THE UNIVERSITY OF MANITOBA

FURTHER PROCESSING: THE CASE OF COPPER IN MANITOBA

by

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ABSTRACT

Canada has been exporting a large amount of minerals with minimum processing. This constitutes a growing concern among Canadians that Canada is forgoing the opportunities of attaining the economic benefits and industrial diversification which are associated with further mineral processing. The aim of this study is to examine the issue of additional processing with specific reference to the case of copper in Manitoba.

An understanding of the mineral industry in Manitoba is essential, so as to facilitate the analysis of the existing structure of the copper sector in the province. To this end the term mineral industry is defined, and the current status of copper in the Manitoban economy depicted. In addition, the existing copper-producing mines in Manitoba are identified.

Economic linkages are generated with further processing. Classified as forward, backward, and final demand in nature, these economic ties established between primary and secondary industries are basic sources of industrial diversification and economic growth. Forward linkage, in particular, is extremely useful in initiating industrial expansion, owing to its ability of reinforcing backward linkage effects. As far as copper in Manitoba is concerned, the metal is not generating any forward linkage within the province, since all of it beyond the smelting stage is currently shipped out of the province for additional processing. It is the contention of this study that Manitoba will benefit from the economic gains which can accrue to further copper processing, if situations are favourable for such economic development.

Indeed, further processing purports to bring home economic benefits of direct, indirect, and induced varieties. However, mineral development of this magnitude cannot be taken for granted, in view of the fact that some possible domestic constraints may jeopardize this investment scheme. The constraints may include the following: availability of mineral resources, market size, market price, capital, energy, labour, transportation, trade barriers, and multi-national firms. As a matter of fact, the ability of Manitoba to build

even a copper refinery of contemporary competitive capacity, for instance, is primarily hampered by insufficient supplies (among other things) of copper ores produced in the province.

Broadly speaking, the development of natural resources in Canada is based on these stated objectives: quality of life, sovereignty & unity, and economic growth & development. These objectives constitute a framework within which a wide range of interactions between the public and private sectors in our society is encompassed. Accordingly, mineral development involves significant elements beyond mere economics, to take into account environmental, social and political implications. As such, a co-ordinated approach to deal with these considerations squarely is absolutely essential; therefore, the development of further processing of copper in Manitoba must be planned in this spirit.

As a strategy of mineral development, further processing can be a significant policy vehicle to bring about greater economic and social well-being in Canada, provided that the investment decision is compatible with the economic and political reality. In fact, it is necessary to establish the feasibility and identify the opportunities of further processing, before any decision on such gigantic investment adventures can be made. This undertaking demands tremendous mutual understanding and co-operation between the government and the resource industry, which naturally points to an awesome task that remains an imposing challenge to policy-makers in the public and private sectors all the same.

TABLE OF CONTENTS

		PAGE
LIST OF TABLES		viii
LIST OF FIGURES		x
CHAPTER		
ONE	INTRODUCTION	1
TWO	COPPER IN THE MANITOBA MINERAL INDUSTRY	5
	The Definition of Mineral Industry	5
	The Place of Copper in Manitoba	9
	Copper-producing Mines in Manitoba	12
	Copper Ore Reserves in Manitoba	15
THREE	FORWARD LINKAGE AND COPPER IN MANITOBA	19
	The Concept of Economic Linkage	19
	A Note on Forward Linkage	21
	The Role of Copper in the Manitoba Mineral Industry in Generating Forward Linkage	24
	Forward Linkage, Economic Growth, and Copper in the Manitoban Economy	29
FOUR	FURTHER PROCESSING OF COPPER IN MANITOBA	33
	The Economic Meaning of Further Processing of Copper	33
	Some Domestic Constraints to Further Processing	36
	Feasibility of Developing Further Processing of Copper in Manitoba	46
	Some Reflections on Further Processing of Copper in Manitoba	49
FIVE	TOWARDS A MINERAL POLICY OF COPPER FOR MANITOBA	52
	The Objectives of a Mineral Policy in Canada	52
	The Economic, Social, Environmental, and Political Considerations of a Mineral Policy	54

PAGE

A Co-ordinated Approach to Copper Development in Manitoba 57

A Concluding Remark 59

APPENDIX 61

SELECTED BIBLIOGRAPHY 63

LIST OF TABLES

TABLE		PAGE
I.	Canada's Share of Selected Minerals, 1972-1973 (% of free-world production and consumption)	1
II.	Per Cent Contribution by Provinces to Canada's Total Mineral Production, Selected Years 1955-1975	3
III.	Manitoba, Value of Leading Minerals as a % of Total Production in the Province, 1975	3
IV.	Canada, % of World Mine Production of Copper, 1971-1980	9
V.	Value of Copper in Manitoba as a % of Mine Production of Copper in Canada, 1971-1975	10
VI.	Manitoba, $ Value of Mineral Production, % of Total, 1970-1975	11
VII.	Manitoba, Value of Copper as a % of Gross Provincial Productivity, 1971-1975	11
VIII.	Copper Operators and Mines in Manitoba, 1974	13
IX.	Published Copper Ore Reserves in Manitoba, 1972-1975	17
X.	Pattern of Copper Concentrates Transaction for Smelting & Refining in Manitoba	27
XI.	Copper, Number of Workers Employed in Canada at the Different Levels of Activity in 1971	34
XII.	Values of Different Levels of a Fully Integrated Copper Industry (% of total value of copper industry)	35
XIII.	Fuel & Power as a Percentage of Value Added, by Stages of Production, 1969	39
XIV.	Energy as a % of Cost of Factor Inputs Per Pound of Contained Copper by Stages of Processing in Canada, 1971	40
XV.	Job Vacancies in Sixty-three Mines in Canada, 1974	41
XVI.	Percentage Labour Turnover by Category in the Canadian Mining Industry, 1973	41
XVII.	Ocean Shipping Costs Between Vancouver and Japan of Copper Products, 1973	43

		PAGE
XVIII.	Import Tariffs, by Stage of Processing, in Effect in Early 1973 (%), Levied on Canadian Commodities	44
XIX.	Import Tariffs by Stage of Processing as of Early 1973, Levied on Canadian Commodities	45
XX.	Capital Investment Requirements for a Copper Smelter/ Refinery Complex of 125,000 Tons Per Year Capacity	48

LIST OF FIGURES

FIGURE		PAGE
1.	Structure of the Mineral Industry	6
2.	Flows of Copper Products	8
3.	The Concepts of Reserves and Resources Illustrated	16
4.	Determinants of Forward Linkage Illustrated	22
5.	Stages of Copper Ore Processing	25
6.	Manitoba Copper Flow Chart	28
7.	The Growth of Income at Full Capacity	30
8.	Employment Growth by Selected Industries in Canada, 1962-1972	42

CHAPTER ONE

INTRODUCTION

The tremendous increase in world demand for minerals since the Second World War has brought about rapid development of mining in Canada. However, Canada has been exporting a significant quantity of minerals with a minimum amount of processing. Indeed, the share of crude materials in total exports from Canada increased from 35% in 1953 to 37% in 1973.[1] This is simply because Canada has large, diversified production of minerals, which happens to be far in excess of her domestic needs. For illustration purposes, Table I shows Canada's production and consumption of some major minerals in 1972-1973.

TABLE I

CANADA'S SHARE OF SELECTED MINERALS, 1972-1973

(% of free-world production and consumption)

MINERAL	PRODUCTION	CONSUMPTION
Asbestos	63.7	3.2
Nickel	50.0	2.4
Zinc	27.8	7.2
Silver	26.5	5.4
Uranium	19.8	1.7
Lead	14.4	2.3
Copper	13.6	3.9
Iron ore	11.6	3.1
Gold	4.9	1.9

(Source: Abridged from Greenshields Incorporated, CANADA: RESOURCES AND POTENTIAL, Summer, 1974, pp.26-27)

1. See B.W. Wilkinson, CANADA'S INTERNATIONAL TRADE: AN ANALYSIS OF RECENT TRENDS AND PATTERNS (Montreal: Private Planning Association, 1968), Table A-13, p.186; and STATISTICS CANADA, External Trade Division.

It seems likely that an expansion of mineral processing in Canada can generate substantial economic gains to the country. Accordingly, the federal and provincial governments are now placing greater emphasis on mineral processing and manufacturing as an industrial objective. Specifically, the federal government has recently stated that:[2]

> Mineral policy should first seek, whenever possible, to increase diversification and growth of national and regional economies based on minerals. This would include not only increased mineral processing but also more mineral-based manufacturing prior to export, and strengthened ties with other sectors of the economy.

In addition, Ottawa had recently introduced Bill C-4 (in May, 1974), by virtue of which the federal government will have the power to impose export controls on any products, in the event that unrestricted export of them will impede efforts to develop more processing in Canada. At the provincial level, Ontario, for instance, has introduced a special tax incentive for processors. The B.C. government has promised to subsidize the proposed Afton Mines Limited smelting project on a basis of two cents per pound on all copper smelted during the first four years of the plant's operation.[3]

Likewise, Manitoba is investigating into the opportunities for some expansion of mineral processing, since the province is endowed with some mineral wealth. Compared with other provinces, Manitoba in these two decades, for example, has been contributing moderately to Canada's total mineral production, which is shown in Table II as follows.

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2. See Department of Energy, Mines and Resources, TOWARDS A MINERAL POLICY FOR CANADA: OPPORTUNITIES FOR CHOICE (Ottawa, 1974).
3. For more information about this project, see J. Schrenier, " B.C. Improving Climate for its Mining Firms, " FINANCIAL POST November 1, 1975.

TABLE II

PER CENT CONTRIBUTION BY PROVINCES TO CANADA'S TOTAL MINERAL PRODUCTION, SELECTED YEARS 1955 - 1975

Province \ Year	1955	1965	1970	1974	1975*
Alberta	18.2	20.5	24.4	38.6	44.8
Ontario	32.5	26.8	27.8	20.7	17.5
British Columbia	10.6	7.5	8.6	9.9	9.1
Quebec	19.9	19.3	14.0	10.2	8.5
Saskatchewan	4.7	8.8	6.6	6.7	6.2
Newfoundland	3.8	5.6	6.2	3.8	4.2
Manitoba	3.5	4.9	5.8	4.2	4.0
New Brunswick	0.9	2.2	1.8	1.8	1.9
Northwest Territories	1.4	2.1	2.4	1.9	1.4
Yukon	0.8	0.4	1.4	1.5	1.7
Nova Scotia	3.7	1.9	1.0	0.7	0.7
Prince Edward Island	-	0.02	0.01	0.01	0.01
TOTAL — CANADA %	100.0	100.0	100.0	100.0	100.0
$ (million)	1,795.3	3,714.9	5,722.1	11,711.0	13,402.6

* preliminary (Source: CANADIAN MINERAL JOURNAL February, 1976, p.32)

Manitoba also produces a variety of minerals; for example, the leading minerals produced in the province in 1975 are illustrated in Table III below.

TABLE III

MANITOBA, VALUE OF LEADING MINERALS AS A % OF TOTAL PRODUCTION IN THE PROVINCE, 1975

Nickel	55.0	Gold	1.4
Copper	16.9	Silver	0.8
Zinc	10.3	Tantalum	0.6
Structural Materials	7.5	Cobalt	0.4
Petroleum Crude	5.9		

(Source: CANADIAN MINERAL JOURNAL February, 1976, p.43)

Copper is currently the second leading mineral produced in Manitoba. This study proposes to look into the absolute size of the copper sector in Manitoba, and then attempts to assess its forward linkage impact on the Manitoban economy. To evaluate the feasibility of developing further processing facilities for copper in Manitoba, the study also seeks to identify some possible domestic constraints which may impede such industrial expansion, with an eye to facilitating the formulation of mineral policy with regard to copper in the province.

CHAPTER TWO

COPPER IN THE MANITOBA MINERAL INDUSTRY

1. The Definition of Mineral Industry

Broadly speaking, the mineral industry consists of sectors from both primary and secondary industries. In terms of economic activities, it represents four distinct levels, namely: mineral exploration, mineral extraction, resource processing, and resource-based manufacturing. At the extractive phase, metallic and non-metallic minerals are mined from the earth; and the mineral-bearing earth materials are mechanically reduced from their bulky forms into finely-ground concentrates. Resource processing refers to smelting and refining, which treat minerals through to their purer forms. Resource-based manufacturing is the stage when mineral products are further processed into semi-fabricated and fabricated commodities.

The " Standard Industrial Classification " (SIC) issued by Statistics Canada is devised to classify industrial groups in conformity with the existing organization and structure within Canada.[1] This is designed to facilitate the compilation of statistics for analysis purposes. Defined in this context, the mineral industry can be viewed as a framework to cover a wide range of economic activities, including exploration, development, processing, and manufacturing of mineral resources. Naturally, the services incidental to mining also account for a substantial portion of economic activities in the mineral industry. The structure of the six major industrial groups which are involved in the mineral industry, for instance, can be diagrammatically represented in Figure 1.

1. For an illustration of SIC with regard to mining and mineral manufacturing, see Appendix A.

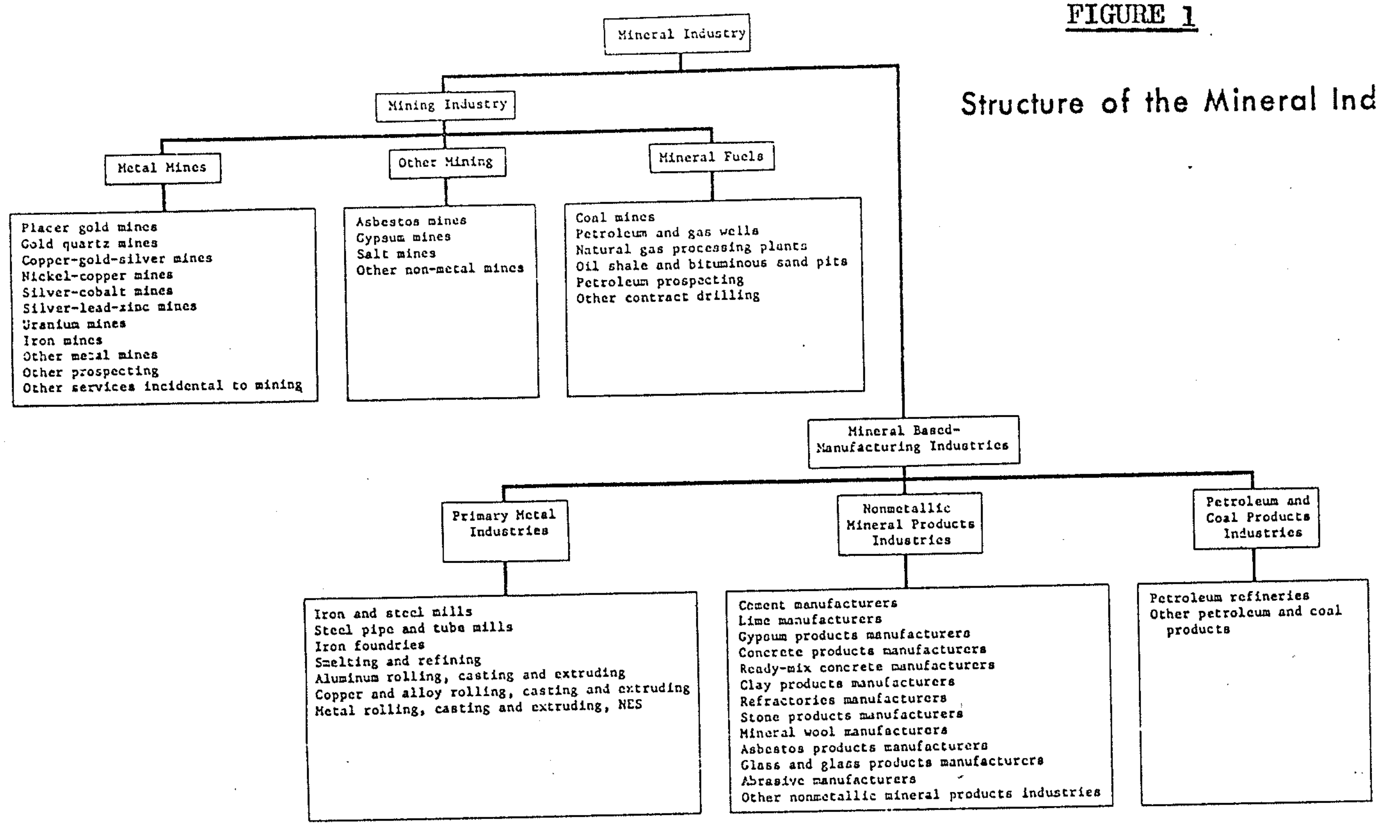


FIGURE 1

Structure of the Mineral Industry

(Source: S.P. Malhotra, RETURN ON CAPITAL ANALYSIS IN THE CANADIAN MINERAL INDUSTRY, Department of Energy, Mines & Resources, Ottawa, 1973, p. 17.)

However, there is no standard definition of mineral industry which gains the consensus of all people. Indeed, different definitions of mineral industry will be adopted for different research motives. This fact is keenly observed as follows:[2]

> ... at present, there is no recognized standard definition (of mineral industry) available which may profitably be used for purposes of mineral economic studies. The use of the term mineral industry in Canada tends to be confusing. It varies from department to department and from user to user. For example, Statistics Canada considers the mineral industry to consist of only mining and milling industries, whereas the Mineral Resources Branch of the Department of Energy, Mines and Resources extends this to include smelting and refining activities as well.

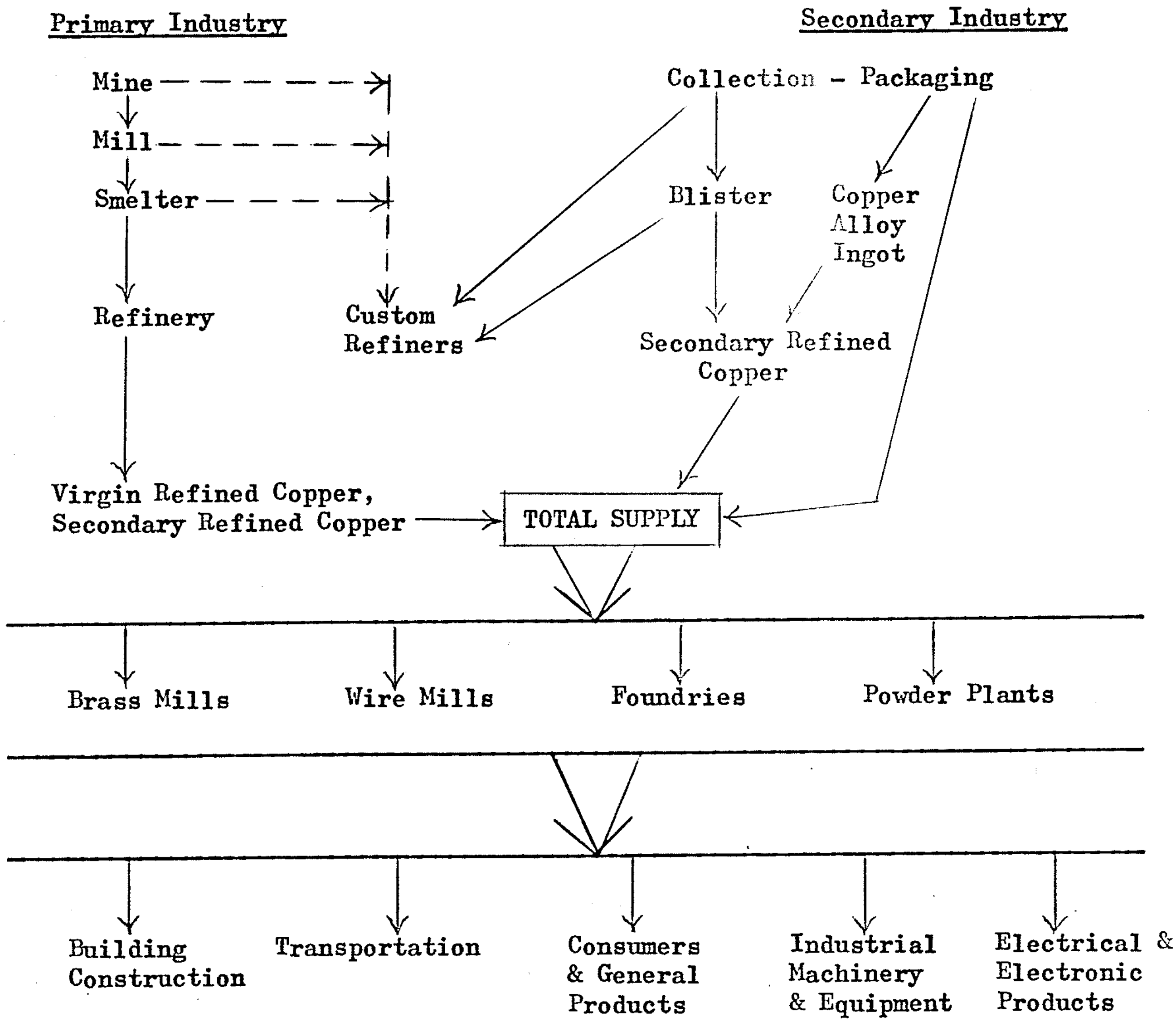
For the purpose of this study, the mineral industry of Manitoba is defined in terms of mining and milling industries, together with smelting and refining activities. In particular, copper is the metal being studied in this context.

It appears instructive at this stage to show the stages of production through which copper ore-bearing materials are converted into end products. The whole process of production from ores to fabricators to final consumers involves both the primary and secondary industries, which is diagrammatically depicted in Figure 2.

2. See S.P. Malhotra, RETURN ON CAPITAL ANALYSIS IN THE CANADIAN MINERAL INDUSTRY, *ibid.*, p. 14.

FIGURE 2

FLOWS OF COPPER PRODUCTS



(Source: Charles River Associates Incoporated, ECONOMIC ANALYSIS OF THE COPPER INDUSTRY, Cambridge, Massachusette, 1970)

2. The Place of Copper in Manitoba

Copper is a useful metal mainly because of its properties of malleability, ductility, conductivity, corrosion resistance and alloying qualities. As a matter of fact, copper is widely used and popularly demanded in the electrical, construction, plumbing and automobile industries. Canada is richly endowed with copper, of which Manitoba's contribution appears moderate but steady.

In terms of world mine production of copper, Canada climbed from fifth place in 1970 to fourth position in 1971. From 1972 onward, Canada has been occupying third place, just behind the United States and U.S.S.R. Indeed, it is also forecast that Canada's mine production of copper will remain stable at approximately 10% of the world total for the next five years to come. The overall situation is illustrated in Table IV.

TABLE IV

CANADA, % OF WORLD MINE PRODUCTION OF COPPER,
1971 - 1980
(000 short tons)

Year	Canada	World	% of World
1971	721.4	7,091.9	10.2
1972	793.3	7,782.4	10.2
1973	908.2	8,303.5	10.9
1974	905.4	8,573.2	10.6
1975[p]	798.1	7,460.0	10.7
1976[f]	860	8,000	10.8
1977	900	8,200	10.9
1978	920	8,900	10.3
1979	920	9,800	9.4
1980	990	10,200	9.7

p : preliminary
f : forecast (1976-1980)

(Source: Based on Statistics Canada; CANADIAN MINERAL YEARBOOK 1972, 1973 & 1974; and CANADIAN MINERAL JOURNAL February, 1976.)

At the same time Manitoba is contributing an average of about 8.2% to the total mine production of copper in Canada between 1971-1975, ranging from 7.7% in 1971 to 8.9% in 1975, as demonstrated in Table V.

TABLE V

VALUE OF COPPER* IN MANITOBA AS A % OF MINE PRODUCTION OF COPPER IN CANADA, 1971 - 1975

Year	1971	1972	1973	1974	1975p
MANITOBA					
(000 short tons)	55.3	59.8	71.3	78.4	70.8
($ million)	58.4	60.9	91.0	121.5	90.2
CANADA					
(000 short tons)	721.4	793.3	908.2	905.4	798.1
($ million)	760.0	806.4	1,157.5	1,402.6	1,016.8
% OF CANADA					
(in short tons)	7.7	7.6	7.9	8.7	8.9
(in dollars)	7.7	7.6	7.9	8.7	8.9

* Blister copper plus recoverable copper in matte and concentrates exported;
p : preliminary

(Source: Based on CANADIAN MINERAL YEARBOOK 1972, 1973 & 1974; and CANADIAN MINERAL JOURNAL February, 1976)

Copper is an important metal produced in Manitoba. At present, copper is the second leading metal in terms of monetary value in the province. For example, between 1970 to 1975, of the total value of the minerals produced in Manitoba, copper has been contributing an average annual share of 19.5%. The annual shares of copper compared with those of the other minerals produced in Manitoba between the same period are shown below.

TABLE VI

MANITOBA, $ VALUE OF MINERAL PRODUCTION,
% OF TOTAL, 1970 - 1975

Mineral \ Year	1970	1971	1972	1973	1974	1975
Nickel	64.7	63.8	58.2	54.4	45.7	55.0
Copper	16.8	17.7	18.9	21.7	25.0	16.9
Zinc	3.8	2.5	5.4	7.7	9.9	10.3
Structure Materials*	7.8	9.2	11.1	9.2	9.4	8.2
Petroleum, Crude	4.5	4.7	4.5	4.1	5.6	5.9
Gold	0.4	0.3	0.7	1.1	1.7	1.4
Silver	0.4	0.3	0.4	0.7	1.2	0.8
Tantalum	0.7	0.9	0.1	0.3	0.7	0.6
Cobalt	0.6	0.4	0.5	0.5	0.4	0.4
Other**	0.5	0.2	0.4	0.5	0.4	0.4

* includes: clay products, cement, gypsum, lime, peat moss, quartz, salt, stone, sand & gravel, and sulphur, elemental.

** includes: cadmium, lead, selenlium, and tellurium.

(Source: Based on Statistics Canada)

Copper continues to contribute steadily to the Gross Provincial Product (GPP) of Manitoba. In terms of a % of GPP in Manitoba, for instance, copper's contribution ranged from 1.46% in 1971 to 1.35% in 1975, rising to a peak of 2.00% in 1974, as illustrated in Table VII.

TABLE VII

MANITOBA, VALUE OF COPPER AS A % OF GROSS
PROVINCIAL PRODUCTIVITY, 1971-1975

Year	Manitoba, Value of Copper ($ million)	GPP of Manitoba ($ million)	% of GPP
1971	58.4	3,9990.0	1.46
1972	60.9	4,430.0	1.37
1973	91.0	5,174.0	1.76
1974	121.5	6,048.0	2.00
1975	90.2^{p}	6,703.0^{e}	1.35

p : preliminary
e : estimate

(Source: Manitoba Bureau of Statistics; and CANADIAN MINERAL YEARBOOK 1972-1974, CANADIAN MINERAL JOURNAL February, 1976.)

3. Copper-producing Mines in Manitoba

There are at present five mining companies which account for the total mine production of copper in Manitoba. These companies are as follows: INCO Limited (INCO)[3], Hudson Bay Mining & Smelting Company, Ltd. (HBMS), Sheritt Gordon Mines Ltd. (SGM), Falconbridge Nickel Mines Ltd., and Dickstone Copper Mines Ltd.[4] In terms of total metal production, including copper, in the province, these companies are ranked in size in the above-mentioned order.

However, SGM and HBMS are the two leading mine copper-producing companies in Manitoba. For example, in 1975 the combined mine copper production from these two companies is estimated to be in excess of 90% of the total mine copper production in Manitoba. Specifically, in 1975 the total copper production from all the Manitoban mines is estimated to be 141,564,000 short tons, of which SGM and HBMS account for 85,284,000 short tons and 47,464,000 short tons respectively.[5] In other words, of the total mine copper production in Manitoba in 1975, SGM accounts for 60.2%, while HBMS produces 33.5%. The other three companies — i.e. Dickstone Copper Mines Ltd., INCO, and Falconbridge Nickel Mines Ltd. — play only an insignificant role in terms of mine production of copper in Manitoba.

Table VIII attempts to illustrate the operators and mine locations with regard to copper production in Manitoba. Available relevant information such as type of mine, date of mill started, mill capacity, production process and products are also shown in the Table. Furthermore, Map I which follows Table VIII serves to depict the actual geographical locations of these mines.

---

3. Until April, 1976, the company was known as The International Nickel Company of Canada, Limited (INCO).
4. The Company suspended its operation in August, 1975, owing to unfavourable economic situations in the markets of copper. This company is an operation in the HBMS.
5. Based on Statistics Canada, and the 1975 Annual Reports of these two Companies.

TABLE VIII

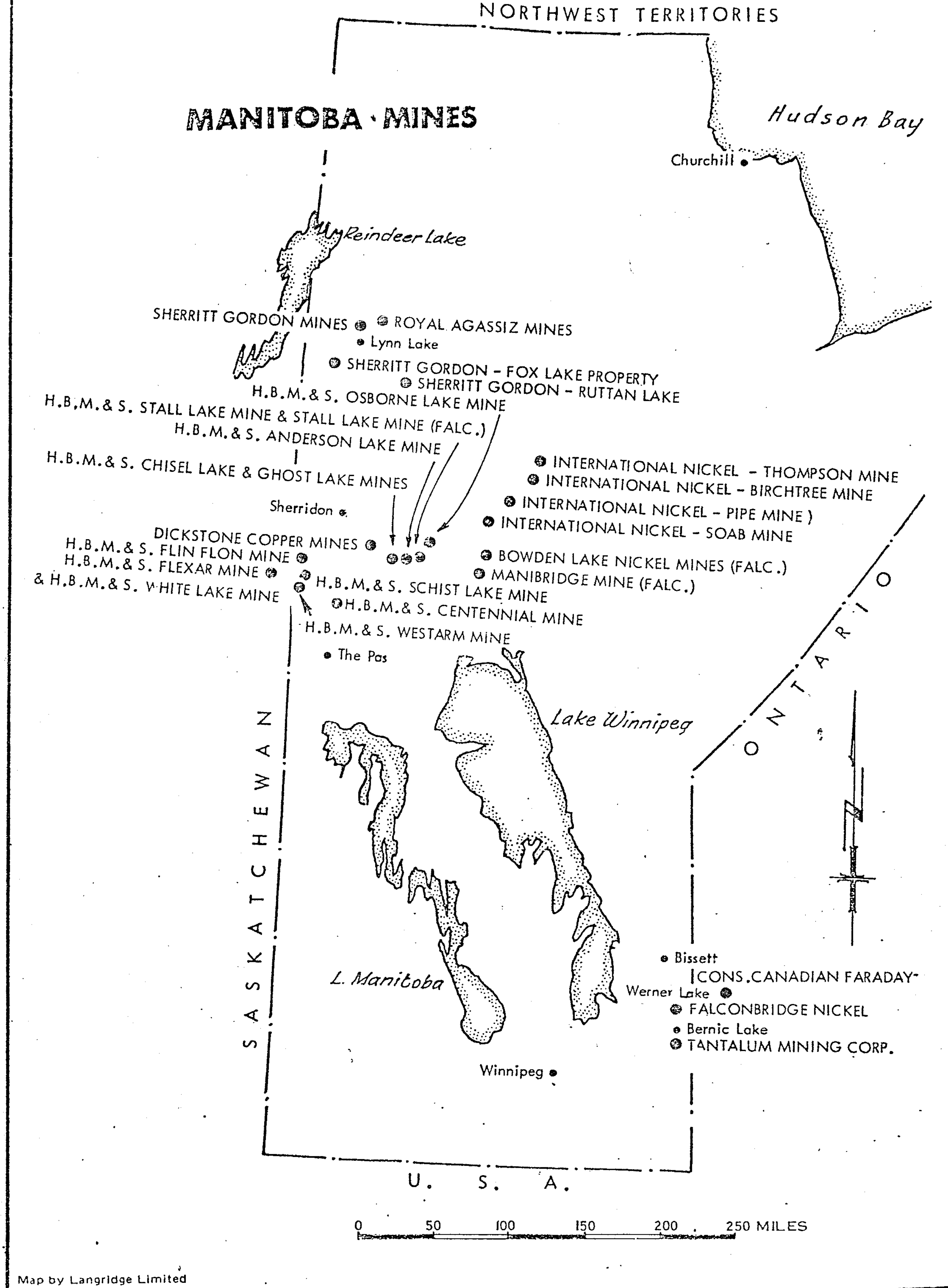
COPPER OPERATORS AND MINES IN MANITOBA, 1974

OPERATOR	MINE/PLANT LOCATION	TYPE OF MINE	MILL STARTED	MILL* CAPACITY	PROCESS	PRODUCT
Dumbarton Mines Ltd.**	Maskwa Lake, Bird River	U	...	...	...	Nickel-copper ore
Falconbridge Nickel Mines Ltd.	Manibridge Mine, Wabowden	U	9/'71	1,000	Flotation	Copper conc & Nickel conc
Hudson Bay Mining & Smelting Co. Ltd.	Flin Flon Mine, Flin Flon	U	1/'31	8,500	Flotation Cyanidation	Copper conc, Zinc conc, & Lead conc
	Anderson Lake Mine+	U	...	...	...	Copper ore
	Chisel Lake Mine+	U	...	...	...	Copper-zinc-lead ore
	Ghost Lake Mine+	U	...	...	...	Zinc ore
	Osborne Lake Mine+	U	...	...	...	Copper-zinc ore
	Stall Lake Mine+	U	...	...	...	Copper-zinc ore
	#Schist Lake Mine+	U	...	...	...	Copper-zinc ore
	White Lake Mine+	U	...	...	...	Copper-zinc ore
Dickstone Mines Ltd.	Dickstone Mine,***	U	...	...	...	Copper-zinc ore
The International++ Nickel Co. of Canada, Ltd.	Thompson Mill, Thompson	U	1961	18,400	...	Nickel conc & Copper conc
	Thompson Mine,+ Thompson	U	...	...	...	Nickel ore
	Birchtree Mine,+ near Thompson	U	...	...	...	Nickel ore
	Pipe Mine,+ near Thompson	O	1971	...	...	Nickel ore
Sherritt Gordon Mines, Ltd.	Lynn Lake Mine, Lynn Lake	U	1953	3,500	Flotation	Nickel conc & Zinc conc
	Fox Mine,+ near Lynn Lake	U	5/'70	3,000	Flotation	Copper conc & Zinc conc
	Ruttan Mine,+	O	7/'73	10,000	Flotation	Copper conc & Zinc conc

* short tons per day ** shut down in June, 1976 *** see footnote 4 above
\# shut down in March, 1976 + same name ++ see footnote 3 above
O open-pit mine or quarry U underground mine ... not applicable

(Source: Department of Energy, Mines & Resources, Canada, <u>OPERATOR LIST I</u>, January, 1975: <u>METAL AND INDUSTRIAL MINERAL MINES AND PROCESSING PLANTS IN CANADA</u>, Ottawa, August, 1975, pp. 30-32.)

MAP I THE FINANCIAL POST SURVEY OF MINES 1976



4. Copper Ore Reserves in Manitoba

At the outset the concept of " reserves " must be distinguished from that of " resources ", since it appears that the two terms are often used interchangeably, perhaps too loosely than it should be the case. These two concepts can be differentiated in the following manner:[6]

> Generally, the term " mineral reserves " implies that some type of physical measurement has been made of the grade and amount of mineral concentration in situ, and that profitable extraction now or in the near future is technologically feasible.
>
> ...
>
> " Resources " is a wider term than reserves; the term includes reserves but goes far beyond. As a rule, it implies some degree of natural mineral concentration, and includes both known and unknown stocks of minerals that may or may not be of commercial value at present, but that seem likely to become so under certain assumptions.

Both " reserves " and " resources " are viewed in terms of the degree of certainty, geologic criteria, cost of recovery, economic and technical considerations. More specifically, reserves are traditionally classified as " proved ", " probable ", and " possible " at a decreasing degree of certainty. Their equivalent counterparts are referred to as " measured ", " indicated ", and " inferred ". From the increasing cost-of-recovery point of view, reserves can be classified as " presently economic ", and " not currently economic ", in accordance with such geologic criteria as " proven ", " para-marginal & sub-marginal " respectively. By the same token, resources are defined in terms of appropriate sets of criteria which are either directly economic or implicitly so. The relationship between reserves and resources is diagrammatically represented in Figure 3.

6. J. Zwartendyk, WHAT IS " MINERAL ENDOWMENT " AND HOW SHOULD WE MEASURE IT ? Mineral Resources Branch, Department of Energy, Mines & Resources, Ottawa, 1972, pp. 3-4.

FIGURE 3

THE CONCEPTS OF RESERVES AND RESOURCES ILLUSTRATED

Decreasing Degree of Certainty →

Increasing Costs of Recovery ↓

	Identified Resources			Undiscovered Resources
Present Economic	Measured (Proven) reserves	Indicated (Probable) reserves	Inferred (Possible) reserves	
Not Currently Economic	Para-Marginal Sub-Marginal	P O T E N T I A L	R E S O U R C E S	

(Source: Gordon T. Alexander, " Canadian Coal Mining Patterns and Developments: Present and Future ", CANADIAN MINERAL JOURNAL April, 1976, p. 42.)

A clear distinction between reserves and resources facilitates the discussion of copper endowment in Manitoba in these contexts: (a) copper ore reserves, and (b) copper resources estimates based on undiscovered sources.

It has been pointed out earlier that Hudson Bay Mining & Smelting Company, Ltd. and Sherritt Gordon Mines Ltd. are the two major companies which account for the lion's share of the mine production of copper in Manitoba. Therefore, it seems reasonable to suggest that the copper ore reserves of these two mining companies can represent a rough conservative estimate of the copper ore reserves in the province at a point of time. Table IX shows the copper ore reserves of these two companies between 1972 - 1975, the most recent data available for this purpose.

TABLE IX

PUBLISHED COPPER ORE RESERVES IN MANITOBA
(000 short tons) 1972-1975

Company Year, Dec. 31	1972	1973	1974	1975
SHERRITT GORDON MINES*				
Ore Reserves	64,300	60,900	56,600	52,300
Copper	1,017	956	874	799
HBMS				
Ore Reserves	17,284	18,001	17,974	17,454
Copper	501	558	521	506
Copper - Combined Total	1,518	1,514	1,395	1,305

* This estimate does not include Lynn Lake Mine, which is exhausting its ores in four years from 1974, according to the company report in 1974.

(Source: Based on Company Reports of these two mining companies, 1975 - 1976)

The Mineral Development Sector of the Department of Energy, Mines and Resources has indicated that the reserves of copper in Manitoba as of January 1, 1975 was 1,405,500 short tons.[7] This figure compares roughly to the figures of annual reserves derived for 1972 - 1975 as shown above. It appears that the copper ore reserves in Manitoba has remained pretty stable at an annual average of 1.43 million short tons between 1972 - 1975.

With regard to copper resources based on estimates of undiscovered deposits, it was pointed out that the Canadian shield in Manitoba might be endowed with 740.62 million short tons which are valued at $ 14,185.3 million in 1972.[8]

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7. See D.A. Cranstone & SA. Hamilton, " Canadian Reserves of Seven Metals, " CANADIAN MINING JOURNAL, February, 1976. p.53. It is also suggested in the article that foreseeable undeveloped deposits accounted for an additional 56,200 short tons of copper reserves in Manitoba as of January 1, 1975.
8. A. Azis et. al., THE UNDISCOVERED MINERAL ENDOWMENT OF THE CANADIAN SHIELD IN MANITOBA , A Federal-Provincial Co-operative Study (Ottawa, 1972), p.13.

The four regions where the value of copper endowment was purported to be the highest in the study region as a whole were listed as follows:[9]

Region XII	(Lynn Lake - Ruttan Lake)	: $2,250.8 million
Region VIII	(Flin Flon - Wekusko Lake)	: $1,967.5 million
Region VI	(Fox River)	: $1,186.8 million
Region VII	(Nickel Belt)	: $ 428.3 million

According to the study (See footnote 8) cited above, the undiscovered copper endowment in Manitoba might amount to approximately 518 times (i.e. 740.62 divided by 1.43) of the average annual reserves in the province as of 1972. However, the ' undiscovered resources ' of copper endowment in Manitoba are not yet proven, and such an estimate cannot be interpreted as a reliable representation of the wealth of copper resources in the province. Indeed, this fact is well recognized and appreciated in this manner:[10]

> ... these endowment estimates (i.e. 740.62 million short tons of copper, etc.) do not constitute a forecast of what actually will be found and mined. The results solely represent estimates of the occurrence of undiscovered mineral deposits (down to currently mineable depths), most of which could now be economically exploited; some would currently be sub-economic, but could be expected to become economic within two decades as a result of techno-logical advance in mining efficiency or by better developed infrastructure. The estimate of the magnitude and distribution of undiscovered mineral endowment may be used in focusing private exploration efforts and in public planning for regional economic development.

9. See A. Azis et. al., *ibid.*, p.18. For a look at the description of the study area and the regions classification, see pp. 3-6 of the study.
10. See A. Azis et. al., *ibid.*, p.III.

CHAPTER THREE

FORWARD LINKAGE AND COPPER IN MANITOBA

1. The Concept of Economic Linkage

Broadly speaking, economic linkage can be visualized as economic ties which bridge two or more economic activities, expressing at the same time " the way in which a basic commodity sets the general pace, creates new activities and is itself strengthened ... by its own creation. "[1] In terms of the staple theory of economic growth, economic linkage is viewed as " the spread effects of the export sector, "[2] generating economic development through a process of industrial diversification around an export base.

More specifically, economic linkage is represented by the inducement to domestic investment as a result of the extent of industrial diversification around the export base. In this context, three linkage effects can be readily identified, namely: backward linkage, forward linkage, and final demand linkage.[3]

These three concepts can be briefly defined as follows. Backward linkage represents the inducement to invest in the domestic production of inputs, including

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1. See C.R. Fay, " The Toronto School of Economic History, " ECONOMIC HISTORY, III, January, 1934, p.171.
2. Melville H. Watkins, " A Staple Theory of Economic Growth, " THE CANADIAN JOURNAL OF ECONOMICS AND POLITICAL SCIENCE, Vol. XXIX, May, 1963, p.144. This article offers an excellent review of the literature of the staple theory of economic growth and a vigorous presentation to consider the relevance of a staple approach to the Canadian case. For the pioneering work of this theory, see Harold Innis, THE FUR TRADE IN CANADA: AN INTRODUCTION TO CANADIAN ECONOMIC HISTORY (Toronto: University of Toronto Press, 1930), and Harold Innis, THE COD FISHERIES: THE HISTORY OF INTERNATIONAL ECONOMY (Toronto: University of Toronto Press, 1940).
3. For an excellent analysis of these economic linkages, see Albert O. Hirschman, THE STRATEGY OF ECONOMIC DEVELOPMENT (New Haven: The Yale University Press, 1958), Chapter 6.

capital goods, which are needed for the manufacturing of the commodities exported. The realization of backward linkage effects will be greater, the more favourable the possibility that the input requirements in terms of resources and technology[4] can be met in the domestic economy. Forward linkage represents the inducement to invest in domestic industries which will utilize the outputs of the export industries as their inputs. The realization of forward linkage effects is directly correlated to the degree at which commodities for export are further processed at home. Final demand linkage represents the inducement to invest in domestic industries which produce consumer goods for factors in the export sector. Naturally, the magnitude of final demand linkage is directly proportional to the level and the distributional equity of income being earned by the consumers.

The economic linkage effects (i.e. ' backward ', ' forward ' and ' final demand ') emanating from one industry toward another industry are appreciated in terms of the net outputs of the latter industry that may be called forth, and the probability that the latter industry will actually come into being. Actually, in mathematical terms, the sum of the products of these two elements purports to measure the total linkage effect at a point of time. Specifically, suppose the economic activities of industry A lead to the establishment of n additional industries through linkage effects, to generate net outputs equal to x_i units ($i = 1, 2, \ldots n$). Also assume that the probability for each one of these additional industries to come into being is p_i ($i = 1, 2, \ldots n$). Therefore, the total linkage effect (L) of industry A is mathematically represented by

4. The element of technology, in effect, is crucial for bringing about favourable growth in the mineral processing industry. This viewpoint is recently reiterated by Charles H. Smith, Senior Assistant Deputy Minister of Energy, Mines and Resources of Ottawa: " Technology is one of the important aspects of our national minerals policy. ... it (is) unfortunate that the mineral processing industry has not grown at the same rate as the export of crude ore and concentrates. ... The reason for this lack of growth ... is the Canadian industry's reluctance to spend more money on research leading to new technology. " See Richard Fish, " Workshop Atmosphere Prevails at Canadian Mineral Processors Meet, " CANADIAN MINERAL JOURNAL, March, 1976, p.20.

this formula:[5] $$L = \sum_{i=1}^{n} x_i p_i$$

2. A Note on Forward Linkage

Forward Linkage arises when a domestically-produced primary raw material is further processed into an input in the secondary or manufacturing industries. It is a source of industrial diversification to bring about economic development. At the same time, forward linkage provides a context to measure the degree of interdependence between industries on the basis that the proportion of one industry's outputs are utilized as inputs in another industry.

There are several significant determinants which help to precipitate the occurrence of forward linkage in a certain industry. To start with, the availability of the resource under consideration is the most essential element. As a matter of fact, the more abundant the resource, the sounder will be the footing of the resource base in terms of supplying the output as input into secondary or manufacturing industries, and vice versa. Second, the technology defined in the production function of the primary industry is a determinant of prime importance, especially in terms of the degree of factor substitutability and the nature of the returns to scale. The more advanced the technology, for instance, the more efficient will the allocation of resources in the industry tends to be. This in turn, will definitely improve the actual and the potential supply of the output, which is necessary in feeding other industries as their inputs. On the other hand, citeris paribus, a less advanced technology in the industry will mean lower production efficiency, which tends to slow down the pace to actualize forward linkage effects. Third, there must be a domestic demand for the output of the primary industry as intermediate inputs in other industries. Actually, demand will normally stimulate supply; and in due process, the opportunities for further processing will be improved and the realization

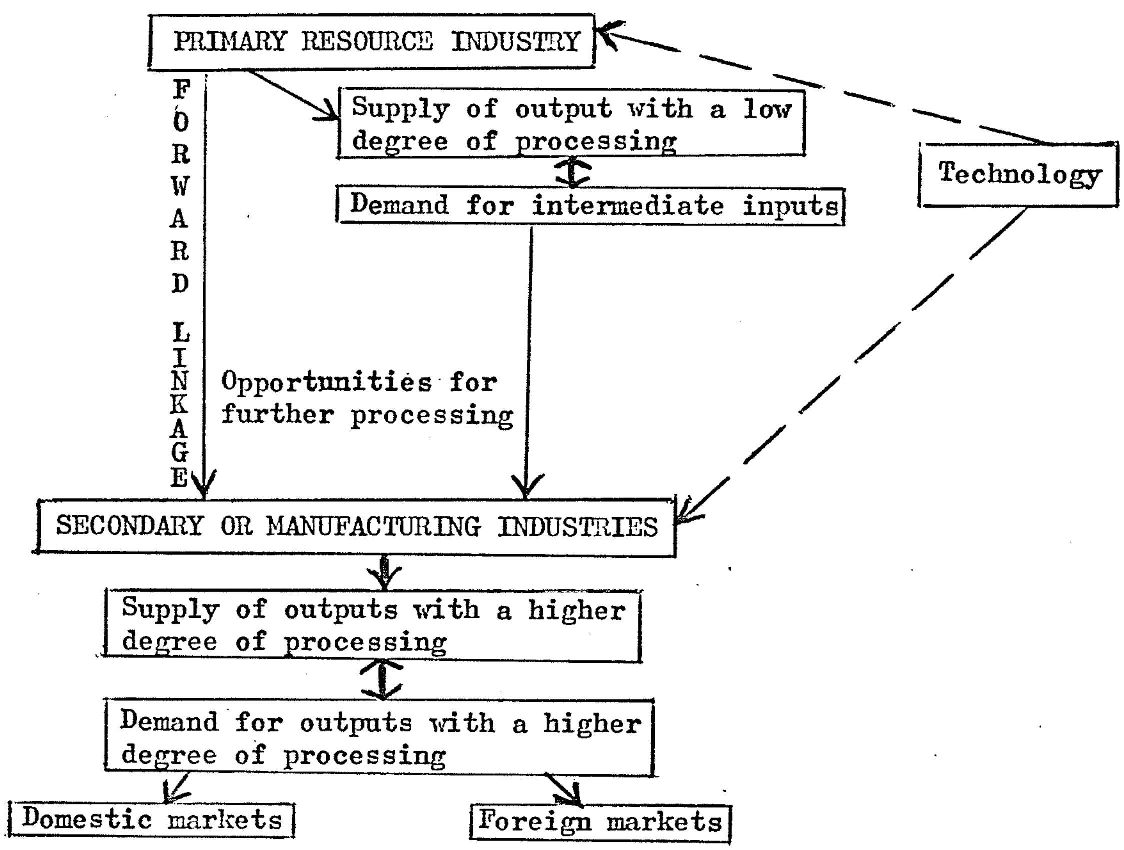
5. For an illustrative discussion of this formula in terms of backward and forward linkages, see Albert O. Hirschman, THE STRATEGY OF ECONOMIC DEVELOPMENT, op. cit., pp.101-104. The probability arbitrarily considered to be meaningful will exceed 0.5. See Hirschman, ibid., p.103.

of forward linkage accordingly augmented. Four, the existence of and the possibilities for developing further processing facilities in the domestic economy determine whether or not any forward linkage will be generated and realized at home. Finally, the average level and even distribution of income of the domestic consumers have much to do with sustaining and possibly increasing demand for more processed commodities. For it is likely that the richer the consumers, the <u>wider</u> and <u>greater</u> is the demand for highly processed goods.

The determinants described above are interrelated with one another. Figure 4 below serves to summarize their interrelationships.

FIGURE 4

DETERMINANTS OF FORWARD LINKAGE ILLUSTRATED



The solid lines and arrows represent the courses and directions of activities. The broken lines and arrows signify *ex ante* courses and directions of activities in conjunction with those indicated by solid lines and arrows.

A brief explanation of the above figure is in order. Suppose technology permits an efficient production of output in the primary resource industry under consideration. The output available at this stage has undergone some degree of processing. Opportunities for additional processing exist provided that there is a demand for the output by some secondary or manufacturing industries as their intermediate inputs, this being supposedly technologically (and economically) efficient. The supply of the outputs with a higher degree of processing now in turn, depends on the demand for them from the domestic as well as foreign markets. Supply and demand in the long-run are mutually responsive to each other. Indeed, demand tends to produce a reinforcing effect on supply. Forward linkage is accordingly generated amidst this train of events.

Forward linkage does not take place in a pure form; it is always accompanied by backward linkage. Indeed, the occurrence of forward linkage inevitably provides a stimulus for backward linkage to occur. But the reverse is not necessarily true. For example, a mining industry achieves forward linkage in selling its outputs to some metal-fabricating industries for additional processing before being exported. At the same time, the mining industry must also be realizing backward linkage in making purchases from other industries of goods and capital equipments which are necessary for extracting the minerals from the ground. Naturally, in the long-run, a larger sale of the output will mean a greater need for purchases of inputs. In other words, increased forward linkage effects based on larger sales of outputs will automatically induce increased backward linkage effects based on bigger purchases of inputs. On the other hand, a mining industry may forgo the opportunities for creating forward linkage by merely exporting its ores with a minimum degree of processing, although backward linkage is achieved in extracting the ores from the ground all the same.

This being the case, the significant implication for decision-makers of economic development seems clear. From the pure economic stand point of view, whereas backward linkage can bring about substantial economic gains, it is most important to emphasize forward linkage creation (when possible), so as to capture the backward-linkage-reinforcing effect as well.

3. The Role of Copper in the Manitoba Mineral Industry in Generating Forward Linkage

Copper needs to undergo several stages of processing from ore to usable commercial shapes. The metal appreciates in value with additional processing. Forward linkage effects are attained when refined copper is sold to metal-fabricating industries. It appears useful at this stage to describe briefly the various stages of copper ore processing, so as to eventually facilitate the determination of the significance (or insignificance) of copper in terms of generating forward linkage effects in Manitoba.

Copper produced in Canadian mines has an average ore content of about 2-3% of the metal; and the ore is usually mixed with other minerals such as: iron, nickel, lead, zinc, gold and silver.

In conventional copper processing, the first stage is concentrating, in which ore is crushed and mixed with water to form a pulp. Flotation is then applied to remove the valuable minerals which are carried in the froth on the surface, while the undesirable residue sinks to the bottom. The copper concentrate is now filtered and roasted.

The second stage is smelting, in which process the copper concentrate is smelted in a furnace mainly to remove iron sulphide. The resultant liquid is copper matte which is then transferred to the converter to be further treated into blister copper of about 99.5% purity.

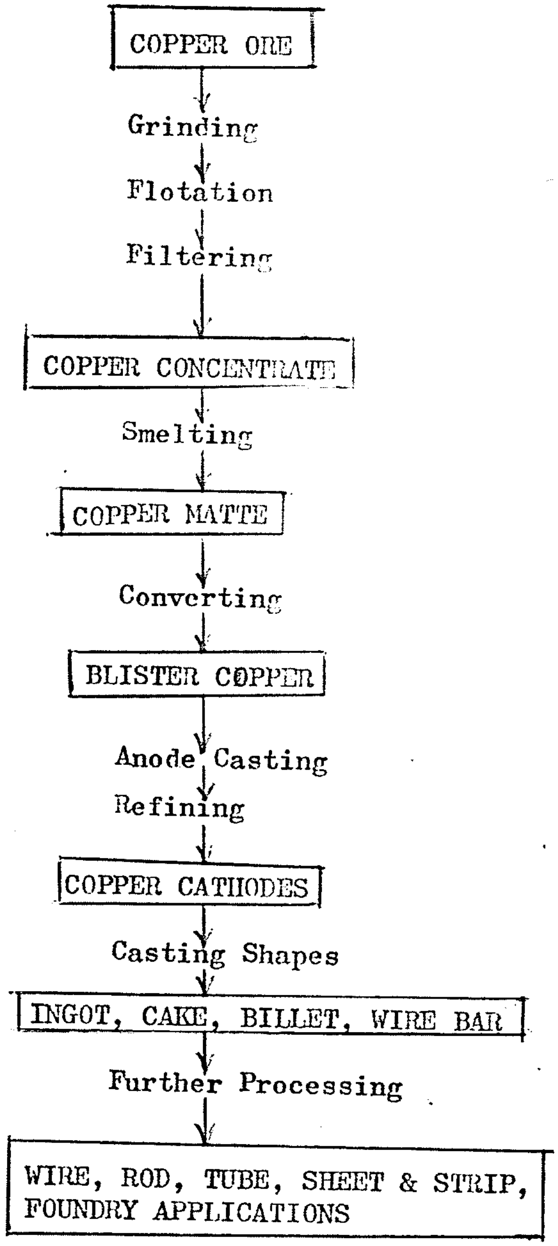
The third stage is refining, in which blister copper is cast into anodes. They are then placed in electrolytic tanks and interleaved with thin sheets of pure copper. An electric current is applied, causing the anode to dissolve. Copper cathodes of about 99.97% purity are formed on the " thin sheets ".

Finally, the cathode copper is cast into commercial shapes such as: ingots, cake, billet and wire bar. They are in turn further processed into wire, rod, tube, sheet & strip, and foundry applications by metal-fabricating industries.

These stages of copper ore processing are represented diagrammatically by Figure 5 below.

FIGURE 5

STAGES OF COPPER ORE PROCESSING



Forward linkage effects can be generally measured in terms of the degree of interdependence between the primary industry and other secondary industries which are involved — i.e. " the proportion of its total output that does not go to final demand but rather to other industries. "[6] This interdependence through sales to other sectors is represented by the ratio of inter-industry sales to total demand for the primary industry's output in question.[7] In terms of copper, forward linkage is realized in the domestic economy when domestically-produced refined copper shapes are sold to domestic metal-fabricating industries for further processing into wire, rod, sheet & strip, and foundry applications.

In the context of copper in Manitoba, the forward linkage effects can be ascertained through an understanding of these facts: (a) the degree of processing undergone by the provincially-produced copper ore; and (b) the disposition of the copper output in the province. This task can be accomplished by looking into the copper-producing mining companies in Manitoba in the above-mentioned contexts.

There are at present five copper-producing mining companies in Manitoba. Aside from some smelting facilities for copper concentrate in the plant owned by Hudson Bay Mining & Smelting Company Ltd. in Flin Flon, there are no refining facilities available to process copper concentrate in the province. Accordingly, copper concentrates produced in Manitoba are shipped to companies which in turn, transfer them to their refining facilities outside the province. Some of the copper concentrates are even sent to Japan for further processing. Table X attempts to illustrate the pattern of copper concentrates transactions for smelting and refining in Manitoba. It is also noted that refined copper is supplied to fabricators and manufacturers in Canada, or exported to foreign countries such as: U.S.A., Europe, and Japan. A complete picture of the flow of the copper outputs in Manitoba from mines through processing to manufacturers is shown in Figure 6, immediately following Table X below.

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6. See Albert O. Hirschman, ibid., p.105.
7. For an illustrative presentation of this theme, see H.B. Chenery & T. Watanabe, " International Comparisons of the Structure of Production, " ECONOMETRICA, 1958.

TABLE X

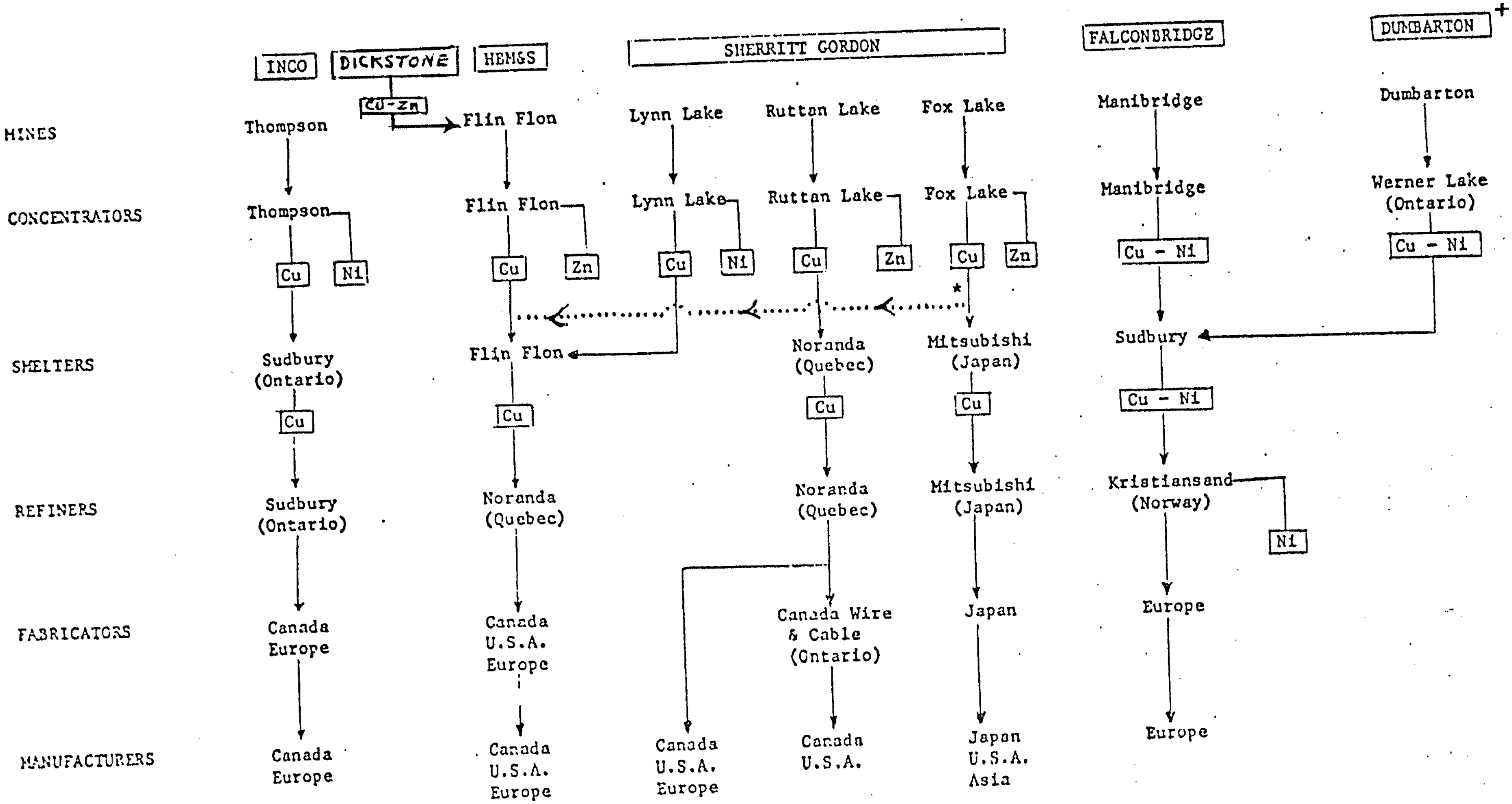
PATTERN OF COPPER CONCENTRATES TRANSACTION
FOR SMELTING & REFINING IN MANITOBA

COMPANY	MINE/MILL LOCATION	MILL CAPACITY (short tons/day)	REMARKS
Dickstone Copper Mines Ltd. Copper, Zinc	Morton Lake/ Herb Lake area	..	Ore is railed to the concentrator of HBMS at Flin Flon and is further treated in that plant's refinery to produce blister copper and refined zinc
Falconbridge Nickel Mines Ltd. Nickel, Copper	Manibribridge Mine Wabowden	1,000	Conc is trucked 2 miles to rail and shipped to the Falconbridge smelter in Ontario
Hudson Bay Mining & Smelting Co. Ltd. Copper, Zinc	Flin Flon Mine	6,800	Ore from company mines in the Flin Flon-Snow Lake area is treated at the Flin Flon Mill; copper conc reduced to anodes in the company's smelter and refined at Canadian Copper Refiners Ltd., Montreal; zinc conc is smelted and refined at the Flin Flon plant
INCO Limited Copper, Nickel	Thompson Mill Thompson Thompson Mine Thompson	18,400	Thompson Mill treats ore from all Thompson area mines. Nickel conc pumped to smelter Copper conc dewatered, dried & shipped to Copper Cliff Mine in Sudbury, Ontario
Sherritt Gordon Mines Ltd. Copper, Nickel, Zinc	Lynn Lake Mine	3,500	Nickel conc shipped to the Company's refinery at Fort Saskatchewan, Alberta; copper conc is shipped to Flin Flon smelter of HBMS
	Fox Mine/near Lynn Lake	3,000	Copper conc is shipped to Mitsubishi in Japan and HBMS; zinc conc is sold to HBMS
	Ruttan Lake Mine	10,000	Copper conc is shipped to Noranda and HBMS; zinc conc is shipped to Flin Flon and to Mitsubishi in Japan

(Source: Slightly abridged from Canada West Foundation, WESTERN CANADA: LOCATION OF OPERATING MINES, PROCESSING PLANTS AND METALLURGICAL WORKS, 1974, 1975, pp.15-16. See also Department of Energy, Mines & Resources, OPERATORS LIST 1, *op. cit.*, pp.30-33.)

FIGURE 6

MANITOBA COPPER FLOW CHART



* Some concentrates have been diverted to HBM&S because of Japan's inability to fulfill its contractual commitments.

+ **shut down in June, 1976.**

(Source: Department of Mines, Resources & Environmental Management, REPORT OF TASK FORCE ON MANITOBA MINERALS POLICY (Manitoba, 1974), p.212 • Dickstone is added in the figure by the author.)

Therefore, it is demonstrated that all the copper ore produced in Manitoba is shipped out of the province with a minimum degree of processing. The upshot is that when additional processing is done outside Manitoba, there is practically no forward linkage created by copper within Manitoba. This is especially the case in view of the fact that there is a lack of metal-fabricating industries for copper in Manitoba, to absorb the locally-produced copper ore. Indeed, there is not even one copper mining company that is vertically integrated from ore extraction to finished manufactured goods <u>within</u> Manitoba.

4. Forward Linkage, Economic Growth and Copper in the Manitoban Economy

If further processing of copper can be attained in Manitoba, instead of merely diverting copper concentrate out of the province, a forward linkage is generated, which will promote greater provincial economic growth. Such achievements will undoubtedly add to the economic and social well-being of the Manitoban economy.

On a theoretical level, a brief explanation can be visualized in the context of Domar's model of economic growth. For the present purpose, only a simple statement of this model will suffice to illustrate the point.[8]

According to Domar, investment has a dual character. To start with, a portion of the income of the economy at a point of time (Y_t) is saved ($s.Y_t$) and invested (I_t), where s is the propensity to save. In equilibrium, $s.Y_t = I_t$. This investment creates new capacity which in turn, when fully utilized, results in an increase in production. Accordingly, income per unit of time is satisfied by this equality: $dY_t/dt = I_t/k_t$, where k_t is the capital-output

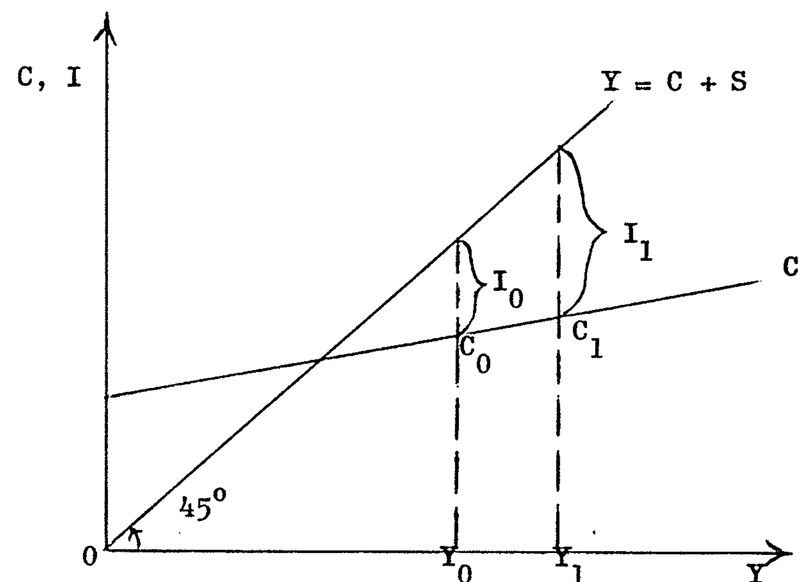
8. Actually, the model is generally referred to as the Harrod-Domar model of economic growth, since the pioneering works done by R.F. Harrod were quite similar with and complementary to E.D. Domar's model. But it will suffice here just to mention Domar's works. For an original presentation of these ideas, see E.D. Domar, " Capital Expansion, Rate of Growth, and Employment, " <u>ECONOMETRICA</u>, April, 1946; E.D. Domar, " Expansion and Employment, " <u>AMERICAN ECONOMIC REVIEW</u>, March, 1947; R.F. Harrod, " An Essay in Dynamic Theory, " <u>ECONOMIC JOURNAL</u>, March, 1939; and R.F. Harrod, <u>TOWARDS A DYNAMIC ECONOMICS</u> (New York: Macmillan Publishing Company, Ltd., 1952).

ratio. Now that $dY_t/dt = s.Y_t/k_t$, it follows that $dY_t/dt \cdot 1/Y_t = s/k_t$ is the resultant warranted rate of growth. In other words, on the one hand, investment contributes to aggregate demand, helping to promote full employment and full production capacity in the short-run. On the other hand, investment brings about an expansion of the stock of capital, contributing to the supply of output that the economic system is capable of producing. This happens if savings-investment equilibrium is to prevail.

The following figure illustrates diagrammatically the logic of this economic model.

FIGURE 7

THE GROWTH OF INCOME AT FULL CAPACITY



where C : Consumption
I : Investment
S : Savings
Y : Income (Output)

Suppose Y_0 is the full-capacity level of output. In order to attain the full-capacity level of income, the level of consumption C_0 must be achieved, and at the same time the level of investment I_0 must be forthcoming. This situation being actually realized, now that the increase in investment I_0 automatically augments the capital stock, the upshot is that the output level which fully utilizes the economy's capacity will rise. This means that if the new full-capacity level of output Y_1 is to be attained, the new level of consumption becomes C_1 which calls into play the requirement of a new intended level of investment I_1 to fill the gap between consumption and full-capacity output. This being the case, investment I_1 further expands the stock of capacity so that a higher full-capacity level of income and greater consumption can be achieved. This growth pattern is sustained by another growth cycle once more. The growth process is self-sustaining[9]; therefore, the result is that the economy must run absolutely faster all the time in remaining at full-capacity, as a result of the dual nature of investment.[10]

This dual character of investment can be likened to the workings of forward linkage and backward linkage in the same manner. Specifically, investment (through forward linkage in this case) is related forward to the increase in income which is required to utilize the additional capacity resulted from the initial investment. At the same time, it is possible to trace back the investment

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9. However, the steady state of the growth pattern seems to rest on a " razor's edge ": if investment increases too fast, then a shortage of capacity results; on the other hand, if investment grows too slowly, then excess capacity follows. These precarious situations can be avoided only when the equilibrium condition of savings-equal-to-investment prevails.
10. Basically, an investment will bring forth economic benefits of direct, indirect and induced varieties. Doeksen and Schreiner had suggested that the economic effects might be classified as short run, intermediate run, and long run in nature. According to these authors, direct and indirect effects occur in all the three categories, with capital formation effect and induced capacity effect occuring in the short run and intermediate run respectively, while induced consumption effect occur in both the intermediate run and long run. (See Gerald A. Doeksen & Dean F. Schreiner, " Simulating Short, Intermediate, and Long Run Effects of Private Investment on Employment by Industrial Groupings, " JOURNAL OF REGIONAL SCIENCE, Vol.12, No.2, August, 1972, pp.219-232). These economic effects are best seen in a dynamic system as follow: " ... first an induced consumption effect arises as the increased production (due to an investment) yields a greater amount of regional personal income that leads to increased consumption of goods and services. Second, in order to produce additional goods generated from indirect and induced consumption effects, the producing sectors need to increase their capacity. This effect is termed the induced capacity effect. (See Fu-Lai Tung, James A. MacMillan, and Charles F. Framingham, " A Dynamic Regional Model for Evaluating Resource Development Programs, " AMERICAN JOURNAL OF AGRICULTURAL ECONOMICS, Vol.58, No.3, August, 1976). Therefore, any investment in further processing must generate first the direct effects (i.e. direct increase in employment and income) and second the indirect and induced effects via the creation of economic linkages (i.e. a further increase in employment and income due to increase in production capacity and consumption).

to the rate of income in output in support of it. Therefore, aside from the intrinsic growth-generating effects of investment by itself, an investment through forward linkage effects can produce additional growth values in inducing further investment via the creation of backward linkage effects.

Accordingly, a development of forward linkage for Manitoba's copper, situations permitting, appears to warrant serious consideration.

CHAPTER FOUR

FURTHER PROCESSING OF COPPER IN MANITOBA

1. The Economic Meaning of Further Processing of Copper

Generally speaking, it makes economic sense for a mineral-producing nation to apply additional processing to her mineral commodities before they are exported, when economic gains which can be derived from this economic operation are retained in the domestic economy. As a matter of fact, further processing brings about direct benefits in the form of increased employment and value added[1] to the mineral products. In addition, domestic processing automatically creates indirect benefits through linkage effects (i.e. forward, backward, and final demand) which generate still more employment and income in the domestic economy.

For instance, in 1970 direct employment in primary mineral processing in Canada numbered 167,000 persons, compared with 93,000 persons directly employed in mining; and a further 410,000 workers were occupied through indirect effects.[2] In other words, with additional processing, direct employment was increased by about 1.8 times that of mining (i.e. 167,000/93,000). At the same time, of the total direct and indirect employment derived from the Canadian

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1. Value added in the mining industry is derived, " ... by deducting the cost of fuel, electricity, process supplies, containers, freight and treatment charges from the value of production. " See Statistics Canada, SURVEY OF PRODUCTION, Catalogue No. 61-202, Information Canada, Ottawa. In other words, value added is equal to the difference between sales revenue and the cost of intermediate goods purchased from other industries.
2. See TOWARDS A MINERAL POLICY FOR CANADA, op. cit., p.26. Primary mineral processing comprises primary metals and non-metallic mineral processing industries. Also, note that the data presented in this case do not reflect the multiplier effects which stem from the expenditure of incomes earned from the mineral industry. Naturally, this means that the " indirect effects " in terms of employment will be even more attractive when multiplier effects are taken into account as well.

mineral industry (i.e. 670,000 persons), indirect employment accounted for 61.2% (i.e. 410,000/670,000 x 100%), a large portion of which came from further processing activities.[3] Therefore, it appears obvious that with additional development of further processing, the increase in direct and indirect employment will be more impressive.

In the context of copper production in Canada, the employment situation for the different processes in 1971, for example, is portrayed by Table XI.

TABLE XI

COPPER, NUMBER OF WORKERS EMPLOYED IN CANADA AT THE DIFFERENT LEVELS OF ACTIVITY IN 1971

LEVEL OF ACTIVITY	NUMBER OF WORKERS EMPLOYED
Mining	22,164
Smelting & Refining	1,800
Brass Mills & Rod Mills	2,850
Wire & Cable Mills	7,900

(Source: Task Force on Upgrading, Department of Industry, Trade & Commerce, FURTHER PROCESSING PRIOR TO EXPORT IN THE COPPER SECTOR, Ottawa, June, 1974, p.14)

From the figures above, direct employment generated by the different levels of processing of copper represented 56.4% of that engaged in mining of copper.[4]

It is also estimated that a substantial portion of wages is earned by workers in the copper processing industries in Canada, and that the value added of copper increases significantly with additional processing applied to it. Table XII attempts to illustrate the percentage of wages paid and the percentage of value added at the different levels of processing in a fully integrated copper industry.

3. However, the indirect employment was generated by both the mining and further processing industries.
4. That is: (1,800 + 2,850 + 7,900)/22,164 x 100%

TABLE XII

VALUES OF DIFFERENT LEVELS OF A FULLY INTEGRATED COPPER INDUSTRY (% OF TOTAL VALUE OF COPPER INDUSTRY)

LEVEL OF ACTIVITY	% OF WAGES PAID	% OF VALUE ADDED
Mines & Concentrators	29	24
Smelters	5	6
Refineries	5	4
Rod Mills	2	2
Wire & Cable	59	64
TOTAL	100	100

(Source: Task Force on Upgrading, Department of Industry, Trade & Commerce, Ottawa, ibid.,)

From Tables XI & XII above, it appears clear that the employment, income and value added effects tend to increase significantly when copper concentrate is carried through to higher levels of processing before it is exported. Indeed, domestic processing activities at the fabricated metal stage — i.e. wire & cable produces the greatest impact on the economy in terms of increasing employment, income and value added, primarily through forward and backward linkages.[5]

Naturally, increased domestic processing can sometimes result in substitution for mineral imports. Furthermore, additional processing provides opportunities for investment which in turn, leads to more investment adventures and greater industrial diversification through multiplier effects accordingly.[6] This is especially the case for copper in Canada, since a substantial percentage of copper produced in Canadian mines is exported in concentrates and matte.[7] Similarly, the situation applies to Manitoba, in view of the fact that all copper produced in the

5. For an excellent discussion of the multiplier effects and corresponding policy implications, see J.E. Stahl & D.J. McCulla, THE CANADIAN MINERAL INDUSTRY AND ECONOMIC DEVELOPMENT, Department of Energy, Mines & Resources, Ottawa, 1974.
6. For example, it is suggested that the investment multiplier in the mineral extractive sector, through its forward linkages to higher manufacturing, is comparable with that of manufacturing itself. See M.W. Bucovetsky & C.P. Cohen, A STUDY OF THE ROLE OF THE RESOURCE INDUSTRIES IN THE CANADIAN ECONOMY, Working Paper Series No. 7301, Institute for the Qualitative Analysis of Social & Economic Policy (Toronto: University of Toronto, June, 1973).
7. For example, Canada exported 37% and 42% of the nation's copper production in concentrates and matte in 1972 and 1973 respectively. See CANADIAN MINERAL YEARBOOK, 1972 & 1973.

Manitoban mines is shipped out of the province for further processing beyond the smelting stage. Manitoba can capture the economic benefits associated with further processing of copper if it stays home in the province.

2. Some Domestic Constraints to further processing

Canada ranks third as the world's leading mineral-producing country, just behind the United States and U.S.S.R. A lot of the nation's mineral production is exported in crude forms, brining in substantial revenue. For example, in 1970 Canada exported the following crude materials with these values: ferrous, $508.9 million; non-ferrous, $993.8 million; non-metals, $331.9 million; and mineral fuels, $884.6 million.[8]

During the last thirty years or so, Canada's prominent position in mineral production had been achieved under a mineral policy of maximum production. There appeared to be a prevailing export drive in the Canadian mineral industry, which helped to bring about a strong tendency to export the crude materials instead of further processing them domestically. Recently, the strategy of " maximum production " has been under attack and its wisdom questioned. A philosophical argument against liberal export of crude materials is that some mineral wealth must be reserved for our near future, especially in the face of the fear that non-renewable resources are being depleted. But it is the economic argument for further processing in Canada that draws more ardent attention. Simply put, it is argued that substantial economic gains in terms of income, employment and value added can be attained when additional processing is applied to Canadian mineral ores before export. Accordingly, Canada can capture these economic benefits if she does not forgo her opportunities for further processing.

However, there are several factors that need to be carefully considered, in order to determine the feasibility of developing further processing facilities

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8. See CANADIAN MINERAL YEARBOOK, 1970.

within Canada. Some major factors are as follows: market size, market price, capital, energy, labour, transportation, trade barriers, and multi-national firms in the Canadian resource industry. They constitute some constraints to further processing, which can be generally applicable to the case of copper in Manitoba.

Market Size

The possibility of developing further processing in Canada depends largely on whether or not there is a domestic market (as well as a world market) for the processed commodities at an appropriate price. Specifically, there must be ample demand in Canada for processed goods, so that it is possible to keep the unit cost at a competitive level with foreign markets, in attempting to achieve economies of scale.

But unit costs for processed and manufactured commodities in Canada are usually higher than the same in the United States, Europe and Japan. This is mainly due to the fact that Canada has a smaller domestic market size for processed goods, with a smaller population which is more dispersed over a wider stretch of geographic space.[9] This fact is keenly observed by an author in his own words:[10]

> ... Canada (is) a country of enormous geographical size, ... with a relatively small population of close to 23 million people. And they are largely dispersed along an extensive border shared with the United States. ... Canada is, in a large measure therefore, a structurally inefficient country with goods being produced in smaller quantities, travelling longer distances to the market and being bought by fewer consumers with less purchasing power. Furthermore, the intense industrialization of the United States, much of it located close to the border, makes Canada an obviously attractive incremental market for American industry.

Therefore, aside from the relatively small market size in Canada, a portion of it is conveniently absorbed by the United States along the border. This adds to a significant element to reduce the Canadian market size all the more.

As a result, investment for further processing of minerals in Canada is likely to be discouraged. A competitive unit cost must be attained if more investment adventures are to be realized. Therefore, Canadian processors tend to be more willing to forgo opportunities for further processing in order to minimize the risk of not achieving a competitive unit cost, owing to the disadvantage of market size

9. See Louis Silver, THE PURSUIT OF FURTHER PROCESSING OF CANADA'S NATURAL RESOURCES (Montreal: C.D. Howe Research Institute, 1975), p.7.
10. See D.G. Willmot, " Productivity & Canada's Competitive Posture, " RECORD, The Conference Board, New York, February, 1976, p.32.

in Canada.

Market Price

The ultimate market prices of metals are determined competitively in terms of supply and demand in the international markets. As such, an individual country has no control over the market prices of metals. Therefore, the fluctuations of market prices of metals may discourage investment in further processing.[11]

Capital

Further processing operations are quite capital-intensive. For example, in copper processing the various stages of process in terms of capital per worker in 1975 are estimated as follows:[12] $210,000 for mining; $400,000 for smelting & refining; $150,000 for rod mills; and $40,000 for wire & cable mills. Indeed, it is asserted that at today's inflationary capital costs, it is necessary to invest about $5,000 to generate an additional annual ton of copper capacity.[13] This follows that in order to develop <u>integrated</u> mining & processing facilities, <u>plus</u> infrastructure for copper on the basis of 100,000 tons per year output capacity, for example, an investment of $500 million (i.e. $5,000 x 100,000) is needed.

Accordingly, in the face of planning for developing further processing facilities of minerals, the future availability of capital goods in Canada constitutes a deep concern. Naturally, the possibility for Canada to finance more further processing developments seems to depend on the ability of the private, business and public sectors within the Canadian economy to save. But it appears that Canada will likely suffer from a shortage of such funds in the coming years, especially when competitive demand for the services of capital is foreseeable from these major sources:[14]

(a) The need to significantly expand industrial capacity, as evidenced by the shortages that emerged in 1973 & 1974;

(b) Rapid labour force growth, which requires high rates of investment in plant and equipment to provide productive new jobs;

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11. I owe this point to Mr. H. Bloy, Executive Secretary of the Mining Association of Manitoba, Inc.
12. See Lorne Sivertson, <u>A REVIEW OF THE REPORT OF THE BRITISH COLUMBIA COPPER TASK FORCE</u>, British Columbia Institute for Economic Policy Analysis, B.C., September, 1975. p.9.
13. " This figure included mining & processing facilities, as well as infrastructure, " See Simon D. Strauss, " Forecasting of Metal Prices Difficult Task, " <u>THE NORTHERN MINER</u>, January 1, 1976.
14. Louis Silver, <u>op. cit.</u>, pp.10-11.

(c) The need to increase the ratio of capital employed to labour employed in response to pressures on Canadian industry to raise productivity;

(d) The growing capital requirements of resource extraction, as conventional resources are depleted and more distant and difficult sources, such as Arctic & offshore oil drilling, are developed;

and (e) Changing social priorities, which demand investment in projects such as pollution control and mass transit.

The rate of domestic savings will have a hard time to cope with the rising capital investment needs in Canada.

Energy

Energy is the significant input in the transformation of a raw material to a processed commodity. It is estimated that more energy is consumed during the intermediate processing stage (except for sawmills, and veneer & plywood in the forest industries) than at either the extraction stage or the manufacturing stage. For example, energy consumed by the different stages of processing for the forest industries, ferrous industries and non-ferrous industries in Canada in 1969 is illustrated in Table XIII.

TABLE XIII

FUEL & POWER AS A PERCENTAGE OF VALUE ADDED, BY STAGES OF PRODUCTION, 1969

EXTRACTION		INTERMEDIATE PROCESSING		MANUFACTURING	
Forest Industries:					
Logging	4.5	Sawmills	4.2	Sash, door & other millwork	2.4
		Veneer & Plywood	3.8	Household furniture	1.9
		Pulp & Paper	13.6	Paper Box & Bag	2.0
Ferrous Industries:					
Iron Mines (including pelletizing)	9.2	Iron & Steel mills	16.2*	Fabricated Structural metal	1.6
				Ornamental & Architectural metal	1.9
				Machinery Equipment	1.5
Non-ferrous Industries:					
Non-ferrous metal Mines	3.2	Smelting & Refining	19.9	Electrical Appliances	1.

* including metallurgical coal & coke

(Source: Statistics Canada, CENSUS OF MANUFACTURERS, 1969)

In the context of copper production, it is also true that energy consumed in the intermediate processing stages (i.e. smelting & refining, and rod mills & brass mills) is higher than that needed in the mining, and fabricated metal stages (i.e. wire & cable mills). The situation is depicted by Table XIV.

TABLE XIV

ENERGY AS A % OF COST OF FACTOR INPUTS PER POUND OF CONTAINED COPPER BY STAGES OF PROCESSING IN CANADA, 1971

STAGE OF PROCESSING	ENERGY,% OF COST OF FACTOR INPUTS
Mining	3.9
Smelting & Refining	7.5
Rod Mills & Brass Mills	4.6
Wire & Cable	1.2

(Source: Adapted from the data presented by Task Force on Upgrading, op. cit., p.15)

Accordingly, promoting further processing will inevitably lead to a substantial increase in the country's long-range energy requirements. This cannot but exert a greater stress on the energy supplies in Canada at a time when estimates indicate that Canada will cease to be self-sufficient in oil and natural gas in 1980s.[15] This being the case, Canada will have to divert energy from areas such as residential and commercial heating to the industrial sector, if more processing is to occur. Such a position, when actually materialized, is likely to result in negative social repercussions, rendering it undesirable to shift energy away from uses of residential and commercial heating. As a result, Canada's ability to attract a larger share of the world's processing developments of minerals in the future tends to be restricted.

Labour

Labour shortage and high turnover rates have been plaguing the Canadian mineral industry during the last few years. For example, the extent of labour shortage by employment category represented by sixty-three Canadian mines being investigated in June-July, 1974 is portrayed by Table XV. And Table XVI illustrates the percentage labour turnover by category in 1973.

15. See National Energy Board, IN THE MATTER OF THE EXPORTATION OF OLI: REPORT TO THE HONOURABLE MINISTER OF ENERGY, MINES AND RESOURCES (Ottawa: National Energy Board, 1974).

TABLE XV

JOB VACANCIES IN SIXTY-THREE MINES IN CANADA, 1974

EMPLOYMENT CATEGORY	VACANCIES	TOTAL LABOUR FORCE	VACANCIES AS A % OF TOTAL LABOUR FORCE
Unskilled Workers	586	9,136	6.4
Skilled Miners	938	19,440	4.7
Office Workers	31	2,379	1.3
Technical Staff	105	2,315	4.5
Supervisory Staff	52	3,588	1.4
Management Staff	8	962	0.8

(Source: Mining Association of Canada, " Labour Survey Probes Problems plaguing the Industry, " CANADIAN MINING JOURNAL, May, 1975, p.27)

TABLE XVI

PERCENTAGE LABOUR TURNOVER BY CATEGORY IN THE CANADIAN MINING INDUSTRY, 1973

CATEGORY	MEAN TURNOVER, ALL MINES, UNWEIGHTED BY SIZE OF MINE	MEAN TURNOVER, ALL MINES, WEIGHTED BY SIZE OF MINE
Unskilled Labour	127.8%	77.5%
Skilled Miners	49.8%	40.5%
Office Workers	41.7%	33.0%
Technical Staff	27.6%	34.4%
Management Staff	22.2%	25.0%

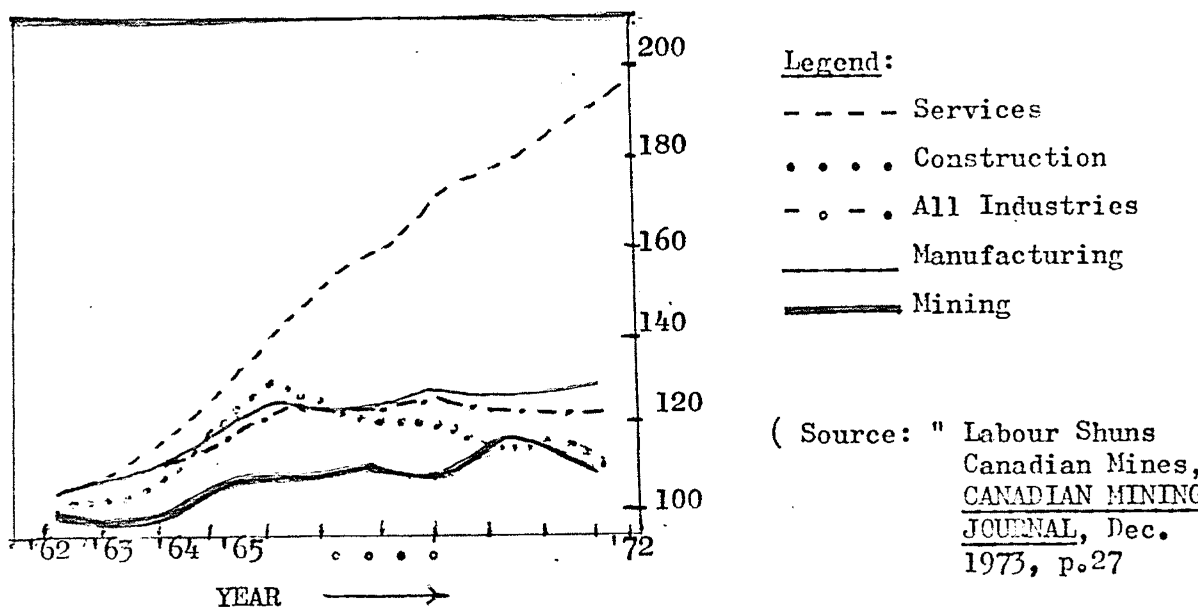
(Source: Mining Association of Canada, LABOUR TURNOVER AND SHORTAGES IN THE CANADIAN MINING INDUSTRY: PRINCIPAL STATISTICS OF THE PROBLEM, Ottawa, August, 1974)

It goes without saying that labour shortage and high labour turnover rates in the Canadian mineral industry will tend to restrain any liberal planning for further processing development within Canada. This constraint appears even more serious in view of the fact that labour requirements in mining are growing at an average rate of 2.5% for the remainder of the century, compared with the annual growth rates in mining employment of 1.5 to 2.0% during the past twenty-five years.[16] The gap between labour demand and supply is likely to widen in the years to come, especially when the number of young workers entering the workforce will decrease, owing to the relatively low birth rates in the past two decades.

Furthermore, it is estimated that the rate of growth of labour in Canada is dropping from 15.6% in 1965-70 to 9.5% in 1980-85.[17] Thus, the Canadian labour market will become much tighter by 1980s. The situation of labour supply in mining becomes even worse if the service sector continues to attract a larger portion of the total labour supply in the Canadian economy, as it has been doing during the last ten years. For instance, between 1955 and 1973, the service sector registered an increase from 47.4% to 63.2% of the total labour force.[18] Actually, compared with other industrial sectors in Canada, the service sector has been expanding rapidly since 1962, absorbing a fast growing number of workers, as illustrated by Figure 8.

FIGURE 8

EMPLOYMENT GROWTH BY SELECTED INDUSTRIES IN CANADA, 1962 - 1972 (1960 = 100)



(Source: " Labour Shuns Canadian Mines," CANADIAN MINING JOURNAL, Dec. 1973, p.27)

16. O. Fisher, THE LABOUR SHORTAGE IN MINING, a paper presented at the 77th Annual General Meeting of the Canadian Institute of Mining & Metallurgy, Toronto, May 4-7, 1975, p.2.
17. See Canadian-American Committee, THE NEW ENVIRONMENT FOR CANADIAN-AMERICAN RELATIONS (Montreal & Washington, D.C., 1972).
18. See " Panel: Mining IS Important to Canada, " CANADIAN MINING JOURNAL, April, 1976, p.26.

This being the case, the development of further processing may well have to compete for workers with other industries, especially with the service sector. In other words, ceteris paribus, policies to promote further processing will run the real risk of exacerbating labour shortages in the years to come.

The prospective labour shortage in the mid-1980s in Canada is further compounded by the nation's more restrictive immigration policies which have come into effect of late.

Transportation

The geographical size in Canada tends to discourage further processing within the country. Ores and concentrates from remote locations have to be transported to processing facilities. Accordingly, transportation costs can become a significant part of the cost factors of production, provided that the locations of mining and processing facilities of the mineral in question are near the final market to which it is sent. An example is transportation of copper through various processing stages from Vancouver to Japan. The freight cost per ton of the commodities increases with additional processing. This is shown in Table XVII.[19]

TABLE XVII

OCEAN SHIPPING COSTS BETWEEN VANCOUVER AND JAPAN OF COPPER PRODUCTS, 1973

PRODUCT	FREIGHT COST/TON
Copper ore	$ 15.00
Concentrate	15.00
Blister Copper	34.00
Refined Copper	34.00
Wire Rod	42.00
Sheet Tubing	67.00
Wire & Cable	78.00

(Source: Adapted from Lorne Sivertson, op. cit., p.33)

19. The freight rates of these materials within Canada (east-west) are of course, different from the ocean shipping costs. It may also be argued that since the tonnage of processed commodities is lower than unprocessed materials, it may be cheaper to transport processed commodities. But this is not necessarily the case, when costs of packaging, insurance, and the like incurred by processed commodities are taken into consideration at the same time.

But the final markets within and outside Canada are relatively distant from the domestic resources. Therefore, mineral ores from remote locations are likely not to be subject to the workings of a high degree of processing within Canada, unless the transportation costs can be reduced when processed commodities are shipped to the final markets.

Trade Barriers

The United States, the European Community, and Japan are Canada's major trading partners, which have long been applying (mutual) restrictive trade policies to discriminate progressively against the import of Canadian processed and manufactured goods. Canadian raw materials are allowed to enter these countries tariff-free. Table XVIII gives a bird's-eye view of this situation with regard to the major Canadian resources.

TABLE XVIII

IMPORT TARIFFS, BY STAGE OF PROCESSING, IN EFFECT IN EARLY 1973 (%), LEVIED ON CANADIAN COMMODITIES

COMMODITY \ COUNTRY		EEC	U.S.	JAPAN
Iron & Steel	Ores & Concentrates	0.0	0.0	0.0
	Unworked	3.7	3.6	5.5
	Semi-manufactured Products	6.7	7.8	10.2
Aluminium	Bauxite	0.0	0.0	0.0
	Alumina	8.8	0.0	0.0
	Unwrought	3.6	4.5	6.8
	Semi-manufactured Products	10.9	7.7	14.9
Nickel	Ores & Concentrates	0.0	0.0	0.0
	Unwrought	0.0	2.4	13.4
	Semi-manufactured	5.1	8.7	12.3
Copper	Ores & Concentrates	0.0	1.7	0.0
	Unwrought	0.0	3.9	6.6
	Semi-manufactured Products	7.4	8.0	16.5
Zinc	Ores & Concentrates	0.0	10.7	0.0
	Unwrought	2.3	11.2	3.3
	Semi-manufactured Products	9.2	7.9	10.4
Lead	Ores & Concentrates	0.0	7.6	0.0
	Unwrought	2.7	9.0	8.4
	Semi-manufactured Products	9.2	7.8	15.6
Wood	Wood and cork in the rough	1.7	2.1	0.3
	Wood-based panels	12.7	12.6	18.0
	Semi-manufactured Products	4.4	2.3	5.4
Pulp & Paper	Paper pulp & Paper waste	1.0	0.0	3.6
	Paper & Paperboard	10.1	5.5	9.2

(Source: See Louis Silver, op. cit., p.6)

With regard to copper, the import tariffs can be further broken down by stage of processing as follows.

TABLE XIX

IMPORT TARIFFS BY STAGE OF PROCESSING AS OF EARLY 1973, LEVIED ON CANADIAN COMMODITIES

COMMODITY	COUNTRY	EEC	U.S.	JAPAN
Copper :	Ores & Concentrates	0.0%	1.7%	0.0%
	Unwrought (refining shapes)	0.0%	3.9%	6.6%
	Wire Rod	8.0%	14 cents/lb.	12.0%
	Uninsulated Wire	8.0%	0.8 cents/lb.+6.0%	12.0%
	Insulated Wire & Cable	11.0%	8.5%	12.0%

(Source: See Louis Silver, ibid., p.6; and Task Force of Upgrading, op. cit., p.28.)

Accordingly, incentives for developing further processing in Canada can be better improved by negotiating with our trading partners to decrease and eliminate tariff differentials based solely on the degree of processing. The Canadian government is acting along this line, for instance, in the new " Tokyo Round " of tariff negotiations with Japan recently. Discriminatory trade tariffs are significant impediments of further processing in Canada.

Multi-national Firms

A substantial share of Canada's mining, oil & gas production is controlled by foreign-owned, vertically integrated firms. These firms open their extractive operations in Canada, so that raw materials are shipped to the processing facilities in the home countries.

The processing development of these foreign-owned integrated firms in Canada is sustained by large domestic markets in their respective home countries. This pattern of industrial activities tends to dampen some incentive to process in Canada. It also contributes toward obstructing the entry of resident-controlled Canadian firms which do not often have the same assured foreign markets.

Therefore, the industrial organization of Canada's extractive sector may also have been a factor to divert some of the processing to other countries. This, of course, by no means helps Canada's position to invest in additional processing.

3. Feasibility of Developing Further Processing of Copper in Manitoba

The various constraints to further processing described above are national in nature. But in similar situations, they hinder such industrial development on the provincial level all the same. This is especially the case when a provincial integrated industry is to be developed for additional processing. A case in point is copper in Manitoba. Thus, it is necessary to take into account these constraints, in considering any planning for developing further processing facilities for copper in Manitoba.

In view of the present elementary stage of industrial development in which the copper sector in Manitoba finds itself, it is neither economically feasible nor socially desirable to divert the necessary resources (in gigantic magnitudes) to transform large quantities of copper concentrates into semi-fabricated or manufactured products in the province, at least in the short-run. In other words, it is not feasible for Manitoba to create a fully integrated copper industry with a 'one-shot' approach, because the constraints are too nagging to overcome overnight. Besides, with the existing framework of development in the Manitoban copper sector, it takes time for the industry to progress and mature, because:[20]

> ... it takes more than industry to industrialize. Industry itself takes time to develop momentum and competitive competence ... .

However, it seems possible that processing facilities can be developed in Manitoba to convert copper concentrates into smelted or refined metal. More specifically, it appears feasible for Manitoba to consider building a copper smelter or refinery. To establish such feasibility, it is essential that sufficient copper concentrates are available for further processing in the province.

To start with, of the copper-producing companies in Manitoba, only Hudson Bay Mining & Smelting Company Ltd. smelts its copper ore in the province, whereas

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20. See W.W. Rostow, THE STAGES OF ECONOMIC GROWTH (Forge Village, Massachusetts: The Murray Printing Company, 1963), p.22.

the rest of these companies send their copper concentrates either to the Hudson Bay Mining & Smelting Company Ltd. or to processing facilities outside of Manitoba. In addition, there is no refinery facilities for copper in Manitoba. The copper smelting facilities are located in Flin Flon, which consist of some roasting furnaces, one reverberatory furnace and three converters, with a smelting capacity equivalent to more than 50,000 short tons of blister copper per year.[21] Compared with a forecast annual production of copper 100,000 short tons in Manitoba,[22] it appears feasible to build an additional smelter with a similar capacity (with that in Flin Flon) in Manitoba, subject to the co-operation of the Manitoban copper-producing companies to retain the copper concentrates in the province for smelting, instead of contracting them away to companies and facilities outside of Manitoba with long-term contracts.[23] For instance, Sherritt Gordon Mines Ltd. is committed until 1980 to ship the copper concentrate produced in its Fox Mine to Mitsubishi Metal Company in Japan.

It is pointed out that at present Manitoba will find it difficult to build a conventional copper refinery in the province. This is so because, among other things, the current supply of smelted copper in Manitoba is not sufficient enough to warrant the construction of even an economic minimum-sized copper refinery. The explanation runs like this:[24]

> A (copper) refinery with a capacity of 100,000 tons annually would require Manitoba's entire projected production from existing mines, including that which is committed under long term contract until the mid-1980s. Such an operation, then, would require inputs from all companies operating in Manitoba. ... the divertion of large quantities of scarce capital to a Manitoba refinery would be ill-advised, since the proposed facility would be unprofitable until approximately 1985. This conclusion is reinforced by the findings of

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21. The actual annual capacity at the Flin Flon smelting facilities for copper is rated at 575,000 tons of copper ores and concentrates. See REPORT OF THE TASK FORCE ON MANITOBA MINERALS POLICY, op. cit., p.205.
22. See Department of Industry & Commerce, SOME FACTORS AFFECTING THE ESTABLISHMENT OF A COPPER REFINERY IN MANITOBA, Manitoba, 1971, p.5.
23. This co-incides with the opinion expressed by REPORT OF THE TASK FORCE ON MANITOBA MINERALS POLICY, op. cit., pp.281-2.
24. See REPORT, ibid., pp.283-4. However, it is suggested in the REPORT that a smaller copper refinery can be feasible in 5 to 15 years, subject to " expected technological breakthrough of a leaching process for refining copper ... (to) make small refineries commercially viable. "

a department review which indicated that a large Manitoba refinery may never be competitive if proposed new facilities in northern Ontario become operational.

Therefore, the availability of copper concentrates for smelting and refining seems to constitute at present the most serious constraint to further processing of copper. Besides, the capital-intensive nature of these economic developments may provide another significant disincentive for private investment in additional processing of copper in Manitoba, especially when such investment only brings back a relatively low rate of return.[25] The capital investment required to build a world-scale copper smelter/refinery complex of 125,000 tons per year capacity, for example, has recently been estimated with brief breakdowns in Table XX below.

TABLE XX

CAPITAL INVESTMENT REQUIREMENTS FOR A COPPER SMELTER/REFINERY COMPLEX OF 125,000 TONS PER YEAR CAPACITY*

PLANT COSTS			(1,000 DOLLARS)
Smelter			55,250
Refinery			39,000
Acid Plant			20,750
Owners Costs:	Project Team	2,200	
	Smelter Staff	3,300	
	Engineering fee	6,000	
	Licence	1,000	
		13,500	13,500
10% Contingency			12,750
Development Interest			21,000
Working Capital			19,000
TOTAL			181,250

* Based on 300-day operating year and 90% recovery.

(Source: Adapted from Department of Economic Development, REPORT OF THE BRITISH COLUMBIA COPPER TASK FORCE, B. C., 1975, p.76)

25. For instance, it is asserted that " The chief obstacle to private investment in a B.C. smelter/refinery is the expectation of a low rate of return. B.C. firms in 1974 paid an average of 13.5 cents per lb. in smelting & refining charges and 3.5 cents per lb. for transportation of concentrates to Japan. A B.C. smelter/refinery charging 20 cents per lb. for treating and refining concentrates would earn approximately 9% on investment after tax. " See Lorne Sivertson, op. cit., p.35.

Indeed, because of the capital-intensive nature of an integrated copper industry, potential producers must require a copper price of at least 80 cents to 90 cents per lb. in order to justify the investment,[26] to mine and process relatively low grade ores. With world copper price fluctuating and dipping below 70 cents per lb. these days,[27] investment for mining, let alone further processing, of copper tends to be greatly discouraged, unless an upturn of copper price is achieved. This can hinder Manitoba's investment adventures in further processing of copper.

It is suggested that conventional processing may give way to hydro-metallurgical processing in the future. Compared with conventional processing, hydro-metallurgical processing has at least these advantages: (a) it bypasses the conventional smelting processing — hence more economical; (b) it produces less negative environmental impact; and (c) it would permit the construction of a plant with a small production capacity. With technological breakthrough, it may soon be feasible to build a hydro-metallurgical plant which is commercially viable.[28]

4. Some Reflections on Further Processing of Copper in Manitoba

Considerations for developing further processing of copper in Manitoba hinges on the ability of the province to supply sufficient inputs of copper concentrates. The ore reserves of copper in Manitoba may well be sufficient to warrant the establishment of an additional smelter of 50,000 tons per year; but it is important to have more propecting work done, so as to discover or confirm ore bodies in the province, with an eye to ' build up ' the inventory to sustain the supply of copper concentrates for the years to come. This is

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26. See Simon D. Strauss, THE NORTHERN MINER, op. cit.
27. For instance, in 1975, the price of copper wirebars on the London Metal Exchange stayed at 52 to 55 U.S. cents per lb. In the same year, the Canadian producers' price of copper declined from 75 cents per lb. to 63.375 cents per lb. for the balance of the year. However, it is forecast that the copper price will rise to 70 cents a lb. at the end of 1976, with further increase in 1977. See G.E. Wood, " Copper, " CANADIAN MINERAL JOURNAL, February, 1976, p.73; and Frank Kaplan, " Copper Resurgence in the Offing, " CANADIAN MINING JOURNAL, March, 1976, pp.8-9.
28. I am indebted to Mr. H. Bloy, Executive Secretary of the Mining Association of Manitoba, Inc. for this idea.

especially necessary when investment in smelters and refineries is of a long-term developmental nature, plus the fact that there is on average a time lag of six years between discovery to initial production for any mines.

The capital investment requirements for establishing a copper refinery may be reduced if technology permits a small-sized refinery to be commercially viable. A possibility exists with a technological breakthrough of leaching process for refined copper. When the situation materializes, the investment incentive for establishing further processing facilities for copper in Manitoba can be greaterly augmented. Furthermore, the opportunities for such industrial development will become more economically meaningful.

In terms of value added, smelting & refining of copper brings home a rate of return much lower than those achieved at the extractive and fabricating stages.[29] Therefore, co-operation and mutual understanding between the Manitoban government and the metal industry must be attained, so as to share the responsibilities between them for investing in additional processing of copper, when such opportunities are present. The financing of further processing of copper in Manitoba, situations permitting, must involve public and private investment endeavours.

Copper is a commodity that has a highly volatile price structure within a period of time. This is primarily because copper seems to respond sensitively to the ebb-and-flow of the forces of supply and demand. Accordingly, investment in further processing of copper in Manitoba must take into account the highs and lows of copper prices, in order that the timing of investment in such industrial development may be more accurately assessed. This is especially important for long-term investment planning.

Further processing can certainly generate significant economic benefits and industrial diversification. In the case of copper in Manitoba at present, heavy odds are against even the establishment of a refinery with an economic size, mainly because the supply of copper concentrates does not appear to be so promising to sustain sufficient inputs into the capacity production of the

29. See Table XX, supra.

refinery. Taking into consideration other constraints (that have been described), one can easily visualize that any large-scale further processing for copper may be merely an academic discussion. This being the case, the economic gains associated with the development of further processing of copper in Manitoba are imaginery rather than real. The feasibility of overcoming these various constraints must be established before there is any hope of realizing the economic gains associated with further processing.

In this perspective, therefore, the need for Manitoba to develop further processing facilities for copper should not be a foregone conclusion. More in-depth research must be conducted in the areas that may restrict further processing. This will enable policy-makers to assess more meaningfully the feasibility of such economic development in Manitoba.

CHAPTER FIVE

TOWARDS A MINERAL POLICY OF COPPER FOR MANITOBA

1. The Objectives of a Mineral Policy in Canada

The national policy of Canada is based on six stated themes, namely:[1] fostering economic growth; safeguarding sovereignty & independence; working for peace & security; promoting social justice; enhancing the quality of life, and securing a harmonious natural environment. Naturally, these themes have formed the basis upon which any Canadian domestic and foreign policies are made. Accordingly, a workable mineral policy in Canada must be compatible with these national values. As a matter of fact, in 1973 the federal and provincial governments arrived at a set of mineral policy objectives basically devised in this national spirit. These objectives are grouped under three separate headings, and are listed as follows:[2]

I. Quality of Life

(a) Relate Mineral Development to Social Needs;

(b) Minimize Adverse Effects of Mineral Development on the Environment;

II. Sovereignty & Unity

(a) Ensure National Self-determination in Mineral Development;

(b) Contribute to Orderly World Mineral Development & Marketing;

(c) Strengthen the Contribution of Minerals to Regional-National Development;

III. Economic Growth & Development

(a) Foster a Viable Mineral Sector;

(b) Ensure Mineral Supply for National Needs;

(c) Improve Mineral Conservation & Use;

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1. For a brief discussion of these policy themes and the emerging policy pattern based on these themes in Canada in the 1970's, see FOREIGN POLICY FOR CANADIANS, Information Canada, Ottawa, 1971, pp.14-16 and pp.34-39.

2. See MINERAL POLICY OBJECTIVES FOR CANADA, Ottawa, 1973, p.19. It is observed that more realistically the issue is tax, royalties, and other revenues. These stated objectives may be used as the rationale to get to these revenues. I am indebted to Dr. P.E. Nickel, Professor & Director of the Natural Resource Institute, for this keen observation.

(d) Realize Opportunities for Further Mineral Processing;

(e) Harmonize Multiple Resource Development;

(f) Strengthen Knowledge Base for National Decision-making;

and (g) Increase the Return to Canadians from Exportable Mineral Surpluses.

These objectives constitute a framework within which any further discussion and subsequent contemplation of mineral policy in Canada are made. The ultimate goal of a mineral policy based on the realization of these objectives is to " obtain optimum benefit for Canada from present and future use of minerals. "

Accordingly, it is not difficult to visualize that a mineral policy tends to encompass a wide range of interactions between the public and private sectors in our society. This initiates significant economic and social implications of mineral development on the Canadian economy. Indeed, a mineral policy is defined as:[3]

> ... the sum of government decisions and actions that influence the mineral system, and the ways in which the system itself affects the economy and society in general. Its elements are diverse and continually changing. Mineral policy contains more than laws and regulations that directly influence mineral exploration, extraction and processing. Other policy elements include export-import permits, regional development funds, pollution control laws, taxation, and social development programs.

Therefore, to contribute to the economic and social well-being of the nation, any mineral policy being contemplated at the provincial level must be tailored to the national interests. This being the case, it seems fair to say that in terms of initiating any policy considerations for copper in Manitoba, the policy framework described above also applies. In other words, from Manitoba's standpoint, the mineral policy to develop copper within the province should address itself generally to the same objectives — i.e. quality of life, sovereignty & unity, and economic growth & development. In addition, the ultimate goal of

3. See TOWARDS A MINERAL POLICY FOR CANADA, op.cit., p.11.

such industrial development is, of course, to benefit the Manitobans, by bringing home optimum economic gains in the province, a là the national policy aspirations. However, federal-provincial mutual understanding and co-operation must be attained, in order to avoid conflicts between the two senior levels of government over resource issues, in view of the fact that:[4]

> ... the action of governments are becoming increasingly interdependent. Any policies which ignore this fact and express the needs of one level of government at the expense of another will be self-defeating.

Actually, a workable mineral policy of copper in Manitoba seeking to actualize the foregoing objectives, will find itself attuned to a number of major measurable economic targets. These include the following: full employment, increase in per capita income, increase in value added, rise in provincial product, and economic growth. An achievement of these favorable targets automatically brings benefits to the Manitobans, in conformity with the Canadian national values.

2. The Economic, Social, Environmental, and Political Considerations of a Mineral Policy

Minerals are significant primary resources which are indispensable bases upon which civilization is built. Iron and copper are oft-quoted classical examples. Indeed, throughout the civilization advancement of human beings, the transformation of an " agricultural " society into an " industrialized " economy is dependent on the ability to exploit the metals and non-metallic minerals in the ground. Social progress is readily achieved through the exploration, extraction, and development of minerals.[5] These activities in turn, bring about a diversity of economic developments such as these: marketing, management, transportation, education, technology, and research. Such developments are basic ingredients of

4. See R.M. Burns, CONFLICT AND RESOLUTION IN THE ADMINISTRATION OF MINERAL RESOURCES IN CANADA (Kingston, Ontario: Centre for Resource Studies, Queen's University, 1976), p.viii. The study offers a good discussion of the recent federal-provincia conflicts in the resource industry in Canada, and instils valuable insight into the resolution of these conflicts.
5. These range of activities basically constitutes the mineral system which is defined as: " ... a series of activities that begins with the location of resources in the ground and ends with final consumption. " See TOWARDS A MINERAL POLICY FOR CANADA, op. cit., p.10.

an industrialized market economy.

Accordingly, a mineral policy must take into account the various aspects of our society. Specifically, any policy that attempts to monitor the development of a mineral resource will naturally involve policy considerations of an economic, social, environmental, and political nature. These various considerations are inter-related; and as such, they must be viewed as basic ingredients comprising a effective mineral policy.

Generally speaking, employment, income, and value added are desirable goals of a mineral policy. These goals are attained amidst a efficient allocation of resources.[6] Accordingly, the underlying economic theme upon which economic decisions are based, lies in the pursuance of the Pareto Principle. More specificall when an economic rearrangement takes place (resultant from a mineral policy, for example), some people stand to gain, whereas others are bound to lose. The welfare criterion for an economic change, therefore, lies in the realization of a <u>potential</u> Pareto improvement which is defined as:[7]

> ... an economic change in which the gains be so distributed as to make everyone concerned better off ... requiring that gainers be able to over-compensate losers.

As a matter of fact, a workable mineral policy must look beyond the window of mere economics, as it were, to take into account the social needs and wants. For instance, the building of a mining town is a case in point. It may well be expensive to provide for the infrastructure (i.e. schools, housing, transportation, etc.) which is essential for the establishment of a town. But it is necessary to come up with such investment, irrespective of the economics of the individual mining projects on the site, if the basic social needs and wants of the people (as defined by this so-called affluent society) to be located in the mining town being contemplated, are to be satisfied. This is especially the case when the government attempts to encourage regional economic development in the context of promoting the " stay option. " By the same token, the closure of a mine upon

6. An excellent discussion of allocative efficiency of resources is furnished by Francis M. Bator, " The Simple Analytics of Welfare Maximization, " <u>AMERICAN ECONOMIC REVIEW</u>, March, 1957.

7. See E.J. Mishan, " Cost-benefit Rules for Poorer Countries, " <u>CANADIAN JOURNAL OF ECONOMICS</u>, Vol. IV, No.1, February, 1971; for an illustrative discussion of the so-called Compensation Principle as a welfare test, see N. Kaldor, " Welfar Propositions in Economics, " <u>ECONOMIC JOURNAL</u>, 1939, and J.R. Hicks, " The Foundations of Welfare Economics, " <u>ECONOMIC JOURNAL</u>, 1939.

mineral exhaustion will initiate a host of social problems in the local community. Indeed, the mining town in question may degenerate into abandonment. Therefore, there must be some contribution in the mineral policy to take care of the social aspects which arise from the economic development of mineral resources.

Mineral development and environmental degradation seem to go hand in hand. Air and water pollution, and landscape deterioration are inevitable by-products of extraction, processing, and fabricating of minerals. These undesirable elements represent very expensive social costs.[8] Policy-makers of mineral resource development will find it impossible to <u>eliminate</u> this form of social cost, but they certainly can try to devise policies to <u>minimize</u> the magnitude of it. This is especially important in view of the fact that misguided exploitation of natural resources tends to destroy the resources (e.g. fish, wildlife, etc.) upon which existing communities depend. Therefore, a effective system of mineral policy, when exercised to bring about a regional development, must be able to leave room for the establishment of a harmonious relationship between economic development, the native people, and their resources.

Resource management is irrevocably locked in politics. As a matter of fact, sound political action is the key to successful resource management. This is because resource problems are more political than economic. In other words, if politics is favorable, the economy can adjust in the process of mustering such appreciation and understanding of resources in relation to culture, technology, civilization, and social achievements. Accordingly, a workable mineral policy is better effected than otherwise by favorable political actions which are intended to help the public accept ways of life more consonant with the exploitation of mineral resources.

In view of the many-faceted nature (i.e. in terms of the economic, social, environmental, and political implications) of the development of a mineral resource, a co-ordinated approach to mineral policy is absolutely essential. This

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8. For a thorough and excellent discussion of the nature of social cost, see Ronald Coase, " The Problem of Social Cost, " <u>JOURNAL OF LAW AND ECONOMICS</u>, October, 1960.

will be devised in such a manner as to take account of all relevant factors conducive to improving the relationship between the standard of living, economic growth, and resource use. More specifically, mineral development must involve consistency and co-ordination in the many separate and individual policies affecting the mineral industries and the many policy areas within the mineral field. This is mainly because many policies that have significant bearings on mineral development are really those within other policy areas. For example, the special tax treatment for encouraging further processing of minerals cannot be considered merely as an element of mineral policy; for it is equally part of the taxation policy. Again, there is the matter of environmental policy as it affects the mineral industry and mineral use by the consumer (e.g. pollution standards and pollution control). But this policy can have results of much greater significance than some aspects of mineral policy *per se*.

It goes without saying that the foregoing general theme should apply to any mineral policy being contemplated for the development of copper in Manitoba. Indeed, the underlying principle in the modern theory of economic policy suggests that in order to secure a stated number of objectives, the government needs to operate an equal number (at least) of different policy instruments. It is only in exceptional circumstances that the same instrument can secure the attainment of more than one objective simultaneously.[9] This being the case, the economic well-being and the social welfare of the Manitobans can only be guarded against any misguiding mineral resource management by means of policies that give careful attention to the economic, social, environmental, and political claims of mineral development.

3. A Co-ordinated Approach to Copper Development in Manitoba

It seems possible that Manitoba can improve the supplies of copper concentrate within the province, if the undiscovered mineral reserves in northern Manitoba[10] are

9. For an excellent discussion of this issue, see J. Tinbergen, ON THE THEORY OF ECONOMIC POLICY (Amsterdam: North Holland Publishing Co., 1952), Chapters IV & V.

10. See Section 4, Chapter Two, *supra*.

to be discovered and mined. Actually, it is desirable to prospect further for these undiscovered copper endowment in Manitoba, particularly in the face of any contemplation to develop further processing facilities for the metal in the province. Basically, it can be argued that the availability from dependable sources of copper concentrate is the essential ingredient of any long-term planning for copper development. This being the case, it is necessary for Manitoba to initiate a co-ordinated copper policy of improving the supply situation of copper from existing as well as new sources within the province.

A co-ordinated copper policy in Manitoba requires significant considerations such as these:

(a) that mutual understanding and co-operation between the federal and provincial governments be promoted and secured, especially in the context of minimizing the conflicts over the sharing of the revenues derived from the exploitation of mineral resources;

(b) that sufficient incentives be provided by the provincial government to enable extensive prospecting for copper, and to support the tremendous research and investment efforts that are required;

(c) that the development of copper be generally subject through the price mechanism to the workings of supply and demand;

(d) that the development opportunities and constraints be identified within the range of activities from extraction, processing, fabricating, and manufacturing of copper;

(e) that the timing of mineral investment be manipulated to keep pace with the political and economic reality within Manitoba, in harmony with the rest of Canada;

and (f) that mineral development be planned in such a way as to strike a rational balance between economic growth and environmental protection, so as to minimize environmental degradation, in conformity with acceptable national standards.

To realize such a co-ordinated mineral policy for copper, the government and industry must get together in a joint effort to work for the common good of the Manitobans. For the government and resource industry, a significant and obvious basis of common interest in developing copper in Manitoba may well be an increase in revenue. But it certainly takes tremendous mutual understanding and co-operation between the public and private sectors beyond the sole motive of economic gains to bring about a satisfactory performance of copper development in the province.

4. A Concluding Remark

While investment in further processing can bring home economic benefits and diversification, the decision on such industrial development is by no means a foregone conclusion. Specifically, to attain the economic gains associated with further mineral processing, a price must be paid. Naturally, two aspects must be at once considered, viz: (a) whether or not the country is capable of paying the price of further processing; and (b) if so, whether or not the benefits obtained are over-balancing the costs incurred, so that it is worthwhile to pay the price for further processing. Underlying the analysis of these issues is a careful examination of the workings and opportunities of the allocative efficiency of the resources subject to a set of constraints in the domestic economy in relation to the outside world.

In broad terms, therefore, policy-makers must look into the areas which may impede the development of further processing in the domestic economy. Upon establishing the feasibility of such industrial development, it is then necessary to identify the more lucrative investment opportunities in the various development phases of the mineral industry. But it is significant to devise the mineral policy within the political and economic reality of the country. For example, it may well be the fact that value added is the highest in the metal manufacturing stage and that smelting and refining yield substantially lower returns. But it may be necessary to sacrifice the more lucrative profits of metal manufacturing, and promote smelting and refining instead, so as to foster an integrated mineral industry, situations permitting. This is especially important in long-term investment planning, since the development of metal manufacturing, in this case, hinges on the supply of refined minerals from the domestic economy.

In the event that the government is contemplating intervention, careful consideration must be given to the repercussions on the investment climate of the country. If the risk of causing ' a fright of capital ' outside of the country as a result of the government actions is too high, the government's efforts are at best self-defeating and at worse scaring away investors and entrepreneurs who may not come back again for a long time. Also, any tampering with the natural market mechanism through government intervention must be based on this principle: that the natural market forces and business setting are not meddled with to such an extent that competition in the private sector is severely hampered beyond remedy. At the same time, a stockplie of supportive policy instruments must be ready for use to minimize the impact of a reduction of competition in the private sector, by promoting competitive business behaviour when the situation sees fit.

On the other hand, when the government decides to encourage further processing by subsidy through, for example, tax concession, such actions are only meaningful when the government subsidies do not become eventually a permanent form of sunken costs which are unrecoverable. More importantly, such subsidies must not be transformed into an unremediable liability for the government (and hence the domestic economy) to bear in the process of promoting further processing.

APPENDIX A

STANDARD INDUSTRIAL CLASSIFICATION
MINING AND MINERAL MANUFACTURING

Division 4 - Mines (including Milling), Quarries & Oil Wells

Major Group 1 - Metal Mines

Industry No.	
051	Placer Gold Mines
052	Gold Quartz Mines
057	Uranium Mines
058	Iron Mines
059	Miscellaneous Metal Mines

Major Group 2 - Mineral Fuels

061	Coal Mines
064	Crude Petroleum and Natural Gas Industry

Major Group 3 - Non-Metal Mines (except Coal Mines)

071	Asbestoes Mines
072	Peat Extraction
073	Gypsum Mines
079	Miscellaneous Non-Metal Mines

Major Group 4 - Quarries & Sand Pits

083	Stone Quarries
087	Sand Pits or Quarries

Major Group 5 - Services Incidental to Mining

096	Contract Drilling for Petroleum
098	Other Contract Drilling
099	Miscellaneous Services Incidental to Mining

Division 5 - Manufacturing Industries

Major Group 12 - Primary Metal Industries

Industry No.	
291	Iron & Steel Mills
292	Steel Pipe & Tube Mills
294	Iron Foundries
295	Smelting & Refining
296	Aluminium Rolling, Casting & Extruding
297	Copper & Copper Alloy Rolling, Casting & Extruding
298	Metal Rolling, Casting & Extruding, n.e.s.

Major Group 17 - Non-Metallic Mineral Products Industries

351	Clay Products Manufacturers
352	Cement Manufacturers
353	Stone Products Manufacturers
354	Concrete Products Manufacturers
355	Ready-Mix Concrete Manufacturers
356	Glass & Glass Products Manufacturers
357	Abrasives Manufacturers
358	Lime Manufacturers
359	Miscellaneous Non-Metallic Mineral Products Industries

Major Group 18 - Petroleum & Coal Products Industries

365	Petroleum Refineries
369	Miscellaneous Petroleum & Coal Products Industries.

(Source: Statistics Canada, STANDARD INDUSTRIAL CLASSIFICATION MANUAL, Third Edition, Ottawa, Information Canada, December, 1970.)

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