence of such strategies has been the weakening of the position of many oil-importing countries relative to others with a comparative cost advantage for energy-intensive manufacturing. Political considerations have reinforced these trends as the establishment of more effective cartels of raw-material producers and increased competition between the developed countries for access to key resources have made it less easy for global corporations to resist pressure to undertake value-added processing operations within the territory of the resource-owner. Recent Japanese investment in Indonesia, for example, has been interpreted as an attempt to secure control of oil and gas (Forbes, 1982), and several oil-rich states in the Middle East are attempting to institute co-operation in major industrial development programmes (El Mallakh and El Mallakh, 1982; Turner and McMullen, 1983).

RETURN TO THE CLASSICS IN REGIONAL ECONOMIC DEVELOPMENT THEORY

The theory of the export base (or economic base) has often been presented in the literature as an alternative to the deterministic development stages theory in accounting for regional economic growth, and, as its name implies, stresses the importance of export industries in the region's economies that grow up within a framework of capitalist institutions (international devision of labour) and can therefore respond to profit maximizing opportunities, in which factors of production can be relatively mobile (North, 1955).

According to the export-base theory, provided there is an increase in demand, an increase in exports of surplus resources in a region can give rise to input requirements by exporting industry for factor services and intermediate products. In turn, this leads to income payments by the exporting industry and 'residentiary industries' supplying intermediate products and services for export production. The additional income received by local households is a catalyst for further growth, resulting in consumption expenditures on domestic goods and imports.

Export production can affect both the quantity and quality of the labour force. If the rate of labour immigration into a region depends on the rate of economic growth of a region, then regional development resulting from an expansion of exports can lead to a general immigration of labour (Borts and Stein, 1964). If the labour force is generally unskilled, the skilled labour is likely to be imported rather than trained from the domestic labour force. On the other hand, when the product of the export industry requires more advanced production techniques, export production can lead to the development of improved domestic labour skills. This may, in and of itself, give rise to external economies in industries requiring skilled labour and lead to domestic production in these industries (Baldwin,1963).

An increase in exports may result also in the adoption of more advanced managerial and production techniques in the region. Technological progress resulting from an increase in export production is likely to be channelled through the economic ties of the export industries within the region. The adoption of improved technological methods tends to depend on the amount of capital formation induced in linked industries and on the technological methods of the export industry in relation to the traditional methods of production in the region. The diffusion of more advanced technology in the region is likely to be influenced strongly by the education and technical training of the domestic labour force. If the export industry generates a more highly educated and skilled labour, then it may encourage technological change in the region either directly or indirectly.

An increase in investment expenditures in the region of export production represents the establishment or expansion of domestic production and service capabilities. New capital formation in the region can become profitable if revenue and cost expectations are affected favourably by the increase in exports, because, for example, of a potential expansion in the size of the market and the realization of economies of scale or economies of industrial production involving the availability of such items as a trained labour force, public utilities, transport systems, and dock facilities. Induced capital formation in the region can take place in the investment-goods industry and service, which usually functions in a backward, forward or final-demand linkage chain with the export product. The establishment of domestic production of linked products and services is likely to depend on the nature of their input requirements in relation to inputs available in the region and on the importance of economies of scale. Particularly in the case of forward linkages, new capital formation in the region is encouraged when the export product is a relatively important input in the production process, when the input requirements are similar to those of the export industry, when there is a large domestic demand for the forward product either for intermediate or final demand purposes, and when further processing of the export product results in a significant weight loss.

The regional economic growth resulting from such an induced expansion of resources may further encourage, and be reinforced by, both private and public expenditures for social overhead capital. Requirements for social overhead capital such as schools, hospitals, dams, drainage systems, highways, railways and airports result, in large part, from the expansion of both the labour force and investment. The development of social overhead capital may, in turn, encourage further investment, and possibly labour immigration, by making external economies available in a number of productive activities.

It is significant that the region's export base is not a fixed datum; that is to say, the base changes with time, as existing produced private and social goods help bring forth new goods that change the base to export capital, skills, and specialized services to less-well developed regions. In other words, as a region's income grows, indigenous savings will tend to spill over into new kinds of activities. As first these activities satisfy local demand, but ultimately some of them will become export industries. This movement is reinforced by the tendency for transfer costs to become less significant. As a result, the export bases of regions tend to become more diversified in tandem with their aggregate predilection to become more diversified, and they tend to lose their identity as regions. Ultimately, we may expect that along with long-run factor mobility will come more equalization of per capita income and a wider dispersion of production (North, 1955).

In the export base or economic-base theory, economic growth is viewed as a response to an autonomous and consistent increase in exports (Krumme, 1968). Economic activity in a region is divided into export activity and non-export activity. Changes in the level of economic activity are believed to be regulated by changes in the level of export activity. The level of economic activity is generally assumed to change as a constant multiple of changes in export activity. This relationship, known as the economic-base multiplier, represents an attempt to encompass in a given figure the endogenous behaviour of the household, government, and industry sectors in a region's economy. Such a model is calibrated empirically to estimate the effect of an increase in exports by determining the value of the multiplier and multiplying this figure by the change in export activity.

In the export or economic-base model, a constant multiplier is assumed to apply to any increase in exports, irrespective of the products involved in the increase or of the economic conditions of the region. The size of the multiplier associated with a particular increase in exports depends on the extent to which the increased production of exports is accompanied by increaes in the size and quality of resources and the application of more advanced technology in the region. Different export products are likely to have different effects on the region's endowments of resources and technology. Also, the size of the multiplier for an increase in exports is dependent on the availability of unemployed resources in the region, which in turn, is likely to influence the extent of export-induced changes in resources and technology. If resources are fully employed, an increase in export activity will have very little impact on the overall level of economic activity in the absence of an expanded endowment of resources or technological advances. A higher rate of employment, on the other hand, is likely to increase the tendency for additional resources to be attracted to the region. Thus, the effect of an increase in exports on economic growth may be lessened by a shortage of unemployed resources but increased by an expansion of resources under such economic conditions.

SOME PROBLEMS

Even as the export base or economic-base theory can provide us with insights into the process of regional economic growth, a number of difficulties crop up with respect to the explanation of export-induced growth, especially of the overall level of regional economic activity.

There is a tendency with the theory to assume a consistent increase in exports. In the export-base theory where the composition of exports can change, the rate of growth depends on the timing of new export production, which could introduce considerable instability in the theory (Caves,1965). The possibility that an increase in exports may lead to an unfavourable shift in the terms of trade or a potentially greater economic instability has not generally been considered in the context of the theory (Pfester, 1961; Sirkin,1959). Such influences might serve to lessen the development effects of given increases in exports. The exploitation of North Sea oil and gas may provide a significant lesson to the effect that the developed counties and regions have to turn to their domestic supply rather than to external sources of export instability in raw material prices. The more dependent the region is on its export industries, the more sensitive it tends to be to external economic conditions, particularly if the region´s export viability rests only on a few kinds of products. The higher the elasticity of demand for such exports, the greater the tendency to strenthen this sensitivity to external influences.

In an open regional economy which is commercially based, or in the process of becoming so, comparative cost advantage is a factor that may influence the division of labour, specialization, and even the location of industries. The more competitive the conditions intra--and interregionally, the greater tends to be its influence. Despite a plethora of rules of the General Agreement on Tariffs and Trade and their application, tariff barriers in the real world persist in distorting the effectiveness of comparative advantage. Perhaps that is a major reason for so many less developed countries and regions relying on the exports of a single product or a few products at the most (Kindleberger, 1965), although they desire to diversify their economies in order to lessen dependence on exports of primary products.

The use of more advanced technology and equipment can increase productivity in the region´s export industry, or improve its terms of trade in favour of its exports. In the meantime, such introductions of advanced technology and equipment tend to strengthen the dependency on other regions.

In fact, the research and development (R & D) of multinational corporations is mainly conducted in core areas of advanced-industrial countries. For example, only 6 per cent of this type of expendicture by US multinationals was spent outside the U.S.A. in 1966. What is more, the R & D activity which does occur outside core countries is "... concentrated on relatively minor technical activity and on techniques which are relatively mature" (Lall, 1979). Host countries have to pay for patents, licences, know-how and trademarks to acquire proprietary technology and to pay additional fees for management and services which these technologies involve (Taylor and Thrift,1981).

The export base theory suggests that internal structural change (an increase in the proportion of employment in manufacturing and services) and expansion of local markets automatically lead to self-reinforcing regional growth; in fact, that internal factors become important in determining regional growth rates. But many instances in the real world fail to substantiate this assertion, For example, in Chile, the development of nitrate and copper-mining enclaves in the northern region have impacted on the national economy through tax revenues from mining corporations. The considerable government revenues so derived resulted in heavy expenditure on public works with special emphasis on the capital city, Santiago, in central Chile. Here an urban upper class, grown wealthy in mining exports, banking and commerce, adopted a sumptuous life-style based on consumption of imported goods. Such a distorted pattern of hyper-urbanization retarded local economic development, diverting scarce resources from investment in highly productive activities, reducing the propensity to save and discouraging agricultural production. The development of resources at the periphery was a catalyst to excessive concentration at the centre (Friedmann, 1973).

SUMMARY

Economic growth studies rightly focus attention on various aspects such as the mechanism of economic growth, its nature, rates and direction. Variables, economic and non-economic, should be examined as to their association and/or causal connection to economic growth as a whole or to the specific area or topic in economic growth. However, a study of contemporary growth theories suggests that we do not know all we need to know about both economic and non-economic variables. But the realization of the significance of economic and non-economic variable as inhibitors and facilitators of economic growth can make us redouble our efforts in quest for better and fuller insights into the construction of more realistic and accurate theories and models of this phenomenon.

The characteristics of the export-base theory stressed whithin this chapter have been those which provide us with insights into the process of economic growth. It would seem from this brief review of the export base theory of regional economic growth that the concept is found wanting for any serious explanatory and predictive purpose. Fortunately, the export-base theory contains several strong points especially in reference to multiplier analyses. From the vantage points of practical studies, it offers ready-made techniques for assessing development spin-offs of mining (i.g. community export) activity; a topic to which we will now turn.

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CHAPTER IV: MODEL CALIBARATION

INTRODUCTION

The reasons for regional changes in economic development are often quite complex. In order to explain such changes authentically, the concepts of the economic base and the multiplier were developed from the 1940s (Richardson, 1985). Both of these have roots in economic theory; the economic-base concept is derived from the export-base model in national development (see Appendix I), and the multiplier is commonly associated with Keynesian economics.

The concept of the economic base theory can help us gain an understanding of why some regions or countries have been growing or declining faster than others. For example, Berry and Kasarda (1977) examined the relationship between the growth of population and the composition of the economic base in the United States. In this study, they found that lower population growth rates were experienced by those regions with an economic base highly dependent upon primary economic activities such as agriculture, and high population growth rates were realized by those regions with an economic base highly dependent on government services and defence procurement programmes.

As Isard (1974) points out, a major limitation of the basic-nonbasic concept is its emphasis on the aggregate effects of increases in regional economic activity. Moreover, although conceptually the notion relates to income changes, its practical application has largely been confined to changes in employment. Another disadvantage of the basic-nonbasic concept is that , with its emphasis on the sale of exports as a return from money flows into a region, the concept does not recognize other ways by which income may flow into a region or country--for example, through investment inflows and government spending. At the same time, money flows out of the region or country in the form, for instance, of wages paid to commuters, and, more importantly, the outflow of money connected with the purchase of imports of goods and services.

An alternative technique that incorporates the real world pattern of money flows is regional input-output analysis (Isard, 1974). The intellectual development of this technique occurred in the 1950s with the contributions of Isard (1951) on the ideal interregional model and the more empirically-oriented applications of Leontief (1953). A major advantage of this technique is that it explicity considers individual sectors in the regional economy, or measures the impact of expansion in a major industry on a region or country, and also elicits the impact of national economic trends and policies on its development.

Besides, though regional growth may be related to the components, or structure, of the economic base, it is also related to the extent to which the income derived from the basic sector is spent locally. The concept of the multiplier, which is a fundamental part of the mechanism of regional growth, is based on the circular flow of income in the regional economic system. In regional input-output analysis, it is assumed that, at a given period income and expenditure are balanced so that a state of equilibrium exists, and under this condition the multiplier becomes effective.

The aim of this chapter, quite simply, is to examine income, employment and output of mining industry in terms of their impacts on the Canadian economy. Analysis is also carried out to determine the magnitude of their multiplier effects. In order to accomplish these tasks, a number of subdivisions are introduced. Section 2 represents the design and construction of a modelling system of the input-output framework. Section 3 represents an application of the model for the purpose of assessing the mining industry. An analysis of economic impacts caused by the development of the mining industry is presented in Section 4. The Statistics Canada documents, the "Input-Output Structure of the Canadian Economy 1981" is the primary analytical tool employed in this chapter.

THE MODELLING SYSTEM

1. The Input-Output Transactions Table.

An input-output table represents the economy to be studied in terms of aggregated industrial or commodity groups or sectors. The table traces out the transactions in dollar terms between the sectors for a given year. Industries sell goods and services to other industries and primary ´final demand" and buy their input from other industries and primary sources. The transations table summarizes the inter-sectoral flows in a given period and is conventionally presented in matrix form.

The transactions table provides not only a concise, descriptive snapshot of a particular economy at a point in time, but also a disaggregated and consistent accounting system for an economy. The final demand components (minus imports) are considered to indicate the equivalent of what GNP measures on the expenditure side, and primary inputs (minus imports) are the same on the receipts side. In the regional policy context, the transactions table gives both a general understanding of the economy of a particular region and important information on particular aspects of the region's economy.

Before discussing the output, income and employment multipliers in some detail, it is necessary to distinguish between the treatment of the household sector in 'open' and 'closed' input-output models. In open input-output models, household personal consumption is located as a column vector in the final demand portion of the table, and the row vector comprising wages, salaries and other household income is included in the primary inputs quadrant. Alternatively, the input-output table may be closed with respect to households by incorporation of the household row and column into the endogenous matrix. This distinction is critical because the range and relevance of regional multipliers vary according to which branch of the input-output framework is favoured.

2. Input-Output Multipliers.

Once the transaction table has been compiled, simple mathematical procedures can be applied to derive output, income and employment multipliers for each sector in the economy. These procedures are illustrated briefly with accompanying explanatory comments.

The input-output transactions table may be represented by a series of equations thus:

$$
\begin{aligned}
X_1 &= X_{11} + X_{12} + \dots + X_{1n} + Y_1; \\
X_2 &= X_{21} + X_{22} + \dots + X_{2n} + Y_2; \\
&\vdots \\
X_n &= X_{n1} + X_{n2} + \dots + X_{nn} + Y_n.
\end{aligned}
$$

where

X_i = total output of intermediate sector i (row or column totals).

X_{ij} = output of sector i purchased by sector j.

Y_i = total final demand for the output of sector i.

It is possible, by dividing the elements of the columns of the transactions table by the respective column totals, to derive coefficients which represent more clearly the purchasing pattern of each sector. These coefficients are variously termed ´direct´ or ´input-output coefficients´ or, less appropriately, ´technical coefficients´. They are normally denoted as a_{ij}´s, and represent the direct effect following an increase in unit output of any sector j; that is $a_{ij} = X_{ij}/X_j$, and a_{ij} is the individual input-output coefficient. This may be represented in matrix term as:

$$\underset{n\times1}{X} = \underset{n\times n}{AX} + \underset{n\times1}{Y}$$

where $A = [a_{ij}]$, the matrix of input-output coefficients.

By transposition we obtain:

$$X (I-A) = Y$$

By solving the about system we derive the general solution:

$$X = (I - A)^{-1} Y$$

$(I - A)^{-1}$ is termed the Leontief inverse.

Now it is appropriate to turn to sector output multipliers. Let

$$Z = (I - A)^{-1} = [Z_{ij}].$$

The matrix Z is termed the matrix of interdependence coefficients. Each element Z_{ij} indicates the total direct and indirect requirement from sector i arising from an increase in sales of one dollar to final demand by sector j. The Z matrix provides, therefore, extremely important structural information relating to the economy under study by virture of its ability to indicate the strength of intersectoral economic linkages. The Z_{ij} coefficients in general indicate the extent to which changes in the level of activity of one sector will affect the level of output of all other sectors. The indiract effects could appropriately be termed ´local industrial support´ effects.

Since each element Z_{ij} shows the direct and indirect effects on the output of each sector from an increase in sales of one dollar to final demand by sector j, it follows that the $\Sigma_i Z_{ij}$,or the column sums of the inverse of the open model, will show the total effect on all sectors in the table (i.e. the total output effect on the regional economy) of an increase in sales of one dollar by sector j to final demand. For this reason $\Sigma_i Z_{ij}$ is termed the simple output multiplier.

When the model is closed with respect to households; that is to say, the household row is included in the processing sector, the inverse $Z^* = [Z^*_{ij}] = (I - A^*)^{-1}$ may be obtained where each element Z^*_{ij} provides, in the non-household rows of the inverse, the direct, indirect and induced effets on the output of each sector of an increase in sales to final demand by sector j. The column sums of the non-household Z^*_{ij} provide a measure of the total output multiplier for each sector.

The facility to disaggregate multipliers into direct, indirect and induced effects is an important advantage of the input-output approach, in that the different components of an impact may be identified and compared. This facility is equally applicable to both income and employment multipliers.

Let us now define sector income multipliers. Recall that income multipliers measure increases in income occasioned by a specified change in the economy. In this study, 'income' is interpreted as household income, and specifically as wages, salaries and supplements before taxation. The direct effect of increase in output on household income is given by the household row coeffient a_{Hi} for each sector, where a_{Hi} is the appropriate entry in the household row of the A matrix. The direct and indirect effect of an increase in sales of any sector to final demand is derived by multiplying the direct and indirect output changes (the elements of the Z matrix) by the corresponding household row coefficient; i.e., though obtaining Z_{ij} a_{Hi} for each element. The direct and indirect income multiplier for sector i is calculated as $\Sigma_i Z_{ij} a_{Hi}$. The indirect income effect on each sector is calculated as $Z_{ij} a_{Hi} - a_{Hi}$.

The direct, indirect and induced income multiplier (total regional multiplier) is obtained from the household row of the Z^* matrix. The induced effect can be calculated as $Z^*_{ij} - Z_{ij} a_{ij}$.

Sector employment multipliers warrant deliberation next. Both output and income multipiers are calculated from elements within the input-output tables. These tables, however, do not contain elements relating to employment per se. It is necessary therefore to derive, independently of the tables, an employment coefficient. The simplest method of obtaining this coefficient is the expression of the number of employees per unit of output. Once this coefficient has been obtained, the calculation of employment multipliers parallels to some extent the calculation of income multipliers. The direct effect on employment in each sector of a change in output of sector i will be given by a_{Ei}, the ˊempoyment equivalentˊ of the household row. The direct and indirect employment effects will be shown as $Z^i_{ij} a_{Ei}$ for each sector and as $\Sigma_i Z_{ij} a_{Ei}$ for all s ectors. The direct, indirect and induced effects are calculated as $Z^*_{ij} a_{Ei}$.

These preliminary derivations can be manipulated to produce Type I and Type II multipliers. Indeed, it has been conventional in input-output analysis for some time to calculate Type I and Type II income and employment multipliers: a process ready accomplished by re-arranging, thus:

Type I multiplier = Direct and indirect effects / Direct effects.

Type II multiplire = Direct, indirect and induced effects/Direct effects.

It is important to establish the distinction between the types of multipliers which have been mentioned. For example, the income multipliers described in the sections above measure the direct and indirect, or direct, indirect and induced effect of a change in sales of one dollar of the output

Table 4-1 Types of Input-Output Multipliers

Output		
	Simple	$O_j = \sum_{n+1}^{n} Z_{ij}$
	Total	$\bar{O}_j = \sum_{i=1}^{n+1} \bar{Z}_{ij}$
Income		
	Simple Household	$H_j = \sum_{i=1}^{n} a_{n+1,i} Z_{ij}$
	Total Household	$\bar{H}_j = \sum_{i=1}^{n+1} a_{n+1,i} \bar{Z}_{ij}$
	Type I	$H_j^{Y1} = H_j / a_{n+1,j}$
	Type II	$H_j^{Y2} = \bar{H}_j / a_{n+1,j}$
Employment		
	Simple Household	$E_j = \sum_{i=1}^{n} w_{n+1,i} a_{ij}$
	Total Household	$\bar{E}_j = \sum_{i=1}^{n+1} w_{n+1,i} \bar{a}_{ij}$
	Type I	$E_j^{Y1} = E_j / w_{n+1,j}$
	Type II	$E_j^{Y2} = \bar{E}_j / w_{n+1,j}$

symbols: n sectors (i,j...); z regions (r,s...),

Z_{ij} = element of Leontief inverse (open model), $B = (I-A)^{-1}$,

a_{ij} = household row coefficient of sector i,

$\bar{Z}_{ij}$ = element of Leontief inverse (closed model with households endogenous),

$\bar{a}_{ij}$ = household row coefficient of closed model (households endogenous).

of a sector to final demand. Type I and Type II income multiplires measure the income generated following a dollar change in household payments, as a result of a change in final demand for the relevant sector. In other words, the regional income multipliers measure the income impact of a change in sales to final demand, while the Type I and II income multipliers measure the income impact of a change in income. Similarly, the regional employment multipliers measure the employment impact of a change in sales to final demand, and the type I and II employment multipliers measure the employment impact of a change in employment. A summary of input-output multipliers is represented in Table 4-1(p.97).

When interpreting input-output multipliers, it is important to bear in mind that their use is subject to the following important assumptions:

(a) fixed coefficients of production--the production function is assumed to be linear, implying constant returns to scale;

(b) homogeneity--each sector has a fixed set of products that are not produced by any other sector;

(c) additivity--the total effect of carrying on several types of production is assumed to be the sum of the separate effects; thus external economies and diseconomies, along with the synergistic effect, are assumed away.

The assumptions, although restrictive, simplify the model and thereby make the empirical derivation of multipliers feasible.

REGIONAL INPUT-OUTPUT———A Non-survey Approach

The various approaches to the derivation of regional input-output multipliers can best be broadly categorized as ˊsurveyˊ or ˊnon surveyˊ. The clear distiction between the two aproaches lies in the fact that the former, which presumably can provide more 'accurate' values, attempts to determine the elements of the technical coefficients from collections of primary data by various 'survey' methods, and the latter attempts to derive these coefficients from other (usually nationl) input-output tables by various modification techniques. In contrast to the former, a significant merit of the non-survey approach lies in its ability to quantify the general impacts on the producing sectors located in a particular region for limited extenditures of both money and time.

In order to derive the regional input-output multipliers, the national coefficients must be converted to the table which shows the (vector of) output of the various sectors in the particular region. Usually, this modification can be carried out through the use of an estimated regional economy, designed to show the percentage of the total required outputs from each sector that could be expected to originate within the region. One straightforward way to estimate these percentages, using data that may often be obtainable at the regional level, requires (1) total regional output of sector j, or X_j^R; (2) exports of good j from region R, or E_j^R; and (3) imports into the region of good j, M_j^R.

Then we can form

$$P_j^R = (X_j^R - E_j^R) / (X_j^R - E_j^R + M_j^R).$$

The numerator is the locally-produced amount of goods that are available to purchasers in regional R; the denominator is the total amount of good j that is available in R, either produced locally or imported. (Thus P_j^R * 100 will produce an estimate of the regional supply percentage for sector j in region R--the percentage of good j available in region R that is produced there).

When we have such proportions, P_i^R, for each sector in the economy (i=1,..., n), each element in the *i*th row of the national coefficients matrix, A, could be multiplied by P_i^R to generate a row of locally produced inputs of good j to all locally-based producers. If we arrange the proportions in an n-element column vector, P, then our working estimate of the regional matrix will be $A^R = \hat{P}A$. Given any Y^R, we could then find X^R as

$$X^R = (I - \hat{P}A)^{-1} Y^R$$

Here, Y^R = exogenous demand for goods made in region R. Recall that a hat over a vector indicates the diagonal matrix created from that vector, and premultiplication by a diagonal matrix uniformly alters the rows of the matrix being premultiplied--the elements in the row of A are each multiplied by P_j^R. This uniform modification of the elements in a row of A is an assumption maintained to facilitate computation.

APPLICATION AND FINDINGS

Concerning the impacts of the mining industry on the Canadian economy, the input-output model was employed to analyse the multipliers of output, income and employment for each industrial sector. First, a 36-sector transactions input-output table was set up in terms of the Statistics Canada 1981 Input-Output tables. The transactions table summarizes the interindustry transactions in dollar terms at basic values for 1981 for the entire country, and it contains an enormous amount of information relating to the economic structure of Canada. The first 32 entries in each row indicate the sales to other sectors in Canada; the last three entries in each row indicate the sales of each sector to households, other final users in Canada and to markets outside the country. The output of "sector export" reflects the type of activity in this sector which is carried out in the country. The transactions table is represented in Table 4-2 (pp.102-04). Second, the relative weightings of 36 entries in each column are compiled. The column structure of the transactions table is important. Since the columns show the pattern of purchases of each sector, they are the basis for the calculation of tables of coefficients for the analytical application of the table in the next step. Third, it then behoves us to subtract the input coefficient matrix from the identify matrix and to invert the result, thereby yielding the Leontief inverse matrix, $(I-A)^{-1}$, of Table 4-3 and 4-4 (pp.105-10). For its part, Table 4-3 represents the initial effect on each sector's output of one dollar's worth of final demand for its product. In other words, it is the dollar's worth of final demand which becomes an additional dollar's worth of each sector's output as the first term in the series assessment of total direct and indirect effects on each sector's production. Table 4-4 shows that when we consider the input coefficient matrix closed with respect to households, then we capture in the model the additional induced effects of household income generation through payments for labour services and the associated consumer expenditures on goods produced by the various sectors. Fourth, to assess the impact of one dollar's worth of final demand for each sector's output, we add the elements in each column of $[I-A]^{-1}$ and $[I-\bar{A}]^{-1}$ (the inversion of the input coefficient matrix closed with respect to households), and then gain the output multipliers of type II for each sector. Continuing in the same vein, the multipliers of income and employment (Type I and Type II) for each sector are found. Of course, before summing up the elements of each column in the $[I-A]^{-1}$ and $[I-\bar{A}]^{-1}$ matrices, we subjected them to multiplication by the coefficients of income and employment respectively.

Table 4-2 35-Sector Transactions Table: Canada, 1981

	1	2	3	4	5	6	7	8	9	10	11	12
1 Agriculture	4780.7	-	-	-	-	-	-	9592.5	101.4	332.5	-	-
2 Fishg Trapg	-	10.1	-	-	-	-	-	672.5	-	-	-	-
3 Logg Forest	1.5	-	562.6	-	-	-	-	-	-	-	-	-
4 Metal Mining	-	-	-	34.2	-	-	-	-	-	-	-	-
5 Crud Pet Gas	20.3	0.4	0.1	43.5	8.5	0.4	3.3	54.8	-	-	7.4	4.6
6 Quarries	29.5	1.7	-	38.8	2.8	4.0	6.8	17.3	-	-	8.2	0.5
7 Ser Mines	-	-	-	462.9	587.7	29.2	-	-	-	-	-	-
8 Food	1962.3	-	-	-	-	-	-	5695.2	377.7	2.1	-	-
9 Beverages	-	-	-	-	-	-	-	-	219.0	-	-	-
10 Tobacco	-	-	-	-	-	-	-	-	-	236.5	-	-
11 Rubber	44.6	-	-	-	-	-	-	0.4	-	-	11.8	0.4
12 Plastic	3.7	-	-	6.8	-	-	-	154.3	22.7	1.9	16.9	173.1
13 Leather	-	-	-	-	-	-	-	-	-	-	-	-
14 Textile	41.2	29.2	6.6	3.9	-	0.2	-	15.5	-	20.9	162.3	25.6
15 Clothing	-	-	-	-	-	-	-	-	-	1.9	-	9.6
16 Wood	7.8	11.1	-	2.3	-	0.4	-	4.2	5.4	-	1.3	9.3
17 Furniture	-	-	-	-	-	-	-	-	-	-	-	-
18 Paper	9.5	-	-	21.7	-	0.7	-	759.2	148.1	140.3	7.9	75.9
19 Printg Publ	-	-	-	1.1	-	-	-	76.3	33.7	-	1.5	3.1
20 Prim Metal	-	-	-	112.4	45.3	-	162.0	10.3	-	-	11.0	6.5
21 Mtal Fabric	76.4	3.6	29.9	16.2	9.1	-	-	396.7	259.9	3.9	76.9	5.0
22 Machinery	147.8	11.3	25.4	367.2	74.0	24.9	98.3	7.9	-	-	-	2.2
23 Trans Equip	3.9	61.0	9.0	174.6	1.3	13.2	-	-	-	-	-	-
24 Electr Prod	-	20.6	-	-	-	-	39.5	-	-	-	-	-
25 N Mtal Prod	1.1	1.2	0.3	23.7	-	0.1	49.7	97.7	162.8	-	0.7	12.2
26 Ref Pet Coal	926.7	104.0	190.2	356.7	62.4	43.8	185.6	150.4	27.0	2.0	14.2	7.2
27 Chemic Prod	2070.9	1.3	5.1	69.8	40.3	9.3	23.9	371.2	47.9	8.8	474.3	1049.5
28 Other Manuf	-	12.8	-	-	-	-	-	4.9	-	-	3.9	23.8
29 Construct	242.7	12.3	87.4	174.8	514.4	2.9	-	51.9	13.1	5.8	7.2	7.1
30 Trans Ser	64.5	7.1	562.7	137.2	24.6	21.2	119.4	212.4	16.4	2.2	6.1	3.8
31 Commu Ser	74.8	0.8	7.6	20.1	25.9	1.8	15.0	84.8	15.5	4.1	12.1	16.5
32 Other Util	239.9	1.0	3.8	289.9	172.6	12.7	42.2	162.6	35.1	3.7	26.5	33.9
33 Trad Ser	621.5	29.2	33.1	331.2	44.6	25.0	87.4	645.5	39.6	20.3	41.5	64.2
34 Finan Ser	813.6	8.0	279.0	786.4	5694.9	22.3	164.9	400.2	99.2	36.8	97.3	65.2
35 Communti Ser	989.6	26.4	630.2	718.0	592.4	71.8	760.3	1722.7	443.1	140.9	180.9	175.8
36 Household	1299.7	156.8	1533.5	2414.1	1366.8	168.7	1083.3	4064.5	876.6	228.6	691.5	635.7
a Other Value Added	8933.1	422.7	618.3	3319.1	8932.7	162.5	895.2	225.7	901.2	247.4	160.3	368.4
b Import	1760.7	179.0	94.2	2182.7	9243.3	1185.0	102.7	3571.3	524.7	41.2	793.2	731.6
c Total	25167.9	11111.3	4716.7	12109.3	27441.8	1800.1	3838.7	31254.9	4370.1	1482.1	2814.9	3510.7

Table 4-2 35-Sector Transaction Table: Canada, 1981 (continued)

	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1	-	-	26.3	-	-	-	-	-	-	-	-	-	-	-
2	-	-	123.8	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	2517.7	0.3	1407.6	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	4181.2	-	-	-	-	51.0	-
5	-	16.7	2.0	18.1	3.9	116.7	4.2	734.2	28.9	11.6	29.5	15.3	100.8	16579.0
6	0.6	-	-	-	-	58.7	-	72.2	3.0	12.5	2.1	1.4	309.0	5.5
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	76.5	5.7	-	-	-	16.9	-	-	-	-	-	-	0.8	-
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	114.7	18.4	0.3	0.3	65.0	-	2.2	-	-	75.0	357.8	25.5	9.2	-
12	28.0	19.7	3.3	39.7	57.4	95.5	7.8	-	42.2	3.3	73.7	44.9	28.9	4.2
13	204.7	0.1	67.8	-	3.3	-	-	-	-	-	15.8	-	-	-
14	25.8	1606.7	1518.0	5.2	163.5	65.9	1.6	-	2.5	-	58.5	7.1	4.8	-
15	-	-	276.9	-	-	-	-	-	-	-	-	-	-	-
16	1.2	1.0	-	917.2	243.7	1072.6	0.7	18.4	30.5	11.7	65.0	19.3	13.0	-
17	-	-	-	11.1	96.3	-	-	-	-	-	-	-	-	-
18	22.4	57.3	43.8	46.8	58.3	2312.1	1365.9	7.4	55.2	11.9	49.8	89.4	111.3	11.2
19	1.2	5.3	5.0	0.5	2.3	13.7	503.9	-	5.0	0.3	-	5.2	1.4	0.3
20	0.1	1.1	-	21.6	127.4	81.6	5.6	3686.4	3088.1	972.8	1726.4	1163.9	46.1	-
21	-	5.0	3.2	109.3	141.5	28.6	3.5	164.7	1521.3	447.2	934.1	310.0	41.8	34.8
22	0.3	-	-	-	5.2	-	3.8	75.4	36.1	1383.5	396.7	603.0	1.1	-
23	-	-	-	-	-	-	-	-	29.9	161.4	9083.2	-	-	-
24	-	-	-	-	2.0	-	-	0.7	26.8	231.6	478.7	1985.8	-	-
25	0.2	0.4	-	45.5	21.2	49.2	-	183.5	79.1	21.1	224.0	60.4	650.9	-
26	2.7	43.1	6.7	77.5	7.7	538.5	19.0	421.4	48.2	22.6	65.0	50.7	123.1	935.7
27	57.1	444.6	11.5	113.5	44.5	664.4	123.9	123.1	150.7	29.1	214.1	233.8	165.4	339.1
28	16.8	53.4	101.4	23.5	15.9	11.2	94.8	16.8	25.4	18.3	139.7	86.0	31.6	-
29	3.0	18.6	4.1	32.5	4.0	79.9	17.5	139.3	27.1	24.6	55.9	24.6	23.9	213.0
30	2.2	14.5	6.6	21.1	4.5	95.2	9.8	110.7	35.4	13.1	98.5	37.7	52.8	465.9
31	7.1	23.0	25.8	30.2	14.7	44.6	121.9	43.8	66.5	49.3	87.2	99.9	23.2	25.9
32	7.5	64.0	18.5	130.8	15.9	579.6	32.4	406.8	85.5	35.1	99.6	71.6	145.3	75.5
33	47.1	141.0	168.6	256.9	146.8	298.0	175.8	588.3	322.4	268.9	320.7	296.4	77.0	61.5
34	38.4	114.7	164.3	193.3	98.1	244.5	239.3	220.7	330.2	192.6	1365.7	367.3	125.3	223.3
35	74.1	300.4	189.4	790.7	138.3	1370.9	498.3	1434.7	724.7	389.7	1125.8	605.0	601.3	438.3
36	405.3	1182.7	1600.3	2625.9	868.6	3535.2	2402.5	3693.6	3570.8	2262.8	5063.8	3259.4	1366.0	780.7
a	136.5	610.6	497.6	482.4	317.7	2683.8	1098.2	1671.1	1621.1	1144.7	1355.0	1666.5	805.7	615.9
b	652.9	2122.8	1251.4	656.9	412.4	1078.4	906.1	3944.3	3346.0	12292.1	19514.2	6060.1	1076.1	1473.9
c	1926.4	6870.6	6107.6	9152.2	3080.4	16543.3	7637.3	21939.2	15302.6	20086.8	43000.5	5986.9	22257.8	22257.8

Table 4-2 35-Sector Transaction Table: Canada, 1981 (continued)

	27	28	29	30	31	32	33	34	35	36	a	b	c
1	-	9.8	130.9	5.4	-	-	482.5	-	338.3	2467.0	1449.7	5451.5	25167.9
2	-	-	-	-	-	-	-	-	15.8	42.6	-	282.4	1111.3
3	-	15.9	-	-	-	-	15.6	-	-	192.3	-	96.9	4716.1
4	21.4	258.9	-	-	-	114.9	1.4	-	7.7	-	6041.1	1397.5	12109.3
5	268.1	5.5	7.5	188.0	4.4	847.4	69.2	97.2	44.0	508.6	979.7	6618.0	27441.8
6	257.0	-	331.3	11.5	-	-	1.0	-	4.4	30.1	-	1364.3	1800.1
7	-	-	2861.0	-	-	-	-	-	-	-	-	-	3838.7
8	109.9	2.4	-	2.8	-	-	78.3	-	3565.9	16035.7	1213.8	2088.9	31254.9
9	-	-	-	-	-	-	0.1	-	226.9	3206.0	176.3	541.8	4370.1
10	-	-	-	-	-	-	-	-	-	1087.3	24.0	134.5	1482.1
11	-	10.4	111.8	181.6	0.5	-	58.5	-	475.1	599.5	242.6	409.3	2814.9
12	106.1	126.7	840.7	10.1	-	-	105.5	-	234.6	150.4	877.9	230.7	3510.7
13	-	17.8	2.1	-	-	-	0.7	-	63.4	1247.7	212.7	90.3	1926.4
14	2.9	76.6	517.1	25.6	3.9	-	47.0	1.1	276.6	1185.6	473.6	495.8	6870.8
15	-	0.7	-	-	-	-	29.5	-	105.1	5375.1	35.8	273.0	6107.6
16	12.4	34.7	2471.9	-	-	-	72.6	0.6	55.8	181.5	128.1	3771.5	9165.2
17	-	-	46.1	-	-	-	1.8	-	5.1	1973.3	654.0	302.7	3080.4
18	180.7	91.3	373.3	15.3	-	-	676.6	11.6	806.3	1039.5	372.6	8519.5	16543.3
19	19.8	14.3	-	15.0	56.8	4.7	68.7	104.4	4343.9	1651.6	781.5	230.7	7637.3
20	125.2	101.7	4887.6	41.9	-	-	31.6	-	83.2	-	187.0	5613.1	21939.3
21	134.9	113.1	1846.8	26.9	-	-	243.5	-	983.2	585.1	-	1319.7	15302.6
22	5.4	5.5	541.1	8.8	-	-	27.0	-	2069.2	431.5	8589.7	5143.7	20086.8
23	-	-	85.4	999.5	-	-	5.8	-	713.4	7477.8	7308.5	16543.0	43000.5
24	-	88.7	1927.4	79.2	301.4	-	25.5	-	745.3	3153.8	5680.2	2403.0	17190.2
25	52.6	22.5	2821.5	16.6	-	-	15.6	-	162.2	452.3	251.2	508.2	5986.9
26	1781.5	12.5	135.8	2825.4	85.4	412.1	1063.8	412.8	996.4	6215.2	-	3068.4	22257.8
27	3928.6	196.4	660.0	31.5	3.2	-	87.1	1.2	1095.7	2417.3	3124.9	596.1	29029.1
28	46.0	471.7	329.7	18.6	22.9	-	44.2	7.4	1173.0	3476.0	945.2	1519.4	8941.7
29	82.7	8.5	28.9	856.5	226.1	358.1	258.9	2575.1	109.7	97.9	53337.6	-	60399.1
30	176.2	7.6	376.4	3357.6	171.5	35.5	851.5	111.2	13682.2	4605.2	2641.1	1700.9	29011.0
31	109.5	36.3	103.1	472.0	384.2	36.7	1181.8	1248.5	1625.1	3655.0	1360.1	179.6	11361.6
32	417.9	24.3	38.3	275.7	57.0	67.6	705.2	948.7	469.0	4637.4	130.9	1198.5	11735.5
33	302.9	154.7	2871.0	529.7	58.4	35.5	494.8	59.0	3579.0	27923.4	8296.5	2656.2	51911.6
34	455.0	239.8	3718.9	1038.3	393.0	360.0	4540.1	8491.7	2838.6	42256.4	4373.2	1880.6	82971.4
35	1419.1	306.9	3221.1	2530.6	775.5	277.1	3818.1	3766.0	6057.7	30386.4	1411.5	4120.8	71805.1
36	2337.2	1287.5	17978.9	10095.6	5517.1	2627.1	25824.1	19926.9	13134.3	6998.4	50686.3	75.1	203626.4
a	2330.7	543.2	10120.3	4578.2	3058.6	6511.2	10660.3	42107.3	11304.2	14122.0	617.3	6337.2	154216.6
b	4374.6	4471.7	-	773.2	241.7	46.9	423.7	4276.6	687.8	7751.2	1449.2	-	80033.5
c	19029.1	8741.7	60399.1	29001.1	11361.6	11735.5	51911.6	82971.4	71805.1	203892.9	162014.1	-	

Table 4-3 35-Sector Coefficients: Canada, 1981

	1	2	3	4	5	6	7	8	9	10	11
1 Agriculture	1.28484	0.00208	0.00678	0.00354	0.00162	0.00206	0.00830	0.48566	0.08048	0.34913	0.00448
2 fishg Trapg	0.00284	1.00926	0.00035	0.00017	0.00008	0.00010	0.00042	0.02779	0.00285	0.00111	0.00023
3 Logg Forest	0.00188	0.00426	1.13691	0.00122	0.00067	0.00052	0.00138	0.00571	0.00578	0.01699	0.00177
4 Metal Mining	0.00293	0.00257	0.00215	1.00724	0.00154	0.00090	0.01171	0.00279	0.00489	0.00203	0.00369
5 Crud Pet Gas	0.07086	0.08083	0.05969	0.04005	1.00853	0.02558	0.05906	0.04599	0.02555	0.03569	0.03595
6 Qyarries	0.00394	0.00209	0.00073	0.00402	0.00052	1.00253	0.00335	0.00311	0.00346	0.00209	0.00639
7 Ser Mine	0.00282	0.00266	0.00297	0.04046	0.02297	0.01707	1.00233	0.00187	0.00129	0.00167	0.00146
8 Food	0.12973	0.00348	0.01348	0.00648	0.00312	0.00388	0.01653	1.27801	0.12928	0.04736	0.00907
9 Beverages	0.00033	0.00017	0.00069	0.00032	0.00016	0.00019	0.00084	0.00044	1.05330	0.00061	0.00037
10 Tobacco	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	1.18987	0.00000
11 Rubber	0.00276	0.00107	0.00173	0.00075	0.00022	0.00043	0.00113	0.00146	0.00075	0.00131	1.00480
12 Plastic	0.00274	0.00125	0.00176	0.00166	0.00070	0.00050	0.00171	0.00851	0.00830	0.00439	0.00884
13 Leather	0.00011	0.00011	0.00023	0.00011	0.00005	0.00007	0.00027	0.00015	0.00018	0.00022	0.00013
14 Textile	0.00421	0.03560	0.00418	0.00151	0.00067	0.00068	0.00199	0.00438	0.00198	0.02555	0.07018
15 Clothing	0.00016	0.00010	0.00034	0.00018	0.00008	0.00010	0.00042	0.00026	0.00029	0.00192	0.00022
16 Wood	0.00263	0.01258	0.00242	0.00193	0.00149	0.00080	0.00161	0.00485	0.00559	0.01128	0.00222
17 Furniture	0.00003	0.00003	0.00004	0.00003	0.00003	0.00001	0.00003	0.00003	0.00003	0.00004	0.00002
18 Paper	0.00989	0.00332	0.00726	0.00620	0.00198	0.00272	0.00899	0.04309	0.04183	0.13958	0.01105
19 Printg Publ	0.00719	0.00344	0.01357	0.00659	0.00342	0.00384	0.01647	0.01224	0.01970	0.01234	0.00831
20 Prim Metal	0.00792	0.01088	0.00989	0.02098	0.00723	0.00393	0.05871	0.01054	0.02200	0.00730	0.01723
21 Mtal Fabric	0.01081	0.00871	0.01423	0.00613	0.00254	0.00224	0.00736	0.02426	0.07622	0.01074	0.03534
22 Machinery	0.01222	0.01493	0.01420	0.03783	0.00551	0.01756	0.03716	0.00871	0.00657	0.00875	0.00436
23 Trans Equip	0.00340	0.07215	0.01445	0.02180	0.00140	0.01150	0.00800	0.00592	0.00447	0.00487	0.00304
24 Electr Prod	0.00285	0.02389	0.00518	0.00359	0.00217	0.00168	0.01642	0.00355	0.00322	0.00364	0.00237
25 N Mtal Prod	0.00280	0.00317	0.00302	0.00476	0.00207	0.00096	0.01677	0.00654	0.04653	0.00256	0.00238
26 Ref Pet Coal	0.07677	0.10599	0.07618	0.04387	0.00890	0.00251	0.07127	0.04886	0.02740	0.03893	0.03660
27 Chemic Prod	0.14228	0.01090	0.01155	0.01341	0.00458	0.03969	0.01924	0.08045	0.03754	0.06159	0.22780
28 Other Manuf	0.00263	0.01415	0.00439	0.00224	0.00115	0.00125	0.00519	0.00370	0.00394	0.00422	0.00502
29 Construct	0.02378	0.01674	0.03377	0.02168	0.02750	0.00484	0.00975	0.01533	0.01050	0.01675	0.00938
30 Trans Ser	0.03215	0.02309	0.20168	0.03840	0.01343	0.02820	0.09433	0.04528	0.04493	0.04972	0.03201
31 Comnu Ser	0.01151	0.00487	0.03840	0.00804	0.00658	0.00424	0.01525	0.01279	0.01226	0.01366	0.01174
32 Other Util	0.13134	0.00522	0.00804	0.02951	0.01064	0.00962	0.01972	0.06082	0.02454	0.04752	0.01963
33 Trad Ser	0.04598	0.03423	0.02951	0.03790	0.00709	0.01921	0.04238	0.05201	0.02924	0.04286	0.02939
34 Finan Ser	0.08785	0.04225	0.03790	0.09974	0.24081	0.02880	0.08865	0.06917	0.05854	0.07989	0.06857
35 Communiti Ser	0.10013	0.05050	0.09750	0.09750	0.04760	0.05842	0.25344	0.13343	0.16288	0.18466	0.11270

Table 4-3 35-Sector Coefficients: Canada, 1981 (continued)

	12	13	14	15	16	17	18	19	20	21	22	23	24
1	0.00514	0.02451	0.00400	0.00903	0.00647	0.00424	0.00626	0.00449	0.00461	0.00362	0.00146	0.00207	0.00231
2	0.00032	0.00137	0.00020	0.02159	0.00032	0.00019	0.00032	0.00022	0.00022	0.00017	0.00007	0.00010	0.00012
3	0.00550	0.00307	0.00241	0.00198	0.34871	0.03234	0.13908	0.02730	0.00150	0.00217	0.00068	0.00142	0.00183
4	0.00260	0.00130	0.00139	0.00136	0.00298	0.01370	0.00323	0.00186	0.23234	0.05275	0.01396	0.01431	0.02003
5	0.00181	0.01575	0.02680	0.01451	0.03887	0.02280	0.06347	0.02258	0.07784	0.02900	0.00898	0.01237	0.01647
6	0.05035	0.00188	0.00182	0.00073	0.00114	0.00180	0.00558	0.00158	0.00590	0.00227	0.00124	0.00116	0.00132
7	0.00921	0.00072	0.00105	0.00062	0.00186	0.00145	0.00238	0.00103	0.01550	0.00311	0.00093	0.00111	0.00142
8	0.01051	0.06217	0.00798	0.00657	0.01244	0.00741	0.01262	0.00860	0.00850	0.00668	0.00259	0.00394	0.00458
9	0.00038	0.00026	0.00029	0.00024	0.00063	0.00035	0.00055	0.00041	0.00043	0.00033	0.00013	0.00019	0.00023
10	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
11	0.00060	0.06732	0.00386	0.00208	0.00103	0.02263	0.00074	0.00079	0.00062	0.00043	0.00430	0.01095	0.00211
12	1.05519	0.01920	0.00554	0.00299	0.00676	0.02258	0.00902	0.00386	0.00138	0.00424	0.00072	0.00316	0.00399
13	0.00018	1.11900	0.00015	0.01314	0.00021	0.00137	0.00018	0.00016	0.00014	0.00011	0.00005	0.00060	0.00009
14	0.01236	0.02541	1.30651	0.34187	0.00336	0.07461	0.00789	0.00276	0.00133	0.00123	0.00070	0.00363	0.00147
15	0.00332	0.00020	0.00017	1.04764	0.00034	0.00026	0.00030	0.00022	0.00023	0.00019	0.00007	0.00011	0.00012
16	0.00667	0.00303	0.00219	0.00187	1.11361	0.09392	0.08510	0.01721	0.00279	0.00406	0.00133	0.00307	0.00276
17	0.00003	0.00002	0.00002	0.00001	0.00142	1.03240	0.00013	0.00004	0.00003	0.00002	0.00001	0.00001	0.00001
18	0.03539	0.02191	0.01781	0.01438	0.01397	0.03020	1.17003	0.22787	0.00631	0.00027	0.00270	0.00468	0.01002
19	0.00905	0.00633	0.00703	0.00605	0.01240	0.00796	0.01184	1.07907	0.00845	0.00699	0.00261	0.00392	0.00489
20	0.01013	0.00409	0.00419	0.00293	0.01290	0.06899	0.01330	0.00612	1.21284	0.27405	0.07235	0.07320	0.10285
21	0.00825	0.00583	0.00459	0.00362	0.02551	0.05891	0.00920	0.00496	0.01465	1.11583	0.02899	0.03398	0.02668
22	0.00520	0.00324	0.00332	0.00287	0.00875	0.00662	0.00686	0.00509	0.01715	0.00922	1.07679	0.01606	0.04607
23	0.00319	0.00217	0.00234	0.00336	0.00754	0.00322	0.00553	0.00333	0.00796	0.00393	0.01223	1.26980	0.00261
24	0.00252	0.00180	0.00196	0.00223	0.00398	0.00319	0.00339	0.00298	0.00318	0.00441	0.01508	0.01749	1.13263
25	0.00668	0.00147	0.00145	0.00092	0.00838	0.01075	0.00632	0.00207	0.01369	0.01020	0.00266	0.00905	0.00641
26	0.05214	0.01707	0.02684	0.01532	0.04415	0.02129	0.06621	0.02389	0.04413	0.02060	0.00684	0.01022	0.01381
27	0.40561	0.07266	0.11400	0.03697	0.02870	0.04659	0.06264	0.03847	0.01702	0.02230	0.00607	0.01576	0.02585
28	0.01113	0.01259	0.01285	0.02314	0.00700	0.00917	0.00466	0.01686	0.00376	0.00435	0.00208	0.00590	0.00764
29	0.01011	0.00635	0.00828	0.00520	0.01885	0.00865	0.01707	0.00951	0.01814	0.00909	0.00381	0.00586	0.00599
30	0.03421	0.02228	0.02561	0.02009	0.09391	0.03293	0.06605	0.03592	0.04127	0.02920	0.01085	0.01806	0.02002
31	0.01341	0.00973	0.00979	0.01040	0.01385	0.01283	0.01194	0.02461	0.00972	0.01093	0.00528	0.00656	0.01066
32	0.02470	0.01282	0.01837	0.01109	0.02320	0.01573	0.04900	0.01737	0.03344	0.01677	0.00540	0.00780	0.01038
33	0.03586	0.03857	0.03581	0.04357	0.04904	0.06686	0.03811	0.03876	0.04967	0.04021	0.02049	0.01768	0.01194
34	0.06022	0.04694	0.04590	0.05432	0.08194	0.06951	0.06685	0.06450	0.06703	0.05411	0.02256	0.05896	0.04290
35	0.11483	0.07937	0.08784	0.07120	0.18802	0.10429	0.16412	0.12319	0.12813	0.09956	0.03859	0.05827	0.06770

Table 4-3 35-Sector Coefficients: Canada, 1981 (continued)

	25	26	27	28	29	30	31	32	33	34	35
1	0.00531	0.00241	0.00806	0.00404	0.00747	0.00508	0.00308	0.00147	0.01610	0.00217	0.03616
2	0.00027	0.00012	0.00043	0.00013	0.00022	0.00024	0.00016	0.00007	0.00025	0.00011	0.00192
3	0.00474	0.00097	0.00296	0.00357	0.01675	0.00149	0.00101	0.00078	0.00335	0.00092	0.00493
4	0.01123	0.00178	0.00393	0.03504	0.02315	0.00272	0.00156	0.01095	0.00132	0.00117	0.00398
5	0.05551	0.79044	0.12394	0.01263	0.03820	0.10400	0.01401	0.10464	0.02802	0.01099	0.04649
6	0.05901	0.00111	0.01793	0.00114	0.00963	0.00126	0.00040	0.00047	0.00046	0.00042	0.00141
7	0.00314	0.01861	0.00382	0.00187	0.04968	0.00435	0.00154	0.00438	0.00117	0.00201	0.00196
8	0.01059	0.00465	0.01804	0.00505	0.00859	0.00921	0.00606	0.00271	0.00988	0.00422	0.07486
9	0.00051	0.00023	0.00045	0.00021	0.00041	0.00046	0.00031	0.00014	0.00035	0.00022	0.00386
10	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
11	0.00231	0.00046	0.00057	0.00168	0.00266	0.00806	0.00053	0.00024	0.00163	0.00027	0.00310
12	0.00728	0.00127	0.00870	0.01675	0.01668	0.00209	0.00104	0.00082	0.00308	0.00092	0.00602
13	0.00018	0.00008	0.00015	0.00242	0.00019	0.00017	0.00011	0.00005	0.00013	0.00007	0.00123
14	0.00484	0.00095	0.00165	0.01281	0.01292	0.00343	0.00149	0.00074	0.00253	0.00091	0.00804
15	0.00027	0.00012	0.00025	0.00025	0.00027	0.00024	0.00015	0.00007	0.00078	0.00011	0.00183
16	0.00579	0.00194	0.00335	0.00628	0.04786	0.00274	0.00168	0.00187	0.00364	0.00199	0.00481
17	0.00003	0.00003	0.00003	0.00002	0.00086	0.00005	0.00003	0.00003	0.00006	0.00004	0.00011
18	0.03037	0.00362	0.01976	0.01668	0.01565	0.00632	0.00490	0.00193	0.01937	0.00295	0.03558
19	0.01043	0.00479	0.01027	0.00615	0.00823	0.00976	0.01262	0.00321	0.00846	0.00577	0.07434
20	0.01711	0.00820	0.01685	0.02187	0.11705	0.01254	0.00692	0.00522	0.00152	0.00507	0.01554
21	0.01323	0.00514	0.01411	0.01753	0.04094	0.00755	0.00361	0.00238	0.00819	0.00271	0.02339
22	0.00699	0.00556	0.00591	0.00468	0.01819	0.00655	0.00464	0.00256	0.00440	0.00267	0.03790
23	0.00499	0.00296	0.00417	0.00229	0.00592	0.05290	0.00303	0.00147	0.00349	0.00169	0.02646
24	0.00309	0.00277	0.00301	0.01327	0.03943	0.00840	0.03347	0.00214	0.00337	0.00282	0.01735
25	1.12345	0.00252	0.00569	0.00423	0.05614	0.00405	0.00192	0.00223	0.00154	0.00227	0.00537
26	0.04290	1.05774	0.13692	0.01253	0.04121	0.12634	0.01630	0.04189	0.03244	0.01096	0.05458
27	0.05013	0.02541	1.27263	0.04120	0.03267	0.01249	0.00537	0.00346	0.01004	0.00337	0.03764
28	0.00953	0.00167	0.00610	1.05752	0.00935	0.00401	0.00444	0.00107	0.00316	0.00165	0.02201
29	0.01184	0.03357	0.01533	0.00518	1.00948	0.04220	0.02469	0.03614	0.01072	0.03636	0.01670
30	0.04927	0.04288	0.04810	0.01751	0.04270	1.16619	0.03928	0.01461	0.04389	0.01709	0.25604
31	0.01179	0.00840	0.01460	0.00856	0.01074	0.02613	1.03973	0.00614	0.02967	0.01964	0.03772
32	0.03463	0.01358	0.03476	0.00844	0.01268	0.01670	0.00835	1.00880	0.01973	0.01438	0.02024
33	0.02844	0.01200	0.03228	0.02652	0.06610	0.03335	0.01325	0.00847	1.01847	0.00702	0.06952
34	0.05953	0.20606	0.08131	0.04837	0.10692	0.09039	0.05487	0.06687	0.11768	1.12407	0.09379
35	0.15455	0.06875	0.13391	0.06255	0.12228	0.13766	0.09310	0.04123	0.10396	0.06490	1.16020

Table 4-4 36-Sector Coefficients: Canada, 1981

	1	2	3	4	5	6	7	8	9	10	11
1 Agriculture	1.31052	0.02796	0.06753	0.03880	0.01797	0.01854	0.05827	0.52302	0.12178	0.39087	0.04637
2 Fishg Trapg	0.00418	1.01061	0.00351	0.00200	0.00093	0.00096	0.00303	0.02974	0.00500	0.00328	0.00241
3 Logg Forest	0.00386	0.00626	1.14159	0.00394	0.00193	0.00179	0.00523	0.00859	0.00897	0.02020	0.00500
4 Metal Mining	0.00436	0.00402	0.00555	1.00921	0.00245	0.00182	0.01450	0.00488	0.00720	0.00437	0.00603
5 Crud Pet Gas	0.09195	0.10208	0.10957	0.06900	1.02195	0.03911	0.10009	0.07668	0.05946	0.06996	0.07035
6 Quarries	0.00455	0.00270	0.00218	0.00486	0.00091	1.00293	0.00455	0.00401	0.00445	0.00309	0.00739
7 Ser Mines	0.00367	0.00352	0.00499	0.04163	0.02354	0.01762	1.00389	0.00311	0.00266	0.00306	0.00285
8 Food	0.17630	0.05041	0.12363	0.07042	0.03275	0.03376	0.10713	1.34577	0.20417	0.12305	0.08503
9 Beverage	0.00707	0.00695	0.01662	0.00957	0.00444	0.00451	0.01395	0.01024	1.06412	0.01156	0.01136
10 Tobacco	0.00246	0.00248	0.00583	0.00338	0.00157	0.00158	0.00479	0.00358	0.00396	1.19387	0.00402
11 Rubber	0.00481	0.00314	0.00659	0.00357	0.00153	0.00174	0.00513	0.00445	0.00405	0.00465	1.00815
12 Plastic	0.00720	0.00574	0.01228	0.00777	0.00354	0.00335	0.01037	0.01499	0.01546	0.01162	0.01610
13 Leather	0.00303	0.00306	0.00714	0.00412	0.00191	0.00194	0.00595	0.00440	0.00487	0.00497	0.00489
14 Textile	0.01226	0.04371	0.02322	0.01256	0.00579	0.00585	0.01765	0.01609	0.01492	0.03863	0.08330
15 Clothing	0.01111	0.01111	0.02617	0.01517	0.00703	0.00711	0.02166	0.01615	0.01785	0.01966	0.01803
16 Wood	0.00471	0.01468	0.00733	0.00478	0.00281	0.00214	0.00565	0.00787	0.00893	0.01466	0.00561
17 Furniture	0.00391	0.00394	0.00922	0.00535	0.00250	0.00250	0.00758	0.00567	0.00626	0.00635	0.00635
18 Paper	0.01915	0.01266	0.02918	0.01893	0.00788	0.00867	0.02702	0.05657	0.05674	0.15464	0.02616
19 Printg Publ	0.01700	0.01333	0.03678	0.02006	0.00966	0.01013	0.03556	0.02651	0.03548	0.02829	0.02431
20 Prim Metal	0.01301	0.01601	0.02193	0.02796	0.01047	0.00719	0.06861	0.01794	0.03018	0.01558	0.02553
21 Mtal Fabric	0.01678	0.01472	0.02835	0.01432	0.00634	0.00607	0.01897	0.03294	0.08582	0.02044	0.04508
22 Machinery	0.01703	0.01977	0.02557	0.04443	0.00857	0.02064	0.04653	0.01571	0.01431	0.01657	0.01220
23 Trans Equip	0.02428	0.09320	0.06386	0.05048	0.01469	0.02490	0.04863	0.03631	0.03806	0.03882	0.03711
24 Electr Prod	0.01203	0.03314	0.02688	0.01619	0.00801	0.00757	0.03428	0.01691	0.01798	0.01856	0.01734
25 N Mtal Prod	0.00530	0.00568	0.00892	0.00819	0.00366	0.00256	0.02163	0.01017	0.05054	0.00662	0.00644
26 Ref Pet Coal	0.10056	0.12997	0.13247	0.07654	0.02405	0.04778	0.11756	0.08348	0.06566	0.07761	0.07541
27 Chemic Prod	0.15849	0.02725	0.04990	0.03568	0.01490	0.02009	0.05079	0.10404	0.06362	0.08794	0.25425
28 Other Manuf	0.01207	0.02366	0.02672	0.01520	0.00716	0.00731	0.02356	0.01744	0.01913	0.01957	0.02042
29 Constrct	0.03089	0.02391	0.05058	0.03144	0.03202	0.00940	0.02358	0.02567	0.02192	0.02830	0.02097
30 Trans Ser	0.06548	0.05668	0.28052	0.08417	0.03464	0.04959	0.15918	0.09378	0.09853	0.10389	0.08638
31 Comnu Ser	0.02570	0.01917	0.04707	0.02753	0.01562	0.01334	0.04287	0.03344	0.03508	0.03673	0.03489
32 Other Util	0.14768	0.02168	0.04717	0.05194	0.02104	0.02010	0.05150	0.08459	0.05080	0.07407	0.04628
33 Trad Ser	0.10940	0.09814	0.17618	0.12498	0.04745	0.05990	0.16577	0.14428	0.13122	0.14594	0.13283
34 Finan Ser	0.20113	0.15642	0.38354	0.25529	0.31291	0.10149	0.30907	0.23400	0.24072	0.26402	0.25336
35 Communiti Ser	0.19242	0.14352	0.42549	0.22424	0.10635	0.11764	0.43303	0.26774	0.31131	0.33468	0.26325
36 Household	0.38834	0.39139	0.91861	0.53325	0.24717	0.24917	0.75562	0.56508	0.62453	0.63122	0.63346

Table 4-4 36-Sector Coefficients: Canada, 1981 (continued)

	12	13	14	15	16	17	18	19	20	21	22	23	24
1	0.04317	0.06272	0.03863	0.05451	0.07018	0.05747	0.05573	0.05891	0.04495	0.04758	0.02133	0.02760	0.03528
2	0.00230	0.00336	0.00200	0.02396	0.00364	0.00296	0.00289	0.00302	0.00232	0.00246	0.00110	0.00143	0.00183
3	0.00843	0.00601	0.00508	0.00549	0.35362	0.03644	0.14290	0.03149	0.00461	0.00556	0.00221	0.00339	0.00437
4	0.00473	0.00344	0.00332	0.00391	0.00654	0.01667	0.00599	0.00491	0.23460	0.05521	0.01508	0.01574	0.02188
5	0.08158	0.04713	0.05523	0.05185	0.09118	0.06651	0.10409	0.06727	0.11096	0.06510	0.02530	0.03340	0.04354
6	0.01012	0.00280	0.00264	0.00182	0.00267	0.00307	0.00676	0.00288	0.00686	0.00332	0.00171	0.00177	0.00211
7	0.00307	0.00199	0.00220	0.00213	0.00397	0.00322	0.00403	0.00284	0.01284	0.00457	0.00159	0.00196	0.00252
8	0.07948	0.13147	0.07077	0.08903	0.12797	0.10393	0.10233	0.10728	0.08164	0.08640	0.03861	0.05039	0.06437
9	0.01035	0.01029	0.00937	0.01216	0.01733	0.01430	0.01352	0.01468	0.01100	0.01186	0.00534	0.00691	0.00887
10	0.00365	0.00367	0.00332	0.00430	0.00611	0.00510	0.00474	0.00522	0.00387	0.00422	0.00191	0.00246	0.00316
11	0.00364	0.07038	0.00663	0.00572	0.00612	0.02688	0.00470	0.00514	0.00384	0.00394	0.00589	0.01300	0.00474
12	1.06178	0.02582	0.01155	0.01088	0.01780	0.03180	0.01759	0.01329	0.00837	0.01186	0.00417	0.00760	0.00970
13	0.00451	1.12335	0.00409	0.01832	0.00746	0.00742	0.00581	0.00635	0.00473	0.00511	0.00231	0.00351	0.00384
14	0.02428	0.03738	1.31736	0.35613	0.02333	0.09129	0.02340	0.01982	0.01397	0.01500	0.00692	0.01166	0.01180
15	0.01939	0.01645	0.01490	1.06697	0.02742	0.02290	0.02133	0.02336	0.01738	0.01888	0.00852	0.01100	0.01414
16	0.00975	0.00612	0.00500	0.00555	1.11876	0.09822	0.08910	0.02162	0.00605	0.00762	0.00293	0.00514	0.00542
17	0.00577	0.00579	0.00525	0.00688	0.01104	1.04044	0.00760	0.00826	0.00612	0.00666	0.00301	0.00388	0.00499
18	0.04911	0.03570	0.03030	0.03079	0.03696	0.04940	1.18788	0.24751	0.02086	0.02514	0.00987	0.01392	0.02192
19	0.02358	0.02093	0.02026	0.02342	0.03675	0.02830	0.03074	1.09986	0.02386	0.02378	0.01020	0.01371	0.01748
20	0.01766	0.01166	0.01105	0.01195	0.02553	0.07954	0.02310	0.01690	1.22084	0.28276	0.07629	0.07827	0.10938
21	0.01709	0.01471	0.01264	0.01419	0.03732	0.07128	0.02070	0.01761	0.02403	1.12605	0.03361	0.03993	0.03434
22	0.01232	0.01040	0.00970	0.01139	0.02068	0.01659	0.01612	0.01528	0.02470	0.01745	1.08051	0.02086	0.05224
23	0.03412	0.03325	0.03050	0.04034	0.05935	0.04651	0.04577	0.04759	0.04076	0.03969	0.02838	1.29064	0.02942
24	0.01611	0.01546	0.01434	0.01844	0.02675	0.02221	0.02107	0.02243	0.01759	0.02012	0.02218	0.02665	1.14442
25	0.01037	0.00519	0.00481	0.00533	0.01456	0.01591	0.01112	0.00736	0.01760	0.01447	0.00459	0.01153	0.00961
26	0.08738	0.05248	0.05892	0.05746	0.10318	0.07061	0.11205	0.07431	0.08150	0.06133	0.02524	0.03395	0.04436
27	0.42962	0.09679	0.13586	0.06568	0.06893	0.08020	0.09387	0.07284	0.04249	0.05006	0.01861	0.03193	0.04667
28	0.02512	0.02664	0.02558	0.03986	0.03042	0.02874	0.02285	0.03687	0.01859	0.02051	0.00939	0.01532	0.01977
29	0.02063	0.01693	0.01786	0.01779	0.03648	0.02338	0.03076	0.02457	0.02930	0.02126	0.00931	0.01295	0.01511
30	0.08358	0.07188	0.07055	0.07911	0.17660	0.10202	0.13026	0.10655	0.09362	0.08625	0.03664	0.05130	0.06281
31	0.03443	0.03085	0.02893	0.03553	0.04906	0.04225	0.03928	0.05469	0.03201	0.06522	0.01626	0.02072	0.02888
32	0.04889	0.03713	0.04040	0.04002	0.06372	0.04958	0.08047	0.05199	0.05910	0.04473	0.01803	0.02410	0.03135
33	0.12977	0.13295	0.12132	0.15589	0.20637	0.19831	0.16028	0.17315	0.14927	0.14877	0.06953	0.08093	0.09336
34	0.22798	0.21552	0.19865	0.25492	0.36297	0.30431	0.28508	0.30456	0.24496	0.24804	0.11019	0.17195	0.18835
35	0.25153	0.21673	0.21230	0.23465	0.41700	0.29560	0.34192	0.31879	0.27310	0.25757	0.10999	0.15033	0.18621
36	0.57513	0.57793	0.52365	0.68769	0.96344	0.80493	0.74812	0.82296	0.60997	0.66481	0.30042	0.38735	0.49862

Table 4-4 36-Sector Coefficients: Canada, 1981 (continued)

	25	26	27	28	29	30	31	32	33	34	35	36
1	0.04737	0.02324	0.03931	0.03018	0.06300	0.06252	0.06586	0.03247	0.08190	0.03662	0.08658	0.10733
2	0.00246	0.00120	0.00205	0.00149	0.00311	0.00323	0.00342	0.00166	0.00368	0.00190	0.00455	0.00559
3	0.00798	0.00257	0.00537	0.00559	0.02103	0.00591	0.00585	0.00317	0.00842	0.00357	0.00884	0.00827
4	0.01359	0.00294	0.00568	0.03650	0.02626	0.00594	0.00507	0.01269	0.00500	0.00310	0.00680	0.00607
5	0.09005	0.80755	0.14960	0.03410	0.08380	0.15117	0.06555	0.13009	0.08205	0.03928	0.08789	0.08813
6	0.06001	0.00161	0.01868	0.00176	0.01096	0.00263	0.00190	0.00121	0.00204	0.00125	0.00261	0.00256
7	0.00453	0.01930	0.00486	0.00274	0.05152	0.00626	0.00362	0.00541	0.00335	0.00315	0.00364	0.00357
8	0.08686	0.04241	0.07471	0.05245	0.10929	0.11338	0.11990	0.05892	0.12920	0.06669	0.16629	0.19462
9	0.01154	0.00569	0.00864	0.00706	0.01497	0.01552	0.01677	0.00827	0.01760	0.00925	0.01708	0.02814
10	0.00403	0.00200	0.00300	0.00251	0.00533	0.00551	0.00602	0.00297	0.00631	0.00330	0.00484	0.01029
11	0.00567	0.00213	0.00306	0.00377	0.00710	0.01265	0.00555	0.00271	0.00689	0.00303	0.00713	0.00858
12	0.01457	0.00488	0.01412	0.02128	0.02630	0.01205	0.01192	0.00619	0.01449	0.00689	0.01476	0.01860
13	0.00496	0.00245	0.00371	0.00539	0.00651	0.00671	0.00725	0.00357	0.00762	0.00399	0.00696	0.01221
14	0.01602	0.00747	0.01144	0.02101	0.03032	0.02143	0.02116	0.01045	0.02315	0.01170	0.02384	0.03363
15	0.01816	0.00897	0.01354	0.01136	0.02389	0.02466	0.02684	0.01325	0.02876	0.01475	0.02327	0.04563
16	0.00920	0.00363	0.00588	0.00839	0.05235	0.00738	0.00676	0.00438	0.00896	0.00478	0.00889	0.00868
17	0.00638	0.00318	0.00475	0.00396	0.00925	0.00872	0.00951	0.00471	0.01000	0.00524	0.00772	0.01621
18	0.04554	0.01113	0.03103	0.02611	0.03569	0.02705	0.02755	0.01312	0.04312	0.01539	0.05378	0.03873
19	0.02650	0.01274	0.02221	0.01613	0.02945	0.03171	0.03661	0.01505	0.03361	0.01894	0.09360	0.04101
20	0.02544	0.01233	0.02304	0.02705	0.12805	0.02392	0.01936	0.01136	0.01815	0.01185	0.02553	0.02127
21	0.02300	0.00998	0.02137	0.02361	0.05385	0.02091	0.01820	0.00959	0.02348	0.01071	0.03511	0.02494
22	0.01487	0.00946	0.01176	0.00957	0.02859	0.01731	0.01639	0.00836	0.01672	0.00912	0.04733	0.02009
23	0.03919	0.01990	0.02958	0.02355	0.05108	0.09962	0.05408	0.02668	0.05701	0.02971	0.06747	0.08729
24	0.01812	0.01021	0.01418	0.02261	0.05928	0.02894	0.05590	0.01322	0.02688	0.01514	0.03537	0.03836
25	1.12753	0.00454	0.00873	0.00677	0.06153	0.00963	0.00802	0.00524	0.00793	0.00561	0.01026	0.01042
26	0.08188	1.07704	0.16588	0.03675	0.09266	0.17957	0.07447	0.07061	0.09342	0.04288	0.10130	0.09945
27	0.07669	0.03856	1.29237	0.05771	0.06773	0.04876	0.04501	0.02304	0.05159	0.02512	0.06948	0.06777
28	0.02499	0.00933	0.01759	1.06713	0.02976	0.02513	0.02752	0.01246	0.02735	0.01432	0.04055	0.03946
29	0.02347	0.03934	0.02397	0.01241	1.02485	0.05810	0.04206	0.04472	0.02893	0.04589	0.03065	0.02970
30	0.10386	0.06991	0.08866	0.05144	0.11477	1.24076	0.12076	0.05484	0.12930	0.06181	0.32148	0.13930
31	0.03504	0.01991	0.03188	0.02300	0.04143	0.05788	1.07442	0.02327	0.06604	0.03867	0.06559	0.05932
32	0.06139	0.02683	0.05463	0.02507	0.04800	0.05324	0.04828	1.02851	0.06159	0.03630	0.05231	0.06827
33	0.13231	0.06343	0.10945	0.09107	0.20323	0.17522	0.16827	0.08502	1.18098	0.09209	0.19403	0.26504
34	0.24507	0.29794	0.21917	0.16367	0.35188	0.34381	0.33179	0.20358	0.40796	1.27604	0.31622	0.47345
35	0.30573	0.14361	0.24623	0.15650	0.32187	0.34415	0.31873	0.15265	0.34074	0.18873	1.34143	0.38576
36	0.63605	0.31497	0.47760	0.39528	0.83977	0.86876	0.94932	0.46876	0.99512	0.52099	0.76250	1.62306

Some Findings. An examination of the results of input-output multipliers (see Table 4-5 & 6, pp.113-14) provides important information with respect to the input and output response of each sector on both national and regional bases. This may be summarized by means of the main findings in the manner stipulated below.

1. Generally, we would expect that the industrial sectors or groups of Canada would display an overall pattern in the size of input-output multipliers which reflects this ranking-- the 'large' groups would be expected to be more diversified and therefore to contain stronger linkages which would contribute to higher input-output multipliers. When the 'size' of a sector is measured in terms of the total output of all sectors there is no correspondence between the ranking of the sectors and the size of the input-output multipliers. For example, the wood industry is the 'largest' group in the size of the output multipliers, but its rank in the size of the total ouput of all sectors emerges substantially lower (see Table 4-5, p.113). Similiarly, the mineral fuels industry registers significately in terms of the total output of all sectors in Alberta (19.9%) but has a rather small stature on the output multipliers (both Type I and Type II; see Table 4-5, p.114). More importantly, we can find that the sizes of the output multipiers of Alberta are much smaller than that of the country as a whole.

2. For commodity groups falling within the mining industry, the output multipliers of Type I at the national level record values of 1.61184 for metal mining, 1.43705 for mineral fuels, 1.29663 for non-metal mining and 1.90233 for mining services. By comparison, the multipliers emerging for manufacturing, services and all other primary resource industrial groups are generally higher, ranging from 1.35189 for financial services to 2.50770 for

food industry, while in the fabricated mineral groups they range from 1.84940 for metal fabricating industry to 2.04590 for the primary metals industry. This situation accords in reference to the size of the Type II multipliers. The mining industry is still the ´lowest´ group in the size of the multipliers among the whole system, although the sizes of the Type II multipliers are somewhat larger than those for the Type I (see Table 4-5, p.114). At the regional level the situation is almost the same as that of the whole country. The values of 1.41525 (Type I) and 1.88354 (Type II) for mineral fuels and 1.26658 (Type I) and 1.73702 (Type II) for non-metal mining are smaller in comparison with those obtaining for manufacturing and services industries.

3. There is a singular occurrence which can be elicited from the analysis of income multipliers. For the mining industry, a range of multipliers can be found, from 1.62947 for mining services sector to 3.05742 for mineral fuels at the national level and from 2.53489 for non-metal mining to 3.90657 for mineral fuels at the provincial level (Type I, see Table 4-5 & 6, pp.113-14). In other words, for each dollar´s worth of mineral fuels´ production, a total of $1.63-3.05 and $2.54-2.91 income is injected into the Canadian and Alberta economies. On the contrary, the sizes of the multipliers for all other groups are lower, except for those referring to the petroleum & coal products industry which ranges from 5.53193 for Type I to 8.67047 for Type II: the largest value in the whole economy. Similiarly, the mineral fuels industry is the third largest group in the range of income multipliers of Alberta.

4. A similar change occurs in the size of the employment multipliers. Among the 36 industrial sectors of Canada, the mining industry, as a group, exceeds most of the others in the size of employment multipliers. The only exception within the group is the non-metal mining sector, the size of which

Table 4-5 Output, Income and Employment Multipliers : Canada (1981)

	Output Multiplier		Income Multiplier		Employment Multiplier	
Sector	Type I	Type II	Type I	Type II	Type I	Type II
1. Agriculture	2.12434	3.21269	4.63342	7.26201	2.39204	3.14636
2. Fishing & Trapping	1.60657	2.50267	1.70900	2.67860	1.22953	1.65064
3. Logging & forestry	2.01478	4.35267	1.74080	2.72841	2.12695	3.70851
4. Metal Mining	1.61184	2.96555	1.64772	2.58297	2.61315	5.57371
5. Mineral Fuels	1.43705	2.06612	3.05742	4.79181	3.38629	7.41797
6. Non-metal Mining	1.29663	1.93079	1.62947	2.56733	1.55539	2.42212
7. Mining Services	1.90233	3.82318	1.64612	2.58557	2.95691	5.52775
8. Food	2.50770	3.94273	1.23369	4.19625	1.61401	1.91015
9. Beverages	1.95631	3.54574	1.91829	3.00653	4.01500	6.72395
10. Tobacco	2.42084	4.02425	2.52140	3.95189	5.92024	10.04257
11. Rubber	1.78674	3.39891	1.58870	2.49003	2.23696	4.53681
12. Plastic	1.99670	3.47042	1.95687	3.06704	2.28621	4.21294
13. Leather	1.71043	3.18130	1.69288	2.65328	1.95247	3.23347
14. Textile	1.79226	3.12496	1.87434	2.93772	2.10407	3.70098
15. Clothing & Knitting	1.79391	3.54416	1.61705	2.53443	1.57708	2.61102
16. Wood	2.17890	4.63518	2.07180	3.24778	2.62065	4.76028
17. Furniture	1.90974	2.92517	1.75874	2.75654	1.74292	3.05954
18. Paper	2.10997	4.01395	2.16613	3.39504	3.35771	6.43173
19. Printing & Publishing	1.77874	3.91219	1.61180	2.52623	1.85574	3.53824
20. Primary Metal	2.04590	3.59826	2.23212	3.49858	3.42114	6.95911
21. Metal Fabric	1.84940	3.46560	1.75530	2.75115	2.03686	3.99249
22. Machinery	1.37260	2.13719	1.64305	2.57523	1.88255	3.70662
23. Trans-equipment	1.69145	2.63108	2.02658	3.17638	2.66707	5.59409
24. Electric Products	1.60791	2.87503	1.62202	2.54224	2.08461	4.44066
25. Non-metal Minerals	1.83128	3.45001	1.72225	2.69935	2.35427	4.36166
26. Petroleum & Coal PROD.	2.32879	3.13238	5.53193	8.67047	9.11375	18.80115
27. Chemical Products	2.04832	3.25273	2.37079	3.71576	3.85600	7.15645
28. Other Manufactured Ind.	1.47897	2.48497	1.69008	2.64892	1.02496	3.32633
29. Construction	1.99122	4.06693	1.73813	2.72426	2.34730	4.88230
30. Transportation Services	1.90912	4.12014	1.53815	2.41079	1.52145	2.48472
31. Communication Services	1.40365	3.81969	1.20447	1.88781	1.41612	3.00969
32. Other Utilities	1.37923	2.57222	1.29014	2.02207	1.41629	2.96553
33. Trade Services	1.51645	3.04907	1.23248	1.93169	1.27899	2.24775
34. Financial Services	1.35189	2.67780	1.35548	2.12449	2.62650	7.62548
35. Community Business & Personal Services	2.16720	4.15594	2.57081	4.26259	1.63433	2.22614

Table 4-6 Output,Income and Employment Multipliers: Alberta, 1981

	Output Multiplier		Income Multiplier		Employment Multiplier	
Sector	Type I	Type II	Type I	Type II	Type I	Type II
1. Agriculture	1.79052	2.18380	4.48376	9.52298	4.10417	5.93306
2. Fishing & Trapping	1.04626	1.11357	2.42668	4.49022	6.53587	7.68618
3. Logging & Forestry	1.00960	1.01041	2.75000	4.91667	5.13377	6.51447
4. Metal Mining	1.00000	1.00000	1.00000	1.00000	2.24220	3.24220
5. Mineral Fuels	1.41525	1.88354	3.90657	8.06229	6.01448	10.55931
6. Non-metal Mining	1.26658	1.73702	2.53489	4.73645	4.72101	8.16975
7. Mining Services	1.79418	2.30780	2.76425	4.73781	1.43248	2.65341
8. Food	1.66725	2.15637	2.99666	2.56829	2.75765	3.11386
9. Beverage	1.22230	1.56053	2.56829	4.83840	2.79086	3.00155
10. Tobacco	1.00000	1.00000	1.00000	1.00000	0.00000	0.00000
11. Rubber	1.04039	1.11140	2.33621	4.27032	2.47330	3.55995
12. Plastic	1.38991	1.88508	2.46136	4.57665	3.28945	4.98558
13. Leather	1.00000	1.00000	1.00000	1.00000	1.78432	1.88432
14. Textile	1.09219	1,23479	2.36278	4.33540	4.16131	5.47803
15. Clothing & Knitting	1,04337	1.12657	2.22212	3.99087	6.91427	8.07820
16. Wood	1.32709	1.92115	2.27800	4.12786	1.83493	3.33006
17. Furniture	1.50815	2.45940	2.41465	4.46248	2.75399	4.29907
18. Paper	1.22083	1.52014	2.48343	4.63022	1.51487	2.68143
19. Printing & Publishing	1.57838	2.83121	2.34899	4.30179	3.86305	6.27814
20. Primary Metal	1.36336	1.70235	2.54675	4.78488	4.90194	7.41691
21. Metal Fabric	1.55779	2.51310	2.44141	4.52792	2.92786	4.72361
22. Machinery	1.23892	1.59796	2.39850	4.42290	3.29934	5.21006
23. Tran-equipment	1.21444	1.36730	2.51829	4.71608	1.39579	2.59900
24. Electric Products	1.15532	1.43416	2.31878	4.22781	3.05297	4.53086
25. Non-metal nimetals	1.50349	2.36474	2.53448	4.75491	4.27552	6.58765
26. Petroleum & Coal PROD.	1.93035	2.35739	6.10271	13.43120	1.29660	2.53444
27. Chemical Products	1.30197	1.58332	2.85576	5.54019	4.45348	6.89381
28. Other Manufactured Ind.	1.33946	1.94647	2.41800	4.47310	12.47095	14.09772
29. Construction	1.62001	3.24470	2.47727	4.59744	4.08229	6.92916
30. Transportation Services	1.76584	3.50992	2.46099	4.57493	5.97358	8.73711
31. Communication Services	1.36868	3.27997	2.17683	3.88023	4.57673	7.05392
32. Other Utilities	1.24609	2.21731	2.24520	4.04601	2.34010	3.98370
33. Trade Services	1.46611	3.45372	2.19973	5.93640	3.66408	5.45279
34. Financial Services	1.33154	2.38358	2.32993	4.25438	8.84227	15.83994
35. Community Busuness & Personal Services	2.04907	3.47113	3.30390	6.63850	9.37568	12.27024

ranges from 1.55539 for Type I to 2.42212 for Type II; that is, a level smaller than most of the other sectors. In Alberta, the mineral fuels and non-metal mining industries rank the third and fourth in the size of the multipliers respectively.

5. Not only can we find remarkable distinctions between the mining industry and other industries, but we can also discern them within the mining industrial group in the sizes of input-output multipliers. In Canada, the non-metal mining industry has a smaller size both for the output multipliers and for the income and employment multipliers. Conversly, the sizes of input-ouput multipliers for mineral fuels industries always show a greater economic impact on Canadian development.

ANALYSIS OF MINING ECONOMIC IMPACTS ON THE CANADIAN ECONOMY

As we have discussed in Chapter II, both forward and backward likages from mining activity under way in Canada are relatively weak in general. What is more striking upon examining the linkage coefficients of the mining industry (Table 4-7, p.116) is the remarkably strong tendency in the size of the coefficients to decline from the forward linkages to backward linkages. This result can be ascribed to the supposition that the forward linkages render a much greater contribution to the larger sizes of input-output multipliers except for those applying to output multipliers. In other words, the strong forward linkages can be seen as a determinant of the greater impacts of income and employment of the industry. In the meantime, the higher forward linkage coefficients for the mining industry indicate that this production is prinmary for domestic consumption, and it is a result of the expansion of mineral resource processing, especially of the metal fabricating manufacturing in the

Table 4-7 Impact Coefficients for Selected Industries: Canada (1981)

sector	Forward linkage	Backward linkage	Employment	Import coefficient	Export coefficient
Mining Industry					
Metal mines	0.64831	0.34629	67.70	0.18025	0.11540
Mineral fuels	0.99840	0.28785	23.04	0.33683	0.24117
Non-metal mines	0.56573	0.15771	108.05	0.65830	0.75790
Mining Srevices	0.99978	0.45784	110.47	0.02675	-
Mineral Manufacturing					
Primary metal PROD.	0.82713	0.57567	64.80	0.17978	0.25585
Metal fabric PROD.	0.98658	0.44205	127.77	0.21866	0.08624
Nonmetal mineral PROD.	0.99323	0.45900	119.09	0.17925	0.08489
Petroleum & coal PROD.	0.57694	0.87103	12.29	0.06622	0.13786
Other Industries					
Agriculture	0.70814	0.52346	193.50	0.06996	0.21661
Food	0.41696	0.68347	717.17	0.11426	0.06683
Wood	0.59890	0.58919	16.49	0.07167	0.41150
Paper	0.47799	0.56076	91.47	0.06491	0.51498
Trans. equipment	0.41688	0.39692	49.74	0.45381	0.38473
Chemical products	0.82478	0.52481	53.82	0.22989	0.03133

Source: 1. Statistics Canada. The Input-Output Structure of the Canadian Economy 1981 (15-201).
2. 1981 Census of Canada: Population: Labour Force (Industry by Occupation) (92-923, Vol.1).

1960's and the petrochemical processing in the 1970's. In such a case, therefore, the true impacts of the mining industry can be captured by looking beyond the direct impacts to effects induced by rounds of consumer responding (that is, to the indirect and induced effects of the mining industry).

This apart, the smaller sizes of the backward linkage coefficients only show that the Canadian mining services industries; for example, the manufacture of mining equipment (see Chapter II), have not developed sufficiently to meet the needs of the local mining industry.

There are two reasons for the small output impacts of the mining industry. First, mining activity is usually to be seen as a capital-intensive business. For example, the capital and repair expenditure by the mining industry in 1981 was $12,685 million, or 12.5 percent of that of Canada's industries as a whole, according to Canada Mineral Yearbook 1982. It is obvious that such a huge magnitude of capital input will have a strong influence on the size of output multipliers if the prices of goods are constant. Second, in fact, the output value of the mining industry has grown slowly since the 1980's while the prices of mineral products have generally declined. According to Morici (1988), the price of crude petroleum in 1982 declined 15.8 percent in comparison with that of 1981, while metals and other minerals registered a 9 percent decline for the equivelent period.

Fig 2-1 evinces that non-metal mining activity, like metal-mining activity, is scattered all across Canada, while mineral fuels mining activity is concertrated in just a few provinces, led by Alberta. With its ubiquitious localized type of mineral resources and the final products mainly used in the local construction industry, the non-metal mining industry is considered as region-serving rather than region-forming, and its development rests on a limited local market which has a relatively small scale of operations. It is fair to say that the expectation is for the non-metal mining industry to generate few impacts on national economies.

SUMMARY

Details aside, a number of generalizatins can be offered about input-output analysis.

Input-output models have been developed which used the transactions accounts to capture the primary impact (direct plus indirect effects) of a change in final demand for a given industry or commondity output; this input can be measured for an individual industry (or commodity) or for the economy as a whole. Both open (i.e., one structured to capture the primary impact) and closed (i.e., geared to capture the total impact) input-output models have been used to measure the impact of the mining industry of Canada. Findings affirm that the latter plays a more important role than the former because the impact of the mining industry extends far beyond the direct impacts.

It should be noted that such models necessarily ignore the following factors which may be critical to industrial performance: (a) supply scarcity; (b) market demand; (c) foreign competition; (d) commodity substitution;and (e) technological and price changes.

Despite the limitations impinging on input-output analysis, impact analysis based on input-output models is a highly useful exercise in one important respect: it allows the application of a uniform methodology to a data base consistently derived across industries. Nickel (1978) has observed that multipliers derived from other techniques are not generally as amenable to interindustry comparison as those rooted in input-output analysis, and are thus somewhst limited in their usefulness for policy purposes. It is clear that to a certain extent the analytical technique chosen depends on the type of study being conducted; for example, the interregional and regional input-output models can be used to assess the impact of specific mining projects.

Finally, it is possible to generalize to some extent about the impact of the mining industry on economies. The input-output multipliers of the mining industry, in general, are neither remarkably high nor remarkably low in comparison with those of other industries. To be specific:

i the total income generated in the economy (GDP) resulting from a million-dollar increase in demand for mining is well within the range calculated for other industries; the multiplier for mining ranges from 2.6 to 4.8;

ii one job in mining creates one to six other jobs in the national economy; an outcome that overshadows the effects of other industries;

iii per million dollars of input, the amount of output created by mining is less than that of other industries;

iv The development of mining's linkages, especially the set of forward linkages, has become a determining factor in the size of its input-output multipliers.

Chapter V: Implications

Over the past several years, the Canadian mining sector's role in the economy has come under increasing scrutiny by both public bodies and outside parties, partly because of concerns over resource scarcity and environmental controls, but especially because of the search for an appropriate 'industrial strategy'.

In the light of the latter, there appear to be two significant policy issues, relating respectively to the size and configuration of the mining industry. The first concerns the rate at which the mining industry should grow relative to other industries. In other words, how prominent do we wish mining to be in the economy? The second issue is whether it would be advantageous if mining were more closely integrated into the national economy. Put otherwise, the question reduces to the issue of whether mining would supply more of its products to domestic processors and fabricators, while purchasing more of its inputs from domestic suppliers, if a closer intergration was encouraged. And if this closer intergration is desirable, how can it be brought about?

THE GROWTH OF MINING AND AN INDUSTRIAL STRATEGY

To a large extent the industry's growth, which is manifested in its ability to maintain or increase its relative size in the Canadian economy, will be determined by such uncontrollable forces as international mineral demand, the activities of other supplier nations, and changing trends in consumption and technology. In truth, the Canadian mining industry has evolved largely as a producer for foreign markets with its strong competitive position based on the substantial endowments of mineral resources; a state of affairs affording it considerable export strength in minerals products. But the development under such an export orientation, paradoxically, has accentuated a three-decade downward trend in the contribution of natural resources to Canadian exports. Specifically, the group petroleum and natural gas, minerals, and basic metals (which, through a statistical quirk, includes forest products) accounted for 65 percent of Canada's total merchandise exports in 1960, 47 percent in 1970 and only 36 percent in 1984. Turning to secondary manufactures, the motor vehicles and parts' portion of Canadian exports has fluctuated significantly but averaged about 23 percent over the past two decades. Meanwhile, other secondary manufactures steadily increased their share from 15 percent in 1960 to 19 percent in 1970, climbing to over 25 percent in recent years. Both trends reflect a fact that transformation of Canadian economic structure demands the mining industry to be closely integrated with the national economy rather than merely to expand its crude mineral products. On the other hand, a changing world environment forces the mining industry to face a number of great challenges. These challenges are briefly reviewed below.

- The slowdown of growth rates in the world economy since 1974.
- The changing geographical patterns of industrial growth and mineral consumption.
- Continued protection against processed mineral imports through tariffs and nontariff barriers in 'developed market economies' such as Japan, and especially in some 'newly industrializing countries' such as South Korea, Singapore, Taiwan, Brazil and Mexico.
- The discriminatory mineral procurement strategies of some major industrialized countries motivated by security of supply considerations.

- International initiatives to manage mineral markets.

These situations may not easily be changed given the export orientation of the Canadian industry. Since Canadian mineral enterprises generally have been quite successful in penetrating and maintaining export markets and in view of the fact that the government gives strong support to the industry's growth and promotes more effective and aggressive bargaining strategies, it is unlikely that the Canadian desire for more open and liberal mineral trading regimes will be received with sympathy by competing international interests. Therefore, it is reasonable to say that there are few opportunities for such an industrial strategy to make much headway. Indeed, the result will be limited because of the small size of the direct effects within the Canadian economy even if the strategy can be carried out successfully.

STRENGTHENED LINKAGE IN AN INDUSTRIAL STRATEGY

This major issue is associated with the role of mining in the economy. What should be the nature of this role? Are there good reasons for suggesting that mining's interaction with the rest of the economy should be altered through the development of more forward or backward likages?

As the study has made clear, the desirability of further development of linkages has not been firmly established. Nevertheless, Canadian governments have articulated policies which call for strengthened linkages to and from mining.

We have attempted to define mining's present linkages, to identify areas where the linkages are less than complete, and to specify where such inadequate linkages ("leakages") are significant for policy purposes. We have also discussed factors that affect the feasibility of developing particular linkages. Therefore, the conclusions which we arrive at contain no surprises. In the first place, they imply that there is only limited scope for expanding mining's forward linkages. Exported items in the 1981 input-output tables represent a relatively small fraction of mining output. Some opportunities do exist for the development of forward linkages, however. Secondly, under current conditions, Canadian processing opportunities are in many instances not financially attractive. Canada has structural disadvantages with respect to domestic market size, limited access to foreign markets and trading blocs, and regimes of transportation costs, wage rates, and environmental controls which could be judged unfavourable. An ample supply of mineral resources and a relatively favourable energy situation may offset these drawbacks in specific cases. The particular constraints associated with the penetration of foreign markets with highly processed items appear to have been underestimated in most analyses.

In contrast, there are some outstanding opportunities for expanding mining's backward linkages. For example, the most significant market forces likely to affect the mining-oriented manufacturing activities during the next decade are: (a) a surge in demand for equipment common to the energy and nonenergy mineral sectors, partly stimulated by tar-sands development; (b) continued strength in the market for open-pit mining equipment; (c) a growing need for energy efficiency that will rapidly make the existing stock of inefficient machinery obsolete; (d) the increasing substitution of capital for labour, resulting from skilled labour shortages and health and safety issues; and (e) environmental regulation (points identified in a discussion paper of Energy, Mines and Resources Canada,1982). Furthermore, the increased demand for an adequate level of mineral-oriented scientific and technological activity in Canada could be considered as a possible means of pursuing such an expansion. This industrial strategy will help the industry to reduce the leakage effects of its backward linkages, retain its competitive standing and thus contribute its full potential towards growth in Canada's per capita income.

Appendix I: The Relationship of Input-output and Economic Base Multipliers

Export-base theory provides the simplest form of regional income model. Its importance lies in the fact that it supplies the theoretical framework for many empirical regional multiplier studies. The central assumption of the theory is that exports are the sole autonomous item of expenditure. All other components of expenditure are treated as functions of income, and the expenditure and import functions are both assumed, as endogenous elements, to have no intercepts but pass through the origin. Thus for region i, for example, we may write:

$$Y_i = (E_i - M_i) + X_i \quad 1$$

income = domestic spending + Export

$$E_i = e_i Y_i \quad 2$$

$$M_i = m_i Y_i \quad 3$$

$$X_i = \bar{X}_i \text{ (exogenous).} \quad 4$$

Substituting 2,3 and 4, into 1 we obtain:

$$Y_i = e_i Y_i - m_i Y_i + \bar{X}_i .$$

Therefore

$$Y_i = \bar{X}_i / 1 - e_i + m_i \quad 5$$

It follows, then that regional income is a multiplier of exports provided that the marginal propensity to spend locally (e - m) is less than unity.

Rearranging 5 we can see that:

$$Y_i / \bar{X}_i = 1 / 1 - e_i + m_i \quad 6$$

Thus, if we measure the ratio of exports to total income, its reciprocal clearly acts as the multiplier. The base multiplier:

$$K_i = 1 / 1 - e_i + m_i$$

is the outcome if we differentiate income with respect to exports; i.e., $dY_i / d\bar{X}_i$. Consequently, the assumptions of the model determine that:

$$Y_i / \bar{X}_i = dY_i / d\bar{X}_i \qquad 7$$

An often quoted drawback of these models is that the size of the export base is an inverse function of the size of a region. It is sometimes implied that this is a crucial objection to base theory since we can more or less obtain any multiplier value we desire by varying the scale of the region studied. But multiplier values are in fact higher for large regions. A large region will tend to have a smaller export base but it will also have a low m, and this will tend to raise K; conversely, a small area will have not only a high export-income ratio but also a high m; both of which will tend to reduce K. Though the variation of the importance of the export base with scale of area remains awkward for the usefulness of base theory, an offsetting factor is the covariation of $\bar{X} / Y$ and m.

For a more satisfactory regional income model, Richardson (1969) suggests that it is appropriate to alter the assumptions of the export base model. The crucial change centres on the proposition that exports are no longer treated as the sole autonomous expenditure component. Firstly, autonomous consumption, private investment and government spending are assumed to be determined exogenously. Secondly, a region's exports will be determined by the import demands of other regions in a closed system. Finally, taxes are logically included in the model and private consumption spending is considered to be encapsulated within the function of disposable income (usually all taxes fall upon income in the simplifying assumption). Therefore, an improved regional model can be represented as follows:

$$Y_i = C_i + I_i + G_i + X_i - M_i \qquad 8$$

where C_i = households; I_i = private investment; G_i = government expeditures;

X_i = exports and M_i = imports;

$$C_i = a_i + C_i Y_i^d \qquad 9$$

where Y^d = disposable income and C = marginal propensity to consume;

$$I_i = \bar{I}_i \qquad 10$$

$$G_i = \bar{G}_i \qquad 11$$

$$X_i = \sum_{j=1} M_{ij} = \sum_{j=1} M_{ij} Y_j^d \qquad 12$$

$$M_i = \sum_{j=1} M_{ji} Y_i^d \qquad 13$$

$$Y_i^d = Y_i - T_i \qquad 14$$

$$T_i = t_i Y_i \qquad 15$$

where t = marginal rate of taxation.

$$A_i = a_i + \bar{I}_i + \bar{G}_i \qquad 16$$

where A_i = total autonomous expenditures.

Substituting equations 9--16 into 8, and rearranging yields the income equation:

$$Y_i = A_i + \sum_{j=1} M_{ij} Y_i (1-t_i) \;/\; 1 - (C_i - \sum_{j=1} M_{ji})(1-t_i) \qquad 17$$

The income of region i thus consists of the sum of autonomous expenditures plus exports, all weighted by the multiplier:

$$1 \;/\; 1- (C_i - \sum_{j=1} M_{ji})(1-t_i). \qquad 18$$

This multiplier is called the Keynesian Income Multiplier.

In regional economic analysis the simplest of all multipliers is derived from the economic base model (Richardson, 1972). Despite its primitive theoretical framework, practical problems arising from its application and the heavy barrage of criticisms that it has had to face over the past decades, the model has recently undergone a resurgence. Isard and Czamanski (1965) and

Garnick (1969, 1970), in particular, have argued that for certain purposes economic base multipliers can be substituted for the input-output (I-O) approach. Garnick (1970) has argued that:

> Basic-service multipliers are... presented as cost-effective alternatives to I-O multipliers for small regional impact studies. Indeed there are inexpensive means for augmenting the former such that differential multipliers are derived approximating most of the differential multipliers derived from I-O matrices.

Isard and Czamanski (1965) conclude that: " The size of the multiplier effect derived and the justification for the use of one model as against another depends primarily upon the problem at hand, data available and the time and the resources which the analyst can command".

The argument rests on two props; namely, that the consolidated closed model I-O multiplier and the economic-base multiplier are mathematically identical; and that empirical estimates of the Type II (see Chapter IV,). I-O multiplier and the economic base multiplier are, when defined in a comparable manner, approximately the same. The mathematical identity between the two multipliers has been demonstrated by Billings (1969) and by Garnick (1970).

The standard regional Leontief model is:

$$X = (I - A)^{-1} Y \qquad 19$$

Miyazawa's disaggregated income multiplier (1968) revised the standard input-output model to:

$$X = B(I - CVB)^{-1} Y \qquad 20$$

where B = the usual Leontief inverse matrix, C = n2 * 2 matrix of regional consumption coefficients (where each element C_i^{rs} = consumer expenditure on commodity i produced in region r from one unit of income earned in the household sector of regions), and V = z * nz matrix of value-added scores in the household sectors in each region (where each element V_j^{rs} = income of a household in region r earned from one unit of production of industry j in region s).

This conversion is carried out via pre-multiplying by the household value-added coefficients. Thus:

$$Y^* = VX = VB(I - VB)^{-1} Y. \qquad 21$$

where Y^* = total income.

The economic-base model divides the regional economy into exogenous basic sectors and endogenous local sectors that are functionally related to total income.

$$Y^* = \sum_{i=1}^{d} Y_{Li} + \sum_{i=d+1}^{n} Y_{Ei} \qquad 22$$

where $\sum_{i=1}^{d} Y_{Li}$ = income earned in local-service industries (i=1,2,...,d).

$\sum_{i=d+1}^{n} Y_{Ei}$ = income earned in the basic or exogenous sector (i=d+1, d+2, ..., n). This latter definition may be expressed as:

$$\sum_{i=d+1}^{n} Y_{Ei} = E \qquad 23$$

For its part, local endogenous income can be expressed in terms of total income:

$$\sum_{i=1}^{d} Y_{Li} = \sum_{i=1}^{d} C_i Y^* \qquad 24$$

where $C_i = Y_{Li} / Y^*$ = the propensity of residents to consume locally-produced goods and services.

Substituting 23 and 24 into 22 we obtain:

$$Y^* = \sum_{i=1}^{d} C_i Y^* + E$$

Therefore:

$$Y^{*} = (1 - \sum_{i=1}^{d} C_i)^{-1} E \qquad 25$$

since Y^{*} is common to both, and if E equals the sum of elements in vector Y, then it follows that the consolidated I-O multiplier of equation 21, i.e., the average industry multiplier in which each inverse column sum is weighted by its industry share of total deliveries to final demand, must equal the aggregate economic-base multiplier of equation 25. thus:

$$VB (I - CVB)^{-1} = (1 - \sum_{i=1}^{d} C_i)^{-1} \qquad 26$$

At the empirical level results are not identical, since it is not possible to make a perfect match between the final-demand vector of the I-O model and exogenous basic sectors. But the I-O and basic-service multipliers are essentially similar: both reflect the direct, indirect and induced income effects of exgenous changes in output and both are average rather than marginal multipliers. In a comparison of five ares (California, Los Angeles, San Francisco, St Louis and Kalamazoo), Isard and Czamanski showed that the economic-base multiplier (after adjustments to treat investement and government expenditure as basic activities) was "generally of the same order of magnitude" as the Type II I-O multiplier. Garnick (1970) went even further. He argued that, with certain exceptions, sector multipliers in the closed I-O model tend to cluster around the value of the consolidated matrix or the adjusted base multiplier. In addition, he estimated differential multipliers for broad industrial groups by combining the base multiplier approach with estimation of direct impacts on basic industries obtained by using adjusted national I-O coefficients. These represented a sensible compromise between the aggregate base multiplier on the one hand and individual sector multipliers from a regional I-O model on the other.

Appendix II: Income and Employment Coefficients: Canada, 1981

sector	Income Coefficients Direct	Income Coefficients Direct & Indirect	Income Coefficients Total	Employment Coefficients Direct	Employment Coefficients Direct & Indirect	Employment Coefficients Total
1 Agriculture	0.19350	0.46286	0.60882	0.19350	0.46286	0.60882
2 Fishg Trapg	0.14110	0.24114	0.37795	0.34932	0.42950	0.57660
3 Logg Forest	0.32512	0.56597	0.88706	0.21829	0.46427	0.80953
4 Metal Mining	0.19936	0.32849	0.51494	0.06770	0.17691	0.37734
5 Crud Pet Gas	0.04981	0.15229	0.23868	0.02304	0.07802	0.17091
6 Quarries	0.09372	0.15352	0.24061	0.10805	0.16806	0.26171
7 Ser mines	0.28221	0.46455	0.72967	0.11047	0.32665	0.61065
8 Food	0.13004	0.34816	0.54568	0.71717	1.15752	1.36990
9 Beverages	0.20059	0.38479	0.60308	0.08665	0.34790	0.58263
10 Tobacco	0.15424	0.38890	0.60954	0.05755	0.34071	0.57795
11 Rubber	0.24566	0.39028	0.61170	0.10352	0.23157	0.46965
12 Plastic	0.18108	0.35435	0.55538	0.11219	0.25649	0.47265
13 Leather	0.21034	0.35608	0.55809	0.16957	0.33108	0.54830
14 Textile	0.17213	0.32263	0.50567	0.12143	0.25259	0.44941
15 Clothing	0.26202	0.42370	0.66407	0.24996	0.39419	0.65265
16 Wood	0.28651	0.59359	0.93035	0.16924	0.44352	0.80563
17 Furniture	0.28198	0.49593	0.77729	0.22975	0.40040	0.70293
18 Paper	0.21279	0.46093	0.72243	0.09147	0.30713	0.58331
19 Printg Publ	0.31458	0.50704	0.79470	0.18384	0.34116	0.65047
20 Prim Metal	0.16836	0.37580	0.58902	0.06480	0.22169	0.45095
21 Mtal Fabric	0.23335	0.40960	0.64198	0.12777	0.26025	0.51012
22 Machinery	0.11265	0.18509	0.29010	0.06190	0.11553	0.22944
23 Trans Equip	0.11776	0.23865	0.37405	0.04974	0.13266	0.27825
24 Electr Prod	0.18940	0.30721	0.48150	0.07954	0.16581	0.35321
25 N Mtal Prod	0.22754	0.39188	0.61421	0.11909	0.28037	0.51943
26 Ref Pet Coal	0.03508	0.19406	0.30416	0.01222	0.11137	0.22975
27 Chemic Prod	0.12282	0.29118	0.45637	0.05382	0.20753	0.38516
28 Other Manut	0.14410	0.24354	0.38171	0.09895	0.18058	0.32914
29 Construct	0.29767	0.51739	0.81093	0.12701	0.29813	0.61375
30 Trans Ser	0.34799	0.53526	0.83893	0.33898	0.51574	0.84227
31 Comnu Ser	0.48560	0.58489	0.91672	0.23390	0.31707	0.67387
32 Other Util	0.22386	0.28881	0.45266	0.11372	0.16106	0.33724
33 Trad Ser	0.49746	0.61311	0.96094	0.38607	0.49378	0.86779
34 Finan Ser	0.23681	0.32099	0.50310	0.03927	0.10288	0.29869
35 Communti Ser	0.18274	0.46979	0.73632	0.48426	0.79144	1.07803

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